Who takes risks when and why:

Determinants of changes in investor risk taking

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Abstract

Between September08 to June09, a period with significant market events and fluctuations, we surveyed UK online-brokerage customers at three-months intervals for their willingness to take risk, three-months expectations of returns and risks for the market and their own portfolio, and self-reported risk attitude. This unique dataset allowed us to analyze (a) how risk and return expectations, risk attitudes, and risk taking changed over time, (b) whether changes in risk taking were related to changes in expectations and/or risk attitudes, and (c) how changes in risk and return expectations related to recent objective changes in market returns and volatility. Risk taking decreased substantially from September08 to March09, and then increased again by June09. Self-assessed risk attitude on average remained stable over this time period, while return and risk expectations changed. Objective/numeric assessments of return and risk expectations were significantly but not very highly correlated with subjective/affective judgments of the same quantities. Consistent with the risk-as-feelings hypothesis, observed changes in risk taking between periods were associated with changes in subjective expectations of market portfolio risk and returns, but not with changes in numeric predictions of market returns and their volatility, and also not with recent experienced changes in stock market performance. Our findings have implications for investment risk communication and investor education, since we show that changes in risk taking are related to subjective risk and return expectations that are not necessarily accurate.

Keywords: Risk Taking, Risk—Return Models, Risk Attitude, Risk Expectation, Return Expectation

1 Introduction

The recent global financial crisis and its aftermath bring questions about risk taking back to the fore. What determines how much risk private investors take? How and why does risk taking change when shocks to the system occur? How long do such changes in risk taking last? Malmendier and Nagel (2011malmendier) found long lasting cohort effects in investors who experienced the great depression but today's investors and their experiences are very different, and today's economic depressions of shorter duration may not have the same impact.

The recent financial crisis also renewed calls for greater consumer information and protection, initiatives that require better knowledge about the investment decision processes of the public. Consumer finance has recently been identified as a field vastly understudied given its importance to the national and international economy (Campbell et al, 2011; Campbell, 2006; Tufano, 2009), at least in part because the economic transactions of individuals and households are hard to observe and interpret with traditional economic methods. As a result, psychologists and behavioral economists start using panel data, where representative sets of respondents answer questions about their values, beliefs, and expectations[1], which (together with socioeconomic variables) can then be related to their hypothetical or real choices. Far from being a negative, the hypothetical nature of investment decisions like the ones used in our study allows people to show what they would do, based on their beliefs and expectations at a specific point in time, without constraints by inertia or other factors (for an overview of the pros and cons of survey data see

[1] E.g., in the US, the University of Michigan Health and Retirement Study (HRS) survey http://hrsonline.isr.umich.edu/index.php?p=qnaires and the Survey of Economic Expectations http://www.disc.wisc.edu/econexpect/Index.html; in Germany, the ZEW Bankprognosen survey http://www.zew.de/de/publikationen/bankprognosen/index.php and the Socio-Economic Panel http://www.diw.de/deutsch/soep/29004.html.

Manski (2005)). By repeating such surveys over time, we can assess the effect of external events on beliefs and expectations and test the strong assumption that decision makers have objectively correct (i.e., rational) expectations.

Our online survey, designed in collaboration with the behavioral finance team at *Barclays Wealth*, questioned the bank's online-brokerage customers between September08 and June09 in three-months intervals about their expectations of risk and returns of market and personal portfolios, their risk attitudes, and hypothetical risk taking behavior. Figure 1 charts the Financial Times Stock Exchange (FTSE) share index of all eligible companies listed on the London Stock Exchange's main market (630 constituents) over the time period of our surveys, showing that this was a period of high stock market uncertainty and volatility, beginning in September08 before some important financial crisis events (around Lehman Brothers and AIG in the US, and around Northern Rock, HBOS, and other banks in the UK) and continuing through some additional declines and then some market recovery in 2009. Our respondents were online investors who frequently trade in stocks and other securities, providing greater external validity to our results than those of studies that have used student samples (e.g., Baucells and Villasis, 2010; Harrison et al., 2005).

Insert Figure 1 here

All four surveys measured financial risk taking with the task of investing £100,000 either into the U.K. stock market (FTSE-All-Share) or into a risk free asset with a guaranteed interest rate of 4%. Greater percentages invested into the stock market are indications of greater risk taking. We expected changes in risk taking over the period of the survey, given external events. Commenting on the financial crisis in September08, the New York Times reported that "investors around the world frantically moved their money into the safest investments like Treasury bills",

and changes in risk taking have also been reported in other situations (Staw, 1976; Thaler and Johnson, 1990; M. Weber and Zuchel, 2005; Malmendier and Nagel, 2011). However, it is still an unresolved question what drives such changes in risk taking. Our goal was to decompose risk taking into different contributing variables and to examine the influence of changes in these components variables on any observed changes in risk taking.

Classic portfolio theory (Markowitz, 1952) assumes that risk taking depends on investors' risk attitude as well as on the investors' return and volatility (variance) expectations:

Risk Taking = f(Expected Value, Expected Volatility, Risk Attitude). (1)

A more general risk-return framework (Sarin and M. Weber, 1993; E. Weber and Milliman, 1997; Jia et al., 1999) also allows for heterogeneous beliefs about the riskiness and the returns of investments:

Risk Taking = f(Return Expectation, Risk Expectation, Risk Attitude). (2)

In such psychophysical risk-return models (E. Weber and Johnson, 2008), changes in risk taking can thus be the result of changes in one or more of these three determinants of risk taking:

ΔRisk Taking = f(ΔReturn Expectations, ΔRisk Expectations, ΔRisk Attitude). (3)

A better understanding of the determinants of investor risk taking is not only of theoretical interest, but also has practical implications, as it can inform existing financial regulatory requirements in Europe and ongoing discussions about such regulation in the United States. Thus the Markets in Financial Instruments Directive (MiFID) by the European Parliament and the European Council (2004 and 2006) requires investment firms to obtain "information as is

necessary for the firm to understand the essential facts about the customer (Article 35, 1)" and to elicit the customers' "preferences regarding risk taking, his risk profile, and the purpose of the investment (Article 35, 4)." However, MiFID provides no guidelines about how or how often investment advisors need to elicit risk preferences and risk profiles, and what "essential facts about the customer" should be collected. To close this gap, our study examines how best to assess risk attitudes and risk and return expectations, whether risk attitudes and/or risk or return expectations of investors change over time, and which of these changes impact risk taking.

This elicitation was done in two different ways. Numeric judgments of best guess (median) percentage returns and expected volatility in returns (computed from median, worst-case (5% percentile), and best-case (95% percentile) percentage return estimates) can serve as proxies of individual investor beliefs most closely related to the return and risk variables of the classical risk—return model of risk taking of Equation 1. In contrast, elicitations of investors' more qualitative risk and return expectations on subjective rating scales (ranging from 'extremely bad' to extremely good' for returns, and from 'not at all risky' to 'extremely risky' for risk) allow investors to incorporate feelings of hope or fear (Loewenstein at al., 2001), i.e., sentiments that may not make it into numeric estimates of such quantities but may nevertheless determine financial decisions (Barberis et al., 1998; Baker and Wurgler, 2006; E. Weber and Hsee, 1998). Building on results for expected risk by E. Weber at al., (2005), we predicted and found that the numeric and subjective measures of risk and return expectations were not highly correlated and that subjective expectation measures predicted risk taking far better than numeric expectations.

As shown in Figure 2, risk taking (i.e., the percentage of their hypothetical £100,000 stake they would invest into the U.K. stock market for the next three months) changed significantly over

the surveyed period. Investments into the risky asset (vs. a guaranteed 4% return asset) dropped from 56.0% in September08 to 52.8% in December08, and even lower to 46.5% in March09, but then increased again to 53.5% in June09. Over that same time period, self reported risk attitudes (further described below) were stable on average. In contrast and also shown in Figure 2, subjective market portfolio risk expectations and return expectations, the measures most predictive of risk taking, changed across assessment periods. Changes in risk expectations mirrored changes in risk taking, with risk expectations increasing from September08 to December08, staying at the same level in March09, and then decreasing in June09. Very surprisingly, subjective market portfolio return expectations showed a small but significant and steady increase from September08 to June09. Previewing our results, changes in risk taking were explained by changes in subjective risk and return expectations for the market portfolio and not by any changes in self-reported risk attitude. This result remains stable even when we control for investors' recent (previous three months) personal stock market experience and for memories of recent market performance.

Insert Figure 2 here

These results have important practical implications, showing that risk attitude (measured in the way we did, with the distribution of responses shown in Figure 3) is a stable individual difference that does not need to be elicited repeatedly. In contrast, subjective risk and return expectations change with external market events, though not necessarily in a rational way. This suggests more frequent assessment of these quantities and some educational interventions to correct faulty expectations.

Insert Figure 3 here

Our results extend the empirical and experimental literature on risk taking in several important ways. Whereas previous studies have documented changes in risk taking, using either field data **(**Brunnermeier and Nagel 2008 and Malmendier and Nagel, 2011) or lab data in reaction to prior gains and losses (Thaler and Johnson, 1990; M. Weber and Zuchel 2005)), our study is the first to identify mediators of such changes (namely changes in subjective risk and return expectations), and to do so for a sample of online investors. Previous studies that examined changes in expectations and/or risk attitudes looked at only one of these variables in isolation (i.e., risk expectations (Glaser and M. Weber, 2005; E. Weber and Milliman, 1997), return expectations (Shiller et al., 1996; Johnson et al., 2004; Hanoch et al., 2006), risk attitudes (Sahm, 2007; Klos, 2008)), and most of these studies did not relate changes in expectations and risk attitudes to changes in risk taking. In addition, we extend the results of Vissing-Jorgensen (2003) and Dominitz and Manski (2007), who used survey data to show that greater expected equity returns were associated with a greater probability of holding stocks, in several ways: by including risk expectations and risk attitudes as predictor variables, by examining changes in return and risk expectations and their influence on changes in risk taking, and by using a different measure of risk taking, namely asset allocation. Finally, we extend results about the superiority of subjective (over numeric) judgments of risk to predict risk taking (E. Weber et al., 2005) to show that the same is true for subjective (over numeric) judgments of returns.

