Beliefs About the Stock Market and Investment Choices: Evidence from a Field Experiment*

Christine Laudenbach Annika Weber Rüdiger Weber Johannes Wohlfart

October 3, 2022

Abstract

We survey retail investors at an online bank to study how beliefs about the autocorrelation of aggregate stock returns shape investment decisions measured in administrative account data. Individuals' beliefs exhibit substantial heterogeneity and predict trading responses to market movements. We inform half of our respondents that, historically, the autocorrelation of returns was close to zero, which persistently changes their beliefs. Among those who initially believe in mean reversion, treated respondents buy significantly less equity during the Covid-19 crash months later. Our results provide causal evidence on the drivers of disagreement and trade in asset markets.

JEL Classification: D83, D84, D91, E71, G11, G12, G41, G50.

Keywords: Expectation Formation, Retail Investors, Trading, Field Experiment.

*Christine Laudenbach, Department of Finance, SAFE and Goethe University (email: laudenbach@safe-frankfurt.de); Annika Weber, House of Finance, Goethe University Frankfurt and SAFE, (email: annika.weber@hof.uni-frankfurt.de); Rüdiger Weber, WU Vienna and VGSF (e-mail: ruweber@wu.ac.at); Johannes Wohlfart, Department of Economics and CEBI, University of Copenhagen, CESifo, Danish Finance Institute (e-mail: johannes.wohlfart@econ.ku.dk). We are grateful for helpful comments from Peter Andre, Felix Chopra, Hans-Martin von Gaudecker, Michalis Haliassos, Tobin Hanspal, Michael Kosfeld, Theresa Kuchler, Christoph Merkle, Emi Nakamura, Arna Olafsson, Enriquetta Ravina, Chris Roth, Sonja Settele, Oscar Stolper, Ernst-Ludwig von Thadden, Julian Thimme, Clemens Wagner, Ole Wilms, Joachim Winter and Basit Zafar, from seminar audiences at WU Vienna, the University of Copenhagen, Copenhagen Business School, the University of Sussex, the University of Tuebingen, Goethe University Frankfurt, the University of Bonn, the University of Cologne, the Helsinki Finance Seminar, the University of St Gallen, and the Berlin Behavioral Economics Seminar Series, and from participants at the WAPFIN conference (NYU Stern), the European Finance Association Annual Meeting, the Field Days Workshop, the SGF Annual Conference, the CEBI Workshop of Subjective Beliefs in Macro and Household Finance, the International Conference on Household Finance (Bundesbank), the Society for Experimental Finance Conference, the Joint ECB-NY Fed Conference on Expectations Surveys, the 12th ifo conference on Macroeconomics and Survey Data, the Behavioral Measurement Conference, and the Bundesbank Workshop on Survey Expectations. Agnete Johansen Pade provided excellent research assistance. We received ethics approval from Goethe University Frankfurt. The survey is registered in the AEA RCT Registry as Trial 8462. We thank the Center for Economic Behavior and Inequality (CEBI), the Leibniz Institute SAFE, Goethe University Frankfurt, the Joachim Herz Foundation, INQUIRE Europe, and the Society for Experimental Finance for financial support. The activities of the Center for Economic Behavior and Inequality (CEBI) are funded by the Danish National Research Foundation, Grant DNRF134. Support from the Danish Finance Institute (DFI) is gratefully acknowledged. Laudenbach: partially funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany´s Excellence Strategy – EXC 2126/1– 390838866.

1 Introduction

Expectations about asset returns are central in macroeconomics and finance. They shape portfolio choices and saving behavior, influence asset prices, and ultimately guide the allocation of scarce capital resources in the economy. Empirically, households' return expectations often deviate from what is implied by standard theories. For instance, there are important deviations from rational expectations (Adam, Marcet and Beutel, 2017; Malmendier and Nagel, 2011) and a substantial amount of disagreement across households, which is reflected in heterogeneity in portfolio decisions (Giglio, Maggiori, Stroebel and Utkus, 2021a). Based on these findings, a recent literature incorporates more realistic belief formation mechanisms into macro-finance models, which has important implications for model predictions about both aggregate and individual outcomes (Adam and Nagel, 2022). However, to date there is limited *causal* evidence on (i) what is driving disagreement about expected returns and (ii) how return expectations affect investors' trading decisions.