Section 2 of this paper provides an extended literature review that motivates our hypotheses. Section 3 presents information on survey respondents and the survey design. The main results are reported in Section 4, and Section 5 discusses the implications of our results.

2 Theory and Hypotheses

Anecdotal evidence suggests that risk taking of personal investors, i.e., their allocation of wealth to risky and risk free assets, can substantially vary over time and in response to market events. According to the Deutsche Aktieninstitut (2008), 6.2 million people in Germany directly held part of their wealth in stocks in 2000 at the height of the internet boom, whereas this number dropped to only 3.5 million by the end of 2008, in the course of the financial crisis. The Wall Street Journal (2008) similarly reports in an article on December 5, 2008 that, in response to the dramatic events on financial markets, investors pulled $72 billion from stock funds in October alone and moved their money into government bonds and cash holdings.

Lab studies also show that risk taking is far from stable. Because preferences are constructed and stochastic, small differences in choice context can sometimes lead to preference reversals (Lichtenstein and Slovic, 2006). Camerer (1989) and Hey and Orme (1994) gave respondents the same set of choice options twice, about 10 days apart, and found that 25%-30% of choices were different across the two time periods. Staw (1976) showed that risk taking substantially depended on previously experienced outcomes, with respondents taking significantly more risks on the same investment opportunity following a loss than a gain, a phenomenon he labeled escalation of commitment. This is consistent with the disposition effect identified by Odean (1998) and M. Weber and Camerer (1998), where investors are more reluctant to sell losing stocks than winning stocks. Thaler and Johnson (1990), on the other hand, found the reverse effect, i.e. enhanced risk taking after gains than after losses, which they called the house money effect. M. Weber and Zuchel (2005) subsequently reconciled the conflicting escalation of commitment and house money effects by showing that the framing of the situation matters. The

"house money effect" is prevalent when the situation is framed as a lottery, whereas the escalation of commitment effect is predominant when the situation is framed as an investment. E. Weber at al. (2002) also found differences in risk taking for risky financial choices when choices were described as gambling decisions than when they were described as investment decisions.

These studies show that the personal experience of winning or losing can influence subsequent risk taking in independent risky, presumably because the affective reactions to prior gains or losses influence perceptions or feelings of risk and/or return of subsequent choice options (Loewenstein et. al., 2001). In other situations outcome feedback has a learning function. Positive or negative outcomes provide additional information about to be expected future returns and risks of this option. E. Weber et al. (2004) showed that risk taking is more variable for decisions from experience (where the decision maker must gradually learn about choice options from repeated outcome feedback), especially when low probability events are involved, than for decisions from description (where outcomes and their likelihood are numerically or graphically described). This is so because recently occurred outcomes have a large impact on decisions from experience. This suggests that economic shocks should increase risk expectations and lower return expectations thus should decrease risk taking and that these effects should disappear as outcomes become more favorable again. Malmendier and Nagel (2011) found that the great depression had a surprisingly long lasting impact by reducing the risk taking of people who lived through it, though this may have been the result of the extended time period (more than a decade) over which negative outcomes were experienced.

In summary, there are reasons to expect that people's risk taking will vary from September08 to June09, which included at least one large market shock in the first month:

Hypothesis 1(a): Financial risk taking will vary over survey period, i.e., the proportion of their initial endowment of £100,000 invested into the U.K. stock market (FTSE-All-Share) and not into the risk free asset with a guaranteed interest rate of 4% will be statistically different from time period to time period.

Rational models allow for changes in risk attitudes as the result of changes in income or wealth. The fact that an increase in wealth should result in a greater risk taking or a decrease in relative risk aversion is a key implication of difference habits models. When Brunnermeier and Nagel (2008) tested this implication empirically, they found that, while wealth changes affected investors' decision to participate in stock markets, they hardly had any effect on asset allocation decisions, i.e. on the proportion a household invests in risky vs. risk free assets. Guiso et al. (2003) analyzed stock ownership in major European countries and also found that the percentage of wealth invested in the stock market was independent of investors' absolute level of wealth.

Lab and field experiments that infer risk attitudes directly from choices (e.g. Holt and Laury (2002)) confound possible individual or situational differences in expected risks and returns with true differences in attitude towards risk (E. Weber and Milliman, 1997; E. Weber and Hsee, 1998; E. Weber and Johnson, 2008). Because of this equating of risk attitude with risk taking, risk attitude often appears to be domain specific because risk taking varies across domains. Investment risk taking, for example, is typically not very highly correlated with risk taking in lottery tasks (E. Weber at al., 2002; Nosić and M. Weber, 2010). Panel surveys such as the Socio-Economic Panel or the Michigan Health and Retirement Survey have assessed risk attitude with psychometric methods instead, i.e., from answers to attitudinal statements on Likert-scales, a method also used in our survey. As one would expect of a trait measure, Klos (2008) found individual risk attitudes

reported in the 2004 and 2006 Socio-Economic Panel to be stable over time. Sahm (2007) also reported relatively high stability of risk attitudes within individuals over time using the Health and Retirement panel data set with more than 12,000 observations. Hence, we expected self-reported attitude towards risk to be stable across our sampling period:

Hypothesis 1(b): Risk attitudes will be stable over survey period, i.e., self-reported risk attitudes will not be statistically different from time period to time period.

Changes in return expectations have been analyzed extensively empirically. Dominitz and Manski (2005) analyzed the dynamics of expectations in the Survey of Economic Expectations (1999-2001) and in the Michigan Survey of Consumers (2002-2004) and found that expectations were not perfectly stable over time but that differences between individuals were larger than differences within person over time. Using cross-sectional UBS/Gallup surveys, Fisher and Statman (2002) and Vissing-Jorgensen (2003) showed that people's long- and short-term return expectations change substantially over time. Using data from the 1998-2003 surveys, Vissing-Jorgensen (2003) show that average 1-year expectations go from a high of 15.8% in January 2000 to a low of around 6% at the end of 2002, a change in expectations largely in line with returns experienced at the time, a result consistent with documented recency effects in experience-based learning and choice (E. Weber at al., 2004). In contrast, also using between-subject data, Glaser and M. Weber (2005) showed that return expectations after the 9/11 event of 2001 and the subsequent market downturn were not in line with recently experienced returns, and actually significantly higher than return expectations before the event, suggesting that their respondents believed in some form of market mean reversion.

Risk expectations can also be assumed to relate to individuals' past experiences with similar events or situations (E. Weber and Hsee, 1998). Loewenstein et al. (2001) argue that risky choice options are evaluated affectively ("risk as a feeling"), and that prior outcomes, good as well as bad ones, influence this emotional response and the way individuals perceive the risk of a situation. E. Weber and Milliman (1997) and Mellers et al. (1997) experimentally showed that risk perceptions change after participants have experienced either good or bad outcomes. Consistent with such experiential learning, Glaser and M. Weber (2005) found volatility estimates to be significantly higher after the terror attacks of September 11 than before.

In summary, previous evidence suggests that both risk and return expectations can vary substantially over time, as the result of macroeconomic events or individually experienced gains or losses. Whereas perceptions of risk seem to consistently increase under adverse conditions, expectations of returns seem at times to reflect experienced events and trends and at other times reflect a belief in mean reversion:

Hypothesis 1(c): Risk and return expectations will fluctuate over sampled time period, i.e., will be statistically different from time period to time period.

Our data will allow us to test what drives changes in risk taking. Consistent with the previously presented literature we hypothesize that changes in risk taking over time are driven by changes in risk and return expectations and not by changes in risk attitude.

Hypothesis 1(d): Changes in risk taking will be mediated by changes in risk and return expectations.

Hypothesis 1 (c) raises questions about both the origin and the target of investors' risk and return expectations. Behavioral research suggests that investors' expectations may not only be based on economic data, but also on affective reactions such as hopes and fears. Asking investors to predict median as well as worst and best case returns for the next three months is the standard way to measure numeric risk and return expectations, but does not allow respondents to express their hopes and fears which may, nevertheless, influence their investment choices (E. Weber et al., 2005). This suggests the following hypothesis:

Hypothesis 2: Subjective measures of risk and return expectations will predict risk taking better than numeric measures, i.e., subjective measures of risk and return expectations will account for a greater proportion of the variance in risk taking across investors than numeric measures.

3 Data

3.1 Survey Respondents and Procedure

Our online survey was designed in collaboration with the behavioral finance team at *Barclays Wealth* and administered in September08, December08, March09, and June09. Over 90% of respondents completed the September08 survey before the 12th of September, i.e., before the bankruptcy of Lehman Brothers and the subsequent downturn on financial markets.[1] Respondents were selected as a stratified sample of Barclays Stockbrokers' client base, where *Age*, *Number of deals per year*, *Number of holdings*, and *Portfolio value* were used as strata. This provided a representative sample, while also accommodating our collaborating bank's desire to undersample

[1] Barclays did not collect the specific date on which each respondent completed the survey. However, the online service remained open only for a maximum of two weeks, with the majority of participants answering within the first week.

clients who trade very little (*Number of deals per year*≤1) or had a relatively low portfolio value (*Portfolio value*<£1,000).[2]

A total of 19,251 clients (approximately 5% of customers) were invited by email in late August/early September to participate in the survey. Of those, 4,520 (23%) opened the email. Of those who opened the email, 849 (20%) went to the website and in the end, 479 out of these 849 subjects completed the survey. This response rate is slightly lower but in the same ballpark as in similar studies by Dorn and Huberman (2005) and Glaser and M. Weber (2007). It took respondents on average 24 minutes to answer the survey.

The 479 investors who answered the September08 survey were contacted again by email in late November/early December08 and invited to participate in a shorter version of the earlier survey.[3] Of those, 240 participated for a second time in December. In addition, *Barclays Wealth* sent out an email invitation to a different set of 700 customers who had not been previously contacted, in order to increase the sample size.[4] This resulted in an additional 138 respondents who joined the panel in December and who completed the longer version of the survey at this point. In March09, all 617 investors who had previously participated in at least one round were contacted again and invited to participate in one more round, with the shorter version of the

[2] In all strata in which trades were less than once a year or portfolio value of less than £1,000, a lower percentage of clients were invited to participate in the survey than in the remaining strata . Note that although we did undersample, we did not exclude these clients, and more than 16% of approached individuals had a portfolio value below £1,000.

[3] The first version of the survey included more demographics, individual characteristics, and various behavioral client profiling questions, that are used by Barclays Wealth within their advisory process.

[4] These 700 had previously participated in another marketing related event of *Barclays Wealth* and had indicated their willingness to participate in surveys.

survey. Overall, 259 investors participated only once, 138 twice, 131 three times, and 89 all four times.

In contrast to previous studies of online brokerage customers (Dorn and Huberman, 2005; Glaser and M. Weber, 2007) that analyzed one-period survey responses, our dataset provided repeated observations of the same investors over time, thus allowing us to regress changes in the dependent measure (risk taking) onto changes in a series of predictor variables. Such analysis requires participants who completed at least two consecutive surveys, i.e. in September and December, in December and March, in March and June, or participated in three or four consecutive periods.

To identify potential selection biases, we compared survey participants to the adult British population, and also compared investors who participated only once with those that participated twice, three or four times, respectively. Table 1 provides mean demographics for all participants of our study ($Group^{all}$) and for the adult British population (GB^{all}), respectively. The next four columns provide mean demographics separately for respondents who participated only once ($Group^{once}$, N=259), twice ($Group^{twice}$, N=138), three times ($Group^{threetimes}$ N=131), and in all four surveys ($Group^{four}$, N=89). The average age of survey participants is 51.4 years, four years older than the average British adult. Survey participants are also more likely to be married (0.74 vs. 0.52) or male (0.93 vs. 0.49) compared to the British average. *Gross income* is highly skewed with a mean of £76,616 and a median of £60,000 and substantially larger than the mean British income of £30,000. Clearly, our respondents are not representative of the typical British adult. However, being predominantly male and having a substantially larger gross income than the overall

population makes them similar to the German private investor population sampled by Dorn and Huberman (2005).

There are hardly any differences between the investor subgroups who participated once, twice, three, or four times, respectively. Only the level of investable wealth, measured in 9 categories from 1 (£0 - £10,000) to 9 (> £1 million), differs significantly. Investors who participated only once had substantially lower investable wealth than investors who participated more frequently. Since the main goal of our study is to analyze changes in different variables at an individual level over time, differences in wealth between the four subgroups should not be problematic. Investor wealth was also included as a control variable. We conducted a similar analysis (not reported here) comparing demographics as well as expectations for those who participated in each subsequent round vs. those who did not participate in the next round and found no significant differences.

Insert Table 1 here

3.2 Survey Design

Besides demographics and other individual characteristics described above and collected only in the first survey in which respondents participated, the following variables, summarized in Table 2, were elicited every three months. The appendix presents the exact wording of the questions as well as the order in which the questions were elicited.

(Financial) Risk taking: Participants were asked to invest £100,000 either into the U.K. stock market (FTSE-All-Share) or into a risk free asset with a guaranteed interest rate of 4%, with a greater percentage allocated to the stock market indicating greater risk taking. Using hypothetical

choices vs. transaction data has advantages and disadvantages. A disadvantage of using real transaction data to make inferences about risk taking in portfolio allocations is that it is hardly possible to obtain complete information on total asset holdings of individuals at all banks at which they have an account. We also know that real transactions are subject to investor inertia and temporary practical constraints that may not be constant from period to period. Hypothetical risk taking with a new stake of equal size provided at each time period does not have these constraints and thus offers a better measure of the effect of changes in risk and return expectations or changes in risk attitude. However, hypothetical actions are hypothetical, and some might argue that such data reflect cheap talk. As outlined in the introduction, survey data should be seen as an additional and complementary source of data to understand determinants of changes in investor risk taking.

Risk attitudes: In the September and December08 surveys we used the three questions shown in Table 2 from *Barclays Wealth's* 8-question psychometric scale of investors' risk attitude. Brooks et al. (2008) show that this scale differentiates individuals with low risk tolerance from those with high risk tolerance and that it has high reliability. All three questions were answered on a 7-point Likert scale with the endpoints "1 = Strongly Disagree" and "7 = Strongly Agree".[5] In the March and June survey, only the most diagnostic of these three risk attitude measures was elicited *(Risk Attitude 2:* "It is likely I would invest a significant sum in a high risk investment."*)*.

Expected return and expected risk: As described above, risk and return expectations were elicited in two different ways, one quantitative/numeric, the other qualitative/subjective. Crossed

[5] Bollen and Barb (1981) and Alwin and Krosnick (1991) have shown that reliability, validity, and discriminating power increases up to 7-point scales and that, after this, additional effects can hardly be observed. Moreover, Viswanathan et al. (2004) argue that the number of response categories should be as close as possible to a natural number of categories for a specific question, and that one should not overburden respondents with too hard a task.

with that, we also asked investors for their risk and return expectations over the next three months for (a) the U.K. market portfolio (FTSE-All-Share) and (b) for their own investment portfolio at the bank. To get respondents' quantitative/numeric risk and return expectations, we asked them to state their best guess (median estimate) for the three-month percentage return, followed by a lower and upper bound on the three-months percentage return they had provided, such that there would be only a 5% chance that the return in three months would be below the lower bound and a 5% chance that it would be higher than the upper bound. Numeric return expectations for the market (*Market-Return-Num.*) or for an investor's own portfolio (*Own-Return-Num.*) are equal to the best guess for the market and own portfolio return, respectively. To obtain numeric risk expectations, we used the two point approximation to the variance of outcomes suggested by Keefer and Bodily (1983), which transforms stated upper and lower bounds into volatility estimates and has been widely used in the empirical literature (e.g. Graham and Harvey (2005) and Glaser et al. (2007)).[6] This provided us with the two numeric risk expectation measures *Market-Risk- Num.* and *Own-Risk-Num*.

For the two qualitative/subjective measures of return expectations (*Market-Return-Subj.* and *Own-Return-Subj.*), respondents were asked how they would rate the returns they expected from the market and their own portfolio over the next three months, on a 7-point Likert scale ranging from "1 = Extremely bad return" to "7 = Extremely good return". Similarly, the qualitative/subjective measures of risk expectations (*Market-Risk-Subj.* and *Own-Risk-Subj.*) were

[6] For the two point approximation of variance we use:

$$variance = \left[\frac{return_{num}(0.95) - return_{num}(0.05)}{3.25}\right]^2$$, see Keefer and Bodily (1983, p. 597)

obtained as judgments of expected market risk and expected own portfolio risk over the next three months, on a 7-point Likert scale ranging from "1 = Not risky at all" to "7 = Extremely risky".

Past performance: We elicited participants' memories of past performance, both of the U.K. stock market in general (FTSE-All-Share) and of their own portfolio over the last three months, using two elicitation methods: (a) as a numeric (percentage return) estimate (*Perf.Own-Num* and *Perf.Market-Num)* and (b) as a qualitative subjective judgment on 7-point Likert scales with the endpoints "1 = Extremely bad return" and "7 = Extremely good return" (*Perf.Own-Subj.* and *Perf.Market-Subj.)*. In addition, we also asked respondents for their numeric (percentage) estimate of past three-months returns of their personal investments held at other banks (*Perf.External)*..

Insert Table 2 here

3.3 Differences in Responses between Groups With Different Response Rates

To test for any selection bias in our data, i.e., the question whether participants who completed one, two, three or four surveys provided different answers on any of the above variables, we conducted a series of Mann-Whitney rank-sum tests. We found a very small number of significant differences (not more than can be expected by chance alone), scattered over different variables with no discernable pattern, suggesting that there were no differences on these variables between these groups of respondents. As mentioned earlier, we did a similar analysis for those who answered in the following round vs. those who did not answer, which also showed no significant differences.

4 Results

4.1 Risk Taking, Risk Attitude, and Risk and Return Expectations across Time

Table 3 reports the means of all repeatedly elicited variables in our study, for the four assessed periods.[7] The last three columns in Table 3 report Wilcoxon signed-rank test statistics that indicate whether the difference in value for that variable is significant between two successive survey administrations. These tests only use data from respondents who participated in the two respective surveys, i.e., use only within-subject data.

For *Risk-Taking* we observe, consistent with Hypothesis 1(a), that the percentage of their £100,000 stake that investors are willing to place into the market (FTSE-All-Share) varies substantially. As shown in Figure 2 and Table 3, risk taking decreases from 56.0% in September08, to 52.8% in December08 and further to 46.5% in March09, and then increases again to 53.5% in June09. All differences are significant at the 1% level.