In this paper, we study these two questions using a field experiment with retail investors. We propose that heterogeneous beliefs about the predictiveness of specific state variables for future returns are an important driver of disagreement about expected returns. Heterogeneous beliefs about predictiveness could arise for different reasons, such as investors relying on different subjective models (Andre, Pizzinelli, Roth and Wohlfart, 2022a), the use of different heuristics (Barberis, Greenwood, Jin and Shleifer, 2015), or investors forming their forecasting rules in light of different experiences (Malmendier and Nagel, 2011). In particular, we focus on beliefs about return predictability based on recent realized returns, that is, the autocorrelation of aggregate stock returns. Heterogeneity in these beliefs could lead to differences in how information about new return realizations is processed, which in turn results in disagreement about future expected returns and trading. Our focus is motivated by previous literature suggesting that recent return realizations are central to households' beliefs about future returns (Dominitz and Manski, 2011; Greenwood and Shleifer, 2014; Vissing-Jorgensen, 2003). However, we also explore the idea that individuals hold divergent views on the predictiveness of other state variables, such as valuation ratios, which might contribute to disagreement about expected returns.

We conduct a survey of about 2,000 stockholders that are clients of a major German online bank. In our survey, we elicit respondents' beliefs about the historical autocorrelation of stock returns using a new, individual-level measure. Specifically, we first ask respondents to think of six bins of historical annual return realizations of the German stock market index (DAX) during the last 50 years. For each return bin, respondents are asked to provide an estimate of the average return of the DAX over the subsequent 12 months when the return over the previous 12 months fell into the respective bin. Subsequently, a random half of the respondents are informed about the actual historical conditional mean return over the following year for each of the six bins. Actual conditional mean returns in the six bins vary only narrowly around the unconditional historical average return of the DAX of 8.5%, illustrating the low historical degree of predictive

power of recent returns for future returns at the annual horizon.[1] In both the main survey and a four-week follow-up survey, we then measure our respondents' posterior beliefs about the autocorrelation of returns and the expected return over the 12 months after the survey.

Our information intervention generates exogenous variation in beliefs about the autocorrelation of aggregate returns, which allows us to examine whether heterogeneity in these beliefs is a causal driver of disagreement in return expectations. Moreover, by linking the treatment variation with administrative account data on trading decisions before and after the intervention, we obtain causal evidence on the role of individuals' subjective beliefs in their investment choices. Due to the randomized nature of our intervention, our experimental evidence is immune to concerns related to omitted variables or reverse causality, which often plague correlational evidence on the relationship between beliefs and economic decisions.

We document four sets of results. First, we provide descriptive evidence on our respondents' prior beliefs. There is a large degree of heterogeneity in beliefs about the historical autocorrelation of stock returns. More than half of the investors believe in a negative autocorrelation and about one fourth believe in a positive autocorrelation, depending on the exact classifications we use. We refer to such beliefs as beliefs in mean reversion and in persistence, respectively. Beliefs in mean reversion are more prevalent among those with higher wealth and among respondents who pay more attention to the stock market. Moreover, respondents' beliefs about the autocorrelation of aggregate returns have strong predictive power for their expectations about the 12-month-ahead return at the time of the survey. This suggests that part of the disagreement in return expectations in the stock market is due to differences in investors' beliefs about the predictiveness of recent return realizations for future returns. We also present evidence suggesting that investors' memory and experiences (Enke, Schwerter and Zimmermann, 2022; Malmendier and Nagel, 2011) play an important role in driving beliefs about the autocorrelation of returns. Moreover, using additional data collections, we show that beliefs about the autocorrelation are similar across samples from Germany and the US but vary strongly across groups, with beliefs in persistence being most prevalent in the general population.