In contrasts, there are hardly any changes in self-reported risk attitudes over the four time periods. *Risk Attitude 2* ("It is likely I would invest a significant sum in a high risk investment") and *Risk Attitude 7* ("Even if I experienced a significant loss on an investment, I would still consider making risky investments") are virtually the same in September08 and in December08. *Risk Attitude 6* ("I am a financial risk taker") rises slightly from 4.43 to 4.61 from September08 to December08, a difference significant at the 5% level, but in a direction that is inconsistent with the observed declines in risk taking over that time period. From March09 onward, we only elicited *Risk Attitude 2*, the single most diagnostic measure from *Barclays Wealth's* 8-question scale, with a distribution of responses across investors that covered the full range of values as shown in Figure 3, and which, as Table 3 shows, did not change across time periods. At the individual-subject level, we find some variation but over 56% of those participating in all four rounds do not

[7] Table 3 includes values only for respondents who participated in at least two of the four surveys, but results are essentially the same if we either include the data for all 617 investors or restrict ourselves to the 89 investors who participated four times.

change their self-reported risk attitude scores by more than one point on the 7-point Likert scales. This stability of risk attitudes across time is in line with findings in Sahm (2007) and Baucells and Villasis (2010) and supports Hypothesis 1(b).

Consistent with Hypothesis 1(c), risk expectations change considerably over time, in ways mostly consistent with market events. Thus all four risk expectation measures (*Market-Risk-Num.*, *Market-Risk-Subj.*, *Own-Risk-Num.*, and *Own-Risk-Subj.)* were significantly higher in December08 than September08, following the Lehman Brothers collapse and subsequent market decline and volatility increase, as shown in Table 3. Whereas the numeric volatility estimates of risk stay steady or increase from December08 to March09 and June09, consistent with market behavior, subjective risk expectations (that are likely more affect- than analysis-based) stay steady from December08 to March09, but then significantly decrease by June09, indicating perhaps some habituation to the continuing volatility, i.e., a decrease in worry or concern.

Return expectations are similarly variable over time, consistent with Hypothesis 1(c), though less so than risk expectations. As shown in Table 3, both the numeric and the subjective return expectations either stay steady or increase from September08 to June09[8]. This suggests that respondents expect some form of market correction for subsequent periods during this period of market turbulence and losses. This expectation is only accurate in the last period, from March09 to June09 where returns in the market did increase by 9%, where return expectations actually, if anything, decreased slightly.

As also shown in Table 3, investors' numeric estimates of past market performance were not too far off actual market returns. The performance of the FTSE-All-Share for the three month

[8] The only exception is a slight, but non-significant decrease in the numeric return expectation from March09 to June09.

period before the questionnaire was distributed was approximately -12% for September08, -25% for December08, -8% for March09, and +14% for June09.

In summary, our results are consistent with Hypotheses 1(a) to (c). Moreover, our results are robust, i.e., remain essentially the same if we analyze differences only for those investors who participated three or four times or if we include all observations at each point of time.

Insert Table 3 here

4.2 Differences between Numeric and Subjective Assessments of Risk and Return Expectations for Market Portfolio and Own Portfolio

We now proceed to test Hypothesis 2. Table 4(a) Panel A shows the correlations between the numeric and the subjective measure of the four solicited expectations (returns and risks, for the market and own portfolio, respectively), for each of the four time periods of elicitation. The pattern of correlations is very consistent across time periods. While all correlations are significant (at the .05 level or higher), there is much greater agreement (i.e., higher correlation) between the numeric and the subjective elicitation value for return expectations than for risk expectations (Wilcoxon signed-rank test $z = 2.52$; $p<.02$). This pattern also shows for the correlation of changes (Panel B) which are generally lower, significant for return and not significant for risk. This is consistent with prior studies that have found much closer correspondence between subjective return expectations and normative values such as the expected value of past returns of investment options than between subjective risk expectations and normative values such as the variance or standard deviation of past returns (E. Weber and Hsee, 1998; E. Weber at al., 2005).

Table 4(b) Panel A shows that there are reasonably high correlations (from .48 to .64) between investors' risk and return expectations for the market and their own portfolios when the expectations are assessed numerically. This is also true for return expectations assessed subjectively (from .45 to .64), but the correlations are much reduced (from .27 to .37) for subjectively assessed risk expectations. While investors on average exhibit some optimism or "better than average" bias, as shown in Table 3, where subjective return estimates are better ($t = 7.92$, $p<.00001$) and subjective risk estimates lower ($t = -13.25$; $p<.00001$) for own portfolios than for the market portfolio, it is possible that different feelings influence the subjective risk expectations of different investors for their own portfolios (for some perhaps hope, while for others fear), lowering the correlation between this estimate and their subjective risk expectation for the market. Again the results are remarkably consistent across the four time periods. Looking at correlations of changes (Panel B), again, the same pattern shows up as in Panel A with most correlation coefficients being a little bit lower.

Finally Table 4(c) Panel A provides some results indicative of investors' financial sophistication. Finucane et al. (2000) observed that, as a result of using their affect towards an investment to judge both its expected risk and return, people's risk and return expectations often show a negative relationship (i.e., options with higher return expectations are being perceived as carrying lower risks), contrary to the actual positive relationship between risks and returns between assets in efficient markets. This negative relation can be seen as evidence for the influence of a specific feeling about a choice option influencing both sets of judgments, with more positive-feeling choice options being seen as less risky and as yielding greater returns. Table 4(c) shows that, different from studies using university students, the investors in our study did not show such a negative relationship in their numeric judgments about their own portfolio, i.e., in an

analysis across subjects their numeric judgments correctly implied a positive relationship between risk and return expectations for their own portfolios.[9] However, for the more qualitative /subjective judgments of expectations, even this set of relatively prosperous and experienced personal investors showed significant negative correlations between what they expected for risks and returns for the market portfolio, and much smaller positive or zero correlation for their own portfolio, suggesting that subjective feelings can affect the perceptions and actions of even financially sophisticated investors (also see Holtgrave and E. Weber, 1993).

Panel B shows that basically no relation between changes in risk and return expectations is present in our data.

Insert Table 4 here

4.3 What Predicts Risk Taking and Drives Changes in Risk Taking?

Although we are interested in the relation of changes of variables, we first present an analysis testing Equation (2), the more general risk-return framework. Table 5 shows (Column 1) that risk taking depends on risk attitude. Column 2 shows that risk taking also depends on subjective market risk and return expectation (as proposed by the framework) and also on numeric return expectation (though less significantly) but not on numeric risk expectation (which turns out to be significant in Column 4 where demographic control variables are included). Column 3 shows that higher past performance measured on a subjective scale results in higher risk taking. Including demographics (Column 4), we find that being male and having a larger number of dependents leads to (marginally) significant more risk-taking. All other variables show no effect.

[9] Within investors the picture is inconclusive, some show positive others negative correlations over time.

Insert Table 5 about here

The analysis underlying Table 5 allows us to further test Hypothesis 2. We run two Tobit regressions with risk taking as the dependent variable and either numeric expectations for return and risk or subjective expectations for return and risk as independent variables (including round dummies). Consistent with Hypothesis 2, we find the r^2 to be higher for subjective factors (.0171 vs. .0056), the t-statistics to be larger (return: subjective 8.79 vs. numeric 3.52; risk: subjective – 4.85 vs. numeric – 1.10) and the F-value to be larger for the regression with subjective factors (31.16 vs. 8.08).

Table 6 shows the same variables as listed in Table 3, now separated for investors whose risk taking either increased or decreased between two successive time periods (Δ RiskTaking >=0; Δ RiskTaking < 0) for the three comparison time periods (September08-December08; December08-March09; March09-June09). The last column for each time comparison shows the results of Mann-Whitney rank-sum tests.

Variables that differ between these two groups of respondents are potential predictors of risk taking. Table 6 shows that this rules out measures of risk attitudes, which hardly show any difference between the two groups for all three transitions in time.[10] Changes in investors' risk and return expectations for their own portfolios (both numeric and subjective) mostly also do not differ significantly between the two groups (Δ R.T.$^+$ and Δ R.T.$^-$). The same is true for changes in their numeric risk and return expectations for the market portfolio, *Diff. Market-Return-Num.* and *Diff. Market-Risk-Num*. However, for changes in subjective/qualitative risk and return

[10] Note that *Diff. Risk Attitude 6* and *Diff. Risk Attitude 7* were not elicited in March. Therefore, we cannot analyse changes in these variables from December to March.

expectations for the market portfolio we find large and reliable differences between the two groups. Investors who take more risks from one time period to the next (Δ R.T.$^{+}$) expect market returns (*Diff. Market-Return-Subj.*) to be substantially higher over the next three month, while investors who take less risk (Δ R.T.$^{-}$) expect market returns to stay fairly stable over time. Differences in changes in subjective market return expectations between the two groups are significant for all three time periods, suggesting that changes in subjective market return expectations are related to changes in risk taking. This result remains stable when we rerun the analysis only for investors who participated in all four surveys. The reverse is true for subjective market risk expectations *(Diff. Market-Risk-Subj.)*: investors who take less risk from one time period to the next (Δ R.T.$^{-}$) expect market risk to increase for the next period, whereas investors who take more risk (Δ R.T.$^{+}$) expect it to decrease. Table 6 also shows that changes in past performance estimates are hardly related to changes in risk taking, as only *Diff. Past Perf. Self Subj.* is significantly different for the two groups.[11]

Insert Tables 6 and 7 here

We use multivariate Tobit regressions to determine what combinations of factors drive changes in risk taking, since our dependent measure (change in percentage of £100,000 invested

[11] Past performance variables affected risk taking indirectly, by affecting both numeric and subjective return expectations across time periods, as shown in Table 7, mostly in rational or sensible ways. I.e., Past market performance affects market return expectations, whereas past own portfolio performance affects own portfolio return expectations. Similarly, numeric judgments of past performance predict numeric judgments of return expectations, whereas subjective judgments of past performance predict subjective return expectations. Table 7 shows no sign of belief in mean reversion: only the subjective evaluations of past market performance are negatively correlated with numeric market return predictions.

into the market) is censored from below (-100) and from above (+100). Table 8 reports the results of clustered Tobit regressions of changes in risk taking from one time period to the next.[12] .

Column 1 of Table 8 shows that changes in self-reported risk attitude (*Diff. Risk Attitude 2)* do not explain changes in risk taking but the coefficients are in the right direction. This result still holds when we rerun the regression while excluding investors who reported the same risk attitude in two subsequent time periods. Column 2 shows that, in contrast to changes in risk attitude, changes in subjective risk and return expectations do explain changes in risk taking. The larger subjective market return expectations are in the current survey round (compared to the previous round), the more risk is taken in the current round (compared to the previous round). The greater the perceived level of risk of the market in the current round, the less risk is taken in the current round. The same regression with numeric estimates of expectations instead of subjective ones (Column 3) shows that changes in numeric expectations cannot explain changes in risk taking, confirming Hypothesis 2.

The regression in Column 4 shows that changes in subjective market risk and return expectations continue to predict changes in risk taking when changes in risk attitude are simultaneously included as a predictor variable. In Columns 5 and 6, we add changes in numeric market expectations, changes in recent market performance, and various demographics as additional predictor variables. Multicollinearity is no issue for adding the numerical expectations, since the correlations between numerical and subjective risk and return expectations are relatively low, as discussed above. However, multicollinearity is an issue for the numeric and subjective judgments about past market performance, which were highly correlated. Thus we only added one

[12] Since *Diff. Risk Attitude 6* and *Diff. Risk Attitude 7* were not elicited at all time periods, they were not included in the analyses. We took into account that most investors participated in more than one survey by clustering our regressions over respondents

or the other to the regression equation. As shown in Columns 5 and 6, neither one of them predicts changes in risk taking, and neither do changes in numeric market risk and return expectations. The only two variables that consistently and reliably predict changes in risk taking are changes in investors' subjective expectations of market risks and returns.[13]

Insert Table 8 and Figure 4 here

Support for Hypothesis 1(d) that changes in risk taking are mediated by changes in risk and return expectations is provided by the results of a mediation analysis (e.g., Shrout and Bolger, 2002), summarized in Figure 4. For each of the three transitions in time (September08 to December08 to March09 to June09), we regressed risk taking in the two subsequent periods on a time dummy. As discussed earlier and shown by the significant regression coefficients for the direct link between time and risk taking in the bottom part of Figure 4, risk taking differed significantly between the two time periods for all three transitions. We next tested the precondition for possible mediation of changes in risk taking by changes in subjective risk and return expectations, namely whether risk and return expectations significantly differed between time periods. As shown by the coefficients for the links between time and either risk or return expectations on the left side of the top portion of Figure 4, this precondition was satisfied for two of the three time transitions. As shown by the coefficients for the links between both risk or return expectations and risk taking on the right side of the top portion of Figure 4, risk taking was significantly predicted by risk and return expectations across time periods. Most importantly, when risk and return expectations are added to the time dummy to predict risk taking, the time

[13] As a robustness check we redid the analysis of Table 8 excluding extreme values for numeric changes. We define those by Diff. Market-Return-Num and Diff Post Perf. Market Num being larger than 50% and Diff.-Risk-Num being larger than 0.5. In regression 3, 5, and 6 we loose 4, 8 and 4 observations. The number 50% might look pretty large but there was a three month period where the real market return was about -25%. The results basically do not change. The coefficient of Diff Risk Attitude 2 becomes marginally significant.

predictor is no longer significant for the two time transitions for which the precondition for mediation was satisfied (i.e., September08→ December08, and March09→ June09). The difference in magnitude and significance level of the indirect effect of time on risk taking (shown by the coefficients for that link in the top part of Figure 4) and the direct effect in the bottom part of Figure 4 provide evidence that changes in risk and return expectations successful mediate observed changes in risk taking over time.

5 Conclusion

In repeated surveys conducted between September08 and June09, a sample of *Barclays Wealth* online brokerage personal investors showed substantial changes in risk taking over time. Using risk-value models that allow for individual and situational differences in risk and return expectations as well as differences in self-reported risk attitude, we tie these changes in risk taking to changes in subjective expectations of risk and return, whereas risk attitudes remain stable over time, as one would expect from a psychological trait. Any existing small changes in self-reported risk attitude do not predict changes in risk taking. These results are stable when we control for past investment performance and demographics.

Consistent with previous work on risk expectations (E. Weber et al., 2005), we find that qualitative subjective judgments of expected market risk and return predict risk taking, but that investors' quantitative estimates of market returns and volatility, far closer to the traditional finance risk-return model, fail to predict observed changes in risk taking. Subjective judgments of risk and return expectation continue to be significant predictors of risk taking even when investors' quantitative estimates of expected market returns and their volatility are included in the

regression, suggesting that it is the more emotion-based components of these judgments that drive changes in risk taking.

We extend previous findings in the literature on changes in risk taking, expectations, and risk attitudes. First, our unique dataset allows us to analyze changes in risk taking, expectations, and risk attitudes of online broker customers. The personal investors in our sample are affluent and frequently trade in stocks and other securities, and are financially sophisticated. They do not show myopia in information use, in the sense that they do not use/substitute subjective risk and return expectations for their own personal portfolios when they make risky decisions involving the market portfolio. They also do not show any halo effect in their numeric risk and return predictions,[14] and their risk taking is not directly influenced by recent investment gains or losses. Thus it is fair to say that our results probably place a lower bound of the degree and type of irrationality that one might expect to see in a broader sample of personal investors.

Whereas previous studies in the literature analyzed only changes in risk taking (see e.g. Malmendier and Nagel (2011)), in expectations (see e.g. Vissing-Jorgensen (2003)), or in risk attitude (see e.g. Sahm (2007)), our study examined the relationship between these variables. This allowed us to examine the mechanism or channel by which risk taking might change over time. Another fortuitous feature of our study is the fact that the first survey was conducted in the beginning of September08, i.e., just before extreme turmoil in financial markets. Hence, we are able to analyze the effect of substantial stock price drops on risk attitudes and expectations by comparing the expectations and attitudes shortly before the crisis to those during and after the crisis, using the same panel of investors. While only a direct manipulation of risk and return

[14] Though they do show one for their subjective judgments of expected risks and returns.

expectations would allow us to conclusively establish their causal role in changing risk taking, our within-subject repeated-measures design and the results of the mediation analysis strongly suggest that observed changes in risk taking over the survey period were the result of changes in subjective feelings about future market risk and return, and not changes in risk attitude.

We observed one significant change in self-reported risk attitude. *Risk Attitude 6* ("I am a financial risk taker") showed a significant increase (from 4.43 to 4.61) from September08 to December08, but in a direction inconsistent with the observed decline in risk taking over that time period. Investors who we know had been losing money in the stock market between September08 and December08, might have concluded that they must be greater risk taker than they had previously thought, in light of these losses. No such changes in self-reports of risk attitudes were observed for the more diagnostic self-report measure *Risk Attitude2.*

Our findings should be valuable for banking practitioners. We show that risk attitudes - if measured correctly and without confounding effects - seem to be fairly stable and that changes in risk taking seem to be caused by changes in risk and return expectations, not by changes in risk attitudes and not, at least directly, by changes in recent market or personal portfolio performance. Thus, practitioners urged (e.g, by the MiFID of the European Union (2006)) to elicit their customers' risk profiles and risk preferences can argue that an elicitation of risk attitudes needs not to be carried out on a quarterly basis. However, as we find that investors have risk and return expectations that change significantly over time and seem to guide their investment behavior, there is ample room for helping investors make better decisions. Our data show that investors' risk and return expectations are influenced by recent events and change considerably over time, and do so in a number of ways not consistent with rational theory. Future research should investigate

which other variables drive risk taking behavior. We know from previous studies that overconfidence and optimism (Nosic and Weber 2010) and even anticipating optimism by others lead to higher risk taking. There are most likely other psychological factors as well, that still have to be investigated,

Our results indicate that it might be worthwhile for practitioners to elicit their clients' risk and return expectations more frequently and to provide some corrective feedback at the end of regular time periods (e.g., at the end of each calendar year), as investors seem to persistently underestimate and subjectively underappreciate the volatility of the market, putting hope over fear.

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Table 1. Demographic characteristics

The first two columns compare mean demographics for survey participants (Group^{all}) to the adult British population (GB^{all}) (from the U.K. Office for National Statistics). The next four columns report mean demographics for the subsets of participants who took part in only one survey (Group^{once}), two surveys (Group^{twice}), three surveys (Group^{thrice}), or all four surveys (Group^{four}). *Age*, *Number of dependants*, and Median *gross income* are self-explanatory. *Gender* and *Marital status* are dummy variables that take the value 1 if the investor is male and married, respectively. Investable wealth is measured in 9 categories from 1 (£0 - £10,000) to 9 (> £1 million).