Second, we study whether respondents' perceived autocorrelation of returns matches the timing of their equity transactions at the online bank over the five years before the intervention. Respondents reporting a belief in mean reversion are significantly more likely to purchase equity following negative returns compared to those believing in persistence, conditional on permanent differences in trading behavior across groups. For instance, mean reverters increase their buying volume by 19% in response to negative returns relative to extrapolators. Moreover, beliefs about the historical autocorrelation predict fluctuations in the equity share of respondents' holdings

[1]This is in line with other evidence suggesting that, empirically, the autocorrelation of aggregate returns is close to zero at the annual horizon (Fama and French, 1988; Huang, Li, Wang and Zhou, 2020; Nagel and Xu, 2022b). By contrast, other variables such as valuation ratios have been shown to be predictive of future aggregate returns (Cochrane, 2008, 2011), albeit with low coefficients of determination and poor out-of-sample performance (Welch and Goyal, 2008).

with the bank over time. These findings validate our survey measure and suggest that beliefs about the autocorrelation of returns play a role in retail investors' trading decisions.

Third, we examine the effect of the information intervention on individuals' beliefs. The treatment strongly reduces respondents' beliefs in mean reversion or persistence of aggregate returns, as measured by their agreement with two corresponding verbal statements. Our treatment completely closes the gaps in these beliefs between prior mean reverters or extrapolators and those who perceived an autocorrelation close to zero before the intervention. Moreover, the information induces respondents to update their expectations about the return of the German stock market over the 12 months after the survey in line with the change in their perceived autocorrelation. Most of the experimentally induced changes in beliefs persist in a follow-up survey conducted four weeks after the intervention, mitigating concerns related to experimenter demand effects or numerical anchoring (Cavallo, Cruces and Perez-Truglia, 2017; Haaland, Roth and Wohlfart, 2021). Taken together, these findings highlight that investors' beliefs about the dynamics of returns are elastic and can be persistently changed through factual information. Moreover, these results imply that heterogeneity in the perceived autocorrelation of returns is a causal driver of disagreement in stock return expectations.

Finally, we study whether respondents adjust their trading behavior as measured in administrative account data in response to the information. The experimentally induced changes in beliefs cause only minor adjustments in respondents' equity investments over the first months after the survey, during which the stock market was fairly stable. However, treated prior mean reverters display a significantly smaller increase in equity purchases in response to the Covid-19 stock market crash four to five months after the intervention compared to non-treated mean reverters. This is consistent with the idea that our treatment reduces the increase in return expectations triggered by the crash among this group. Our treatment closes between 60% and 100% of the gap in trading reactions to the shock between mean reverters and non-mean reverters as measured in the control group. For instance, the treatment reduces the buying volume among mean reverters by about 29%, while in the control group non-mean reverters reduce their buying volume by about 32% relative to mean reverters in response to the crash. Among prior non-mean reverters, the treatment effects are smaller and insignificant but directionally in line with the change in their beliefs. These findings suggest that retail investors' beliefs about the dynamics of returns causally affect their trading decisions.

Taken together, our findings highlight substantial heterogeneity in beliefs about the predictiveness of recent returns for future returns, which in turn causally contributes to the previously documented disagreement in stock return expectations across investors (Giglio et al., 2021a). Retail investors' beliefs about the dynamic properties of returns also causally affect their investment choices, which suggests that heterogeneity in these beliefs is potentially an important driver of trade in asset markets. Our findings lend support to a class of models in which trade arises due to differences in how investors evaluate the same piece of information (Banerjee

and Kremer, 2010; Dumas, Kurshev and Uppal, 2009; Harris and Raviv, 1993; Harrison and Kreps, 1978; Scheinkman and Xiong, 2003). Our results are most supportive of theories such as Barberis et al. (2015), where one class of investors extrapolates recent returns, while another class believes in mean reversion. In line with this model, our findings suggest that extrapolators' higher equity demand following high return realizations is at least partly accommodated by groups of retail investors believing in mean reversion. While we focus on recent return realizations, our findings likely extend to other state variables that individuals may use to form their return expectations. Using an additional data collection, we confirm our findings