	Group^{all}	**GB^{all}**	**Group^{once}**	**Group^{twice}**	**Group^{thrice}**	**Group^{four}**
Age	51.42	47.66	50.77	50.65	51.43	54.45
Number of dependents	1.14	-	1.12	1.23	1.17	1.00
Gender	0.93	0.49	0.92	0.93	0.95	0.96
Median gross income (in £)	60,000	30,000	60,000	60,000	65,000	53,000
Marital status	0.74	0.52	0.76	0.70	0.77	0.72
Investable wealth (in £)	4.80	-	4.50	4.53	5.03	5.73

Table 2: Definition of survey variables

Variable	Question / Description
Risk Taking	
Risk Taking	Measures the (hypothetical) amount of money an individual is willing to invest into the FTSE-All-Share compared to a risk free asset with a 4% return (0 = invest everything into the risk free asset; 100 = invest everything into the risky stock market).
Risk Attitude	
Risk Attitude 2	"It is likely I would invest a significant sum in a high risk investment." (1 = Strongly disagree ... 7 = Strongly agree)
Risk Attitude 6	"I am a financial risk taker." (1 = Strongly disagree ... 7 = Strongly agree)
Risk Attitude 7	"Even if I experienced a significant loss on an investment, I would still consider making risky investments." (1 = Strongly disagree ... 7 = Strongly agree)
Expectations	
Market-Return-Num.	Measures individuals' return expectations for the FTSE-All-Share in 3 months in percent
Market-Risk-Num.	Measures individuals' volatility expectations for the FTSE-All-Share in 3 months by transforming estimates of bounds into volatility estimates.
Market-Return-Subj.	"How would you rate the returns you expect from an investment in the UK stock market (FTSE-All- Share) over the next 3 months?" (1 = Extremely bad ... 7 = Extremely good)
Market-Risk-Subj.	"Over the next 3 months, how risky do you think the UK stock market (FTSE-All- Share) is?" (1 = Not risky at all ... 7 = Extremely risky)
Own-Return-Num.	Measures individuals' return expectations for the own portfolio at the bank in 3 months in percent
Own-Risk-Num.	Measures individuals' volatility expectations for the own portfolio at the bank in 3 months transforming estimates of bounds into volatility estimates.
Own-Return-Subj.	"How would you rate the returns you expect from your own portfolio over the next 3 months?" (1 = Extremely bad ... 7 = Extremely good)
Own-Risk-Subj.	"Over the next 3 months, how risky do you think the investments in your own portfolio are?" (1 = Not risky at all ... 7 = Extremely risky)
Past Performance	
PastPerf.-External	What do you think the return of your investments held at other banks over the past 3 months was?
PastPerf.-Market-Num.	"What is your best estimate of the return of the UK stock market (FTSE-All-Share) over the past 3 months?"
PastPerf.-Market-Subj.	"How would you rate the returns of the UK stock markets (FTSE-All-Share) over the past 3 months?" (1 = Extremely bad ... 7 = Extremely good)
PastPerf.-Own-Num.	"What do you think the return of your own portfolio over the past 3 months was?"
PastPerf.-Own-Subj.	"How would you rate the returns of your own portfolio over the past 3 months?" (1 = Extremely bad ... 7 = Extremely good)

Table 3: Survey Responses across Time Periods

This table reports mean responses on indicated variables by time of elicitation. The last three columns provide z-statistics of Wilcoxon signed-rank tests of differences between successive time periods, for those investors who participated in both time periods.

* significant at the 5% level; ** significant at the 1% level.

	Mean				**Difference Dec-Sept**	**Difference Mar-Dec**	**Difference June-Mar**
	Sept.	Dec.	March	June	z-score	z-score	z-score
	(N=265)	(N=305)	(N=239)	(N=188)			
Risk-Taking	56.02	52.77	46.52	53.47	-2.59**	-3.90**	3.86**
Risk Attitude 2	3.34	3.63	3.55	3.55	1.89	-0.73	0.46
Risk Attitude 6	4.43	4.61	-	-	2.51*	-	
Risk Attitude 7	5.04	5.06	-	-	0.39	-	
Market-Return-Num	1.57	3.57	5.42	4.25	1.66	3.31**	-1.11
Market-Risk-Num	0.052	0.075	0.072	0.090	7.29**	-0.57	2.54**
Market-Return-Subj	3.50	3.67	3.84	4.20	1.09	-0.48	2.52**
Market-Risk-Subj	4.76	5.17	5.15	4.52	4.60**	1.53	-6.21**
Own-Return-Num	4.38	6.23	8.18	5.98	2.94**	3.32**	-0.59
Own-Risk-Num	0.053	0.078	0.067	0.087	6.74**	-2.56**	3.59**
Own-Return-Subj	3.89	3.91	4.17	4.42	-1.09	2.60**	2.53**
Own-Risk-Subj	4.20	4.45	4.53	4.34	3.68**	1.29	-2.32**
PastPerf-Ext	-2.14	-12.57	-3.19	11.83	-7.41**	3.62**	7.05**
PastPerf-Market-Num	-8.20	-16.79	-6.96	13.86	-8.20**	7.78**	10.09**
PastPerf-Market-Subj	2.32	1.82	2.42	5.27	-7.43**	4.64**	9.99**
PastPerf-Own-Num	-7.70	-18.51	-8.48	13.14	-9.52**	7.03**	9.20**
PastPerf-Own-Subj	2.95	2.33	2.92	4.66	-7.26**	4.26**	8.20**

Table 4: Correlations between return and risk expectation measures for market and own portfolio

This table reports the Pearson correlation coefficients between (a) numeric and subjective measures of return and risk expectations for market and own portfolios, respectively; (b) assessments for market portfolio and own portfolio of return and risk expectations, assessed either numerically or subjectively, respectively; and (c) risk and return expectations assessed either for market or own portfolio, numerically or subjectively, respectively. Panel A presents the analysis for absolute levels of variables , Panel B for changes in those variables from the previous time period to the indicated time period.

Panel A: Correlations of absolute levels of variables

(a)	**Numeric--Subjective Correlation**				
		Return		Risk	
	DATE	Market Portfolio	Own Portfolio	Market Portfolio	Own Portfolio
	"Sept08"	0.49	0.4	0.18	0.26
	"Dec08"	0.49	0.49	0.18	0.26
	"March09"	0.49	0.49	0.22	0.32
	"June09"	0.64	0.55	0.3	0.18
(b)	**Market—Own Correlation**				
		Return		Risk	
	DATE	Numeric	Subjective	Numeric	Subjective
	"Sept08"	0.48	0.47	0.63	0.27
	"Dec08"	0.56	0.51	0.63	0.37
	"March09"	0.64	0.45	0.58	0.31
	"June09"	0.61	0.64	0.59	0.37
(c)	**Risk--Return Correlation**				
		Market Portfolio		Own Portfolio	
	DATE	Numeric	Subjective	Numeric	Subjective
	"Sept08"	-0.05(ns)	-0.26	0.21	0.1
	"Dec08"	-0.02(ns)	-0.31	0.3	-.04(ns)
	"March09"	0.12(ns)	-0.32	0.29	-0.01(ns)
	"June09"	-.01(ns)	-0.21	.11(ns)	.01(ns)

Panel B: Correlations of changes in variables from previous to indicated time period

(a)	**Numeric--Subjective Correlation**				
		Return		Risk	
	DATE	Market Portfolio	Own Portfolio	Market Portfolio	Own Portfolio
	"Sept08"	---	---	---	---
	"Dec08"	0.22	0.30	-0.02(ns)	-0.06(ns)
	"March09"	0.18	0.25	0.07(ns)	0.07(ns)
	"June09"	0.49	0.36	0.15	0.05(ns)
(b)	**Market--Own Correlation**				
		Return		Risk	
	DATE	Numeric	Subjective	Numeric	Subjective
	"Sept08"	---	---	---	---
	"Dec08"	0.58	0.42	0.48	0.14
	"March09"	0.51	0.22	0.39	0.22
	"June09"	0.34	0.33	0.74	0.07(ns)
(c)	**Risk--Return Correlation**				
		Market Portfolio		Own Portfolio	
	DATE	Numeric	Subjective	Numeric	Subjective
	"Sept08"	---	---	---	---
	"Dec08"	0.02(ns)	-0.22	0.05(ns)	-0.04(ns)
	"March09"	0.19	-0.09(ns)	0.11(ns)	-0.06(ns)
	"June09"	-0.00(ns)	-0.12(ns)	0.02(ns)	0.01(ns)

Table 5: Predictors of risk taking

This table reports regression coefficients) of clustered Tobit regressions where standard errors take clustering over subjects into account. The dependent variable in each model is risk taking (*Risk Taking*). Independent variables are: risk attitude, expectations, and past performance as well as demographic variables. The regressions include round dummies with round one as the baseline. Columns are explained in the text. *significant at the 10% level, **significant at the 5% level, and *** significant at the 1% level.

Type of Variable		1	2	3	4
Why?	Risk Attitude 2	3.47 ***	3.30 ***	3.27 ***	3.03 ***
Why?	Market-Return-Num		0.24**	0.29***	0.38***
Why?	Market-Risk-Num		-19.25	-19.07	-45.20**
Why?	Market-Return-Subj		5.75***	5.33***	5.40***
Why?	Market-Risk-Subj		-4.27***	-4.13***	-2.95***
Why?	Past Perf. Market Num			-0.11	
Why?	Past Perf. Market Subj			0.87**	
Who?	Age				0.04
Who?	Gender				9.47*
Who?	Dependents				1.67*
Who?	Decider				-10.17
Who?	Marital status				-5.00
Who?	Financial literacy				0.62
Who?	Income (categorical)				0.19
Who?	Wealth				0.59
When?	Round 2	-4.33**	-3.47*	-3.76*	-4.41*
When?	Round 3	-10.28***	-10.94***	-10.97***	-10.46***
When?	Round 4	-2.83	-8.59***	-10.95***	-6.27**
	Constant	44.77***	46.11***	41.89***	38.00***
	Observations	1264	1219	1216	876

Decider: Do you make the financial decisions in the household?

Financial literacy was measured using four questions.

Table 6: Changes in risk attitudes, expectations and past performance

Mean changes in reported risk attitudes, expectations and past performance across time periods, separately for investors who took more risk or less risk in the second time period. The Mann-Whitney rank-sum test statistic indicates whether the change in the row variable is different for these two groups. * significant at 5% ; ** significant at 1% level.

	Numeric Return Predictions		**Subjective Return Predictions**	
	Market Portfolio	Own Portfolio	Market Portfolio	Own Portfolio
Predictors	n = 1163	n = 1163	n = 1160	n = 1163
PastPerf-Ext-Num	.005	.028	-.005*	-.000
PastPerf-Market-Num	.242**	.108	.001	.001
PastPerf-Market-Subj	-1.052**	-.289	.185***	.099***
PastPerf-Own-Num	-.026	-.054	-.010***	-.006**
PastPerf-Own-Subj	-.042	.273	.178***	.221***
Constant	7.656***	6.073**	2.602***	3.031***

Table 7. Regression coefficients for effects of past performance variables on numeric and subjective return expectations for market and personal portfolio.

- significant at 5% ; ** significant at 1% level.; *** significant at 0.1% level

	September - December			**December – March**			**March – June**		
	Δ Risk Taking >0	Δ Risk Taking <0	z-score	Δ Risk Taking >0	Δ Risk Taking <0	z-score	Δ Risk Taking >0	Δ Risk Taking <0	z-score
Diff. Risk Attitude 2	0.18	0.01	0.54	0.04	-0.09	1.19	0.14	0.12	0.60
Diff. Risk Attitude 6	-0.01	0.22	-1.23	-	-	-	-	-	-
Diff. Risk Attitude 7	0.03	-0.04	0.22	-	-	-	-	-	-
Diff. Market-Return-Num	0.94	3.94	-0.07	3.13	0.52	1.40	-0.14	-2.39	1.45
Diff. Market-Risk-Num	0.02	0.03	-0.62	0.00	-0.01	1.57	0.02	0.02	0.35
Diff. Market-Return-Subj	0.40	-0.03	2.02*	0.51	0.05	2.47*	0.58	-0.18	2.31*
Diff. Market-Risk-Subj	-0.05	0.56	-3.35**	-0.20	-0.02	-1.21	-0.69	-1.12	1.19
Diff. Own-Return-Num	2.98	3.25	0.25	3.15	3.41	0.56	0.73	-0.15	1.36
Diff. Own-Risk-Num	0.03	0.02	0.93	0.00	-0.02	2.09*	0.02	0.02	-0.43
Diff. Own-Return-Subj	-0.07	-0.02	0.04	0.30	0.02	1.33	0.59	-0.03	2.07*
Diff. Own-Risk-Subj	0.24	0.32	-0.77	0.46	0.06	1.27	-0.25	-0.18	-0.32
Diff. Past Perf. External	-8.99	-14.83	0.56	5.57	4.47	0.15	16.37	18.71	-1.52
Diff. Past Perf. Market Num	-11.84	-5.88	-1.42	9.04	10.10	-0.70	25.40	20.70	0.87
Diff. Past Perf. Market Subj	-0.70	-0.67	-0.17	0.35	0.68	-1.18	2.96	2.91	0.07
Diff. Past Perf. Self Num	-13.00	-12.89	0.60	11.60	8.91	0.40	22.71	19.11	0.94

Table 8: Predictors of changes in risk taking.

This table reports regression coefficients of clustered Tobit regressions where standard errors take clustering over subjects into account. The dependent variable in each model is changes in risk taking (*Diff. Risk Taking*). Independent variables are changes in: risk attitude, expectations, and past performance as well as demographic variables. All change or differences variables are calculated for each person separately, as the value on the current survey minus the value on the previous survey. Columns are explained in the text.

*significant at the 10% level, **significant at the 5% level, and *** significant at the 1% level.

	1	**2**	**3**	**4**	**5**	**6**
Diff. Risk Attitude 2	0.93			0.98	1.11	1.05
Diff. Market-Return-Num			0.08		0.10	0.04
Diff. Market-Risk-Num			3.23		6.47	9.88
Diff. Market-Return-Subj		2.65***		2.62***	2.33***	2.32***
Diff. Market-Risk-Subj		-1.423*		-1.451*	-1.52*	-1.57**
Diff. Past Perf. Market Num					-0.10	
Diff. Past Perf. Market Subj						0.25
Demographics	no	no	no	no	yes	Yes
Dummy-Period 2-1	-12.36	-10.14***	-12.49***	-10.26***	-13.66***	-9.50**
Dummy-Period 3-2	-14.48***	-13.08***	-15.52***	-12.89***	-14.86***	-12.65***
Constant	7.99***	6.17***	8.19***	6.09***	10.15	5.03
Observations	572	569	539	569	527	527

Figure 1.

Value of Financial Times Stock Exchange (FTSE) all-share index representing approximately 98% of the UK's market capitalization from June08 to September09.

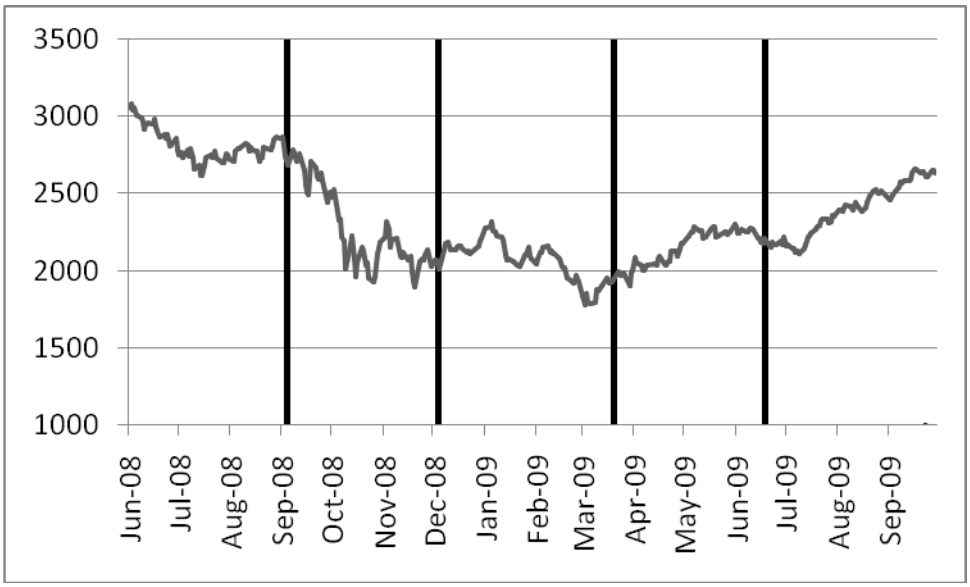


Figure 2.

Mean percentage invested into risky market portfolio (diamond symbols), mean subjective market risk expectation (triangle symbols), and mean subjective market return expectation (square symbols) at four consecutive assessed time points.

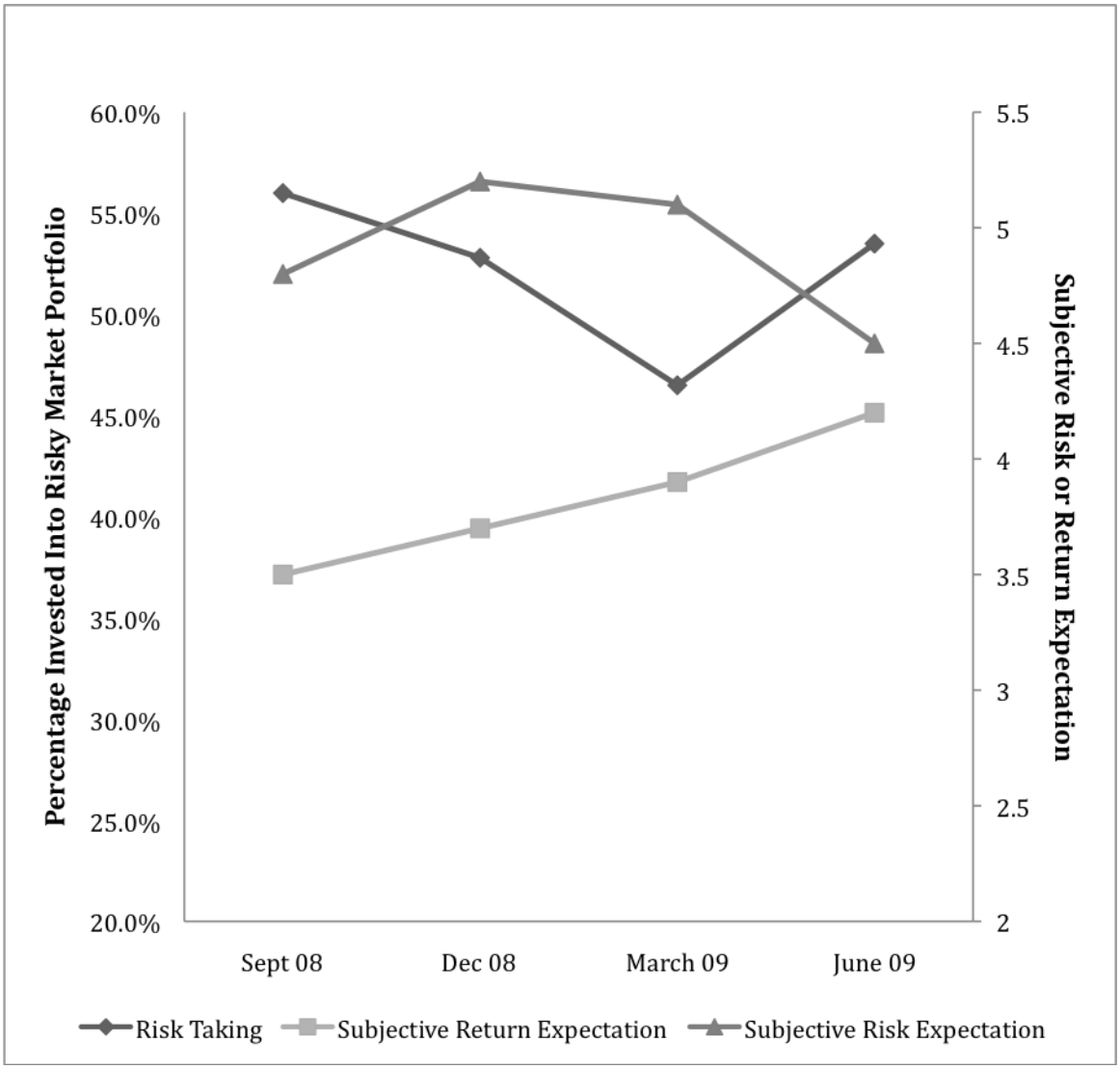


Figure 3.

Distribution in percentage of self-reported risk attitudes (Risk Attitude 6: "I am a financial risk taker," with categories ranging from 1=strongly disagree to 7=strongly agree), by time of elicitation (Round 1 = Sept08, Round 2 = Dec08, Round 3 = March09, Round 4 = June09).

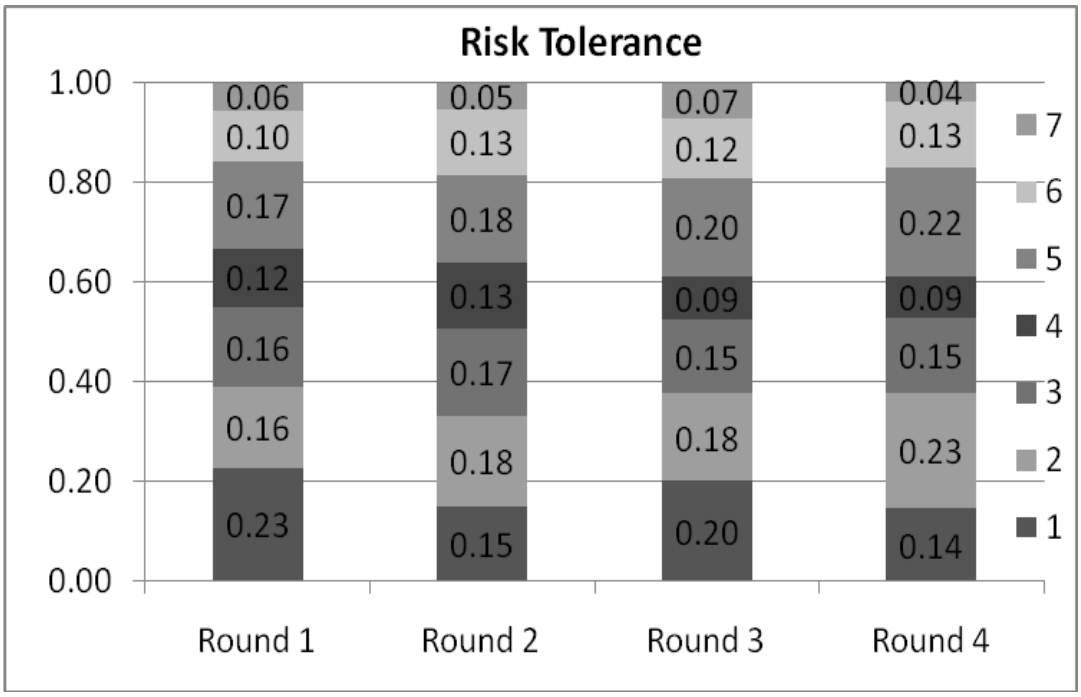
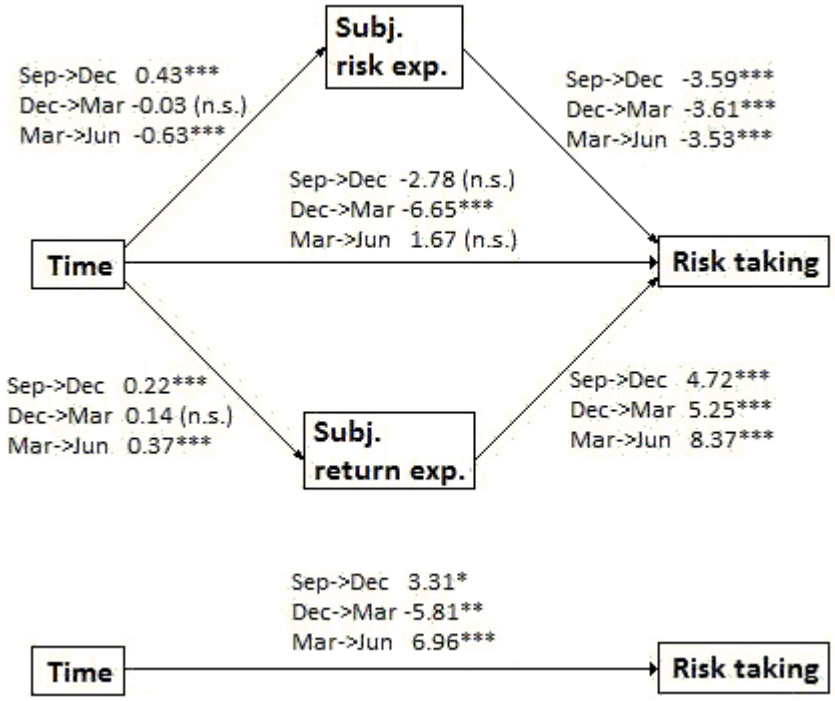


Figure 4.
Results of Mediation Analysis.



Appendix

Variable (Order)	Exact wording of survey questions
Risk Taking	
Risk Taking (3) *(3) = third question*	"Now imagine you have an overall wealth of £100,000 and you could invest this amount either in a risk-free investment with a safe interest rate of 4% or into the UK stock market (FTSE all-share). How much would you invest in the in the UK stock market (FTSE all-share)?" (0 = invest everything into the risk free asset; 100 = invest everything into the risky stock market).
Risk Attitude	
Risk Attitude 2 (7)	"It is likely I would invest a significant sum in a high risk investment." (1 = Strongly disagree ... 7 = Strongly agree)
Risk Attitude 6 (8)	"I am a financial risk taker." (1 = Strongly disagree ... 7 = Strongly agree)
Risk Attitude 7 (9)	"Even if I experienced a significant loss on an investment, I would still consider making risky investments." (1 = Strongly disagree ... 7 = Strongly agree)
Expectations	
Market-Return-Num. *Market-Risk-Num(4).*	"In the next questions, we would like you to make three estimates of future stock market returns. * Your middle estimate should be your best guess (as likely be above the actual value as below it); * Your high estimate should be lower than the actual value very rarely (about once in 20 estimates); * Your low estimate should be above the actual value very rarely (about once in 20 estimates); Please enter your response as a percent, i.e. a rise as X%, or a fall as -X%. The return of the **UK stock market (FTSE all-share)** in **3 months**:"

	For *Market-Return-Num.* the middle estimate is used. For *Market-Risk-Num.* the implicit expected volatility is calculated from the high and low estimates using the two-point approximation by Keefer and Bodily (1983).
Market-Return-Subj.(1)	"How would you rate the returns you expect from an investment in the UK stock market (FTSE-All- Share) over the next 3 months?" (1 = Extremely bad ... 7 = Extremely good)
Market-Risk-Subj.(2)	"Over the next 3 months, how risky do you think the UK stock market (FTSE-All- Share) is?" (1 = Not risky at all ... 7 = Extremely risky)
Own-Return-Num. *Own-Risk-Num. (12)*	"In the next questions, we would like you to make three estimates of future returns on investments held with us. * Your middle estimate should be your best guess (as likely be above the actual value as below it); * Your high estimate should be lower than the actual value very rarely (about once in 20 estimates); * Your low estimate should be above the actual value very rarely (about once in 20 estimates); Please enter your response as a percent, i.e. a rise as X%, or a fall as -X%. The return of **your portfolio held with us** in **3 months** time:" For *Own-Return-Num.* the middle estimate is used. For *Own-Risk-Num.* the implicit expected volatility is calculated from the high and low estimates using the two-point approximation by Keefer and Bodily (1983).
Own-Return-Subj.(13)	"How would you rate the returns you expect from your own portfolio over the next 3 months?" (1 = Extremely bad ... 7 = Extremely good)

Own-Risk-Subj.(14)	"Over the next 3 months, how risky do you think the investments in your own portfolio are?" (1 = Not risky at all ... 7 = Extremely risky)
Past Performance	
PastPerf.-External (15)	"What do you think your return (percentage change) of investments held elsewhere over the past three months was? If you hold all of your investable assets with us, enter zero. Please enter your response as a percent change, i.e. a rise as X%, or a fall as -X%."
PastPerf.-Market-Num. *(10)*	"What do you think the UK stock market (FTSE all-share) return (percentage change) over past three months was? Please enter your response as a percent change, i.e. a rise as X%, or a fall as -X%."
PastPerf.-Market-Subj *(11).*	"How would you rate the returns of the UK stock markets (FTSE-All-Share) over the past 3 months?" (1 = Extremely bad ... 7 = Extremely good)
PastPerf.-Own-Num.(5)	"What do you think your return (percentage change) with us over past three months was? Please enter your response as a percent change, i.e. a rise as X%, or a fall as -X%."
PastPerf.-Own-Subj.(6)	"How would you rate the returns of your portfolio (all investments held with us) over the past three months?" (1 = Extremely bad ... 7 = Extremely good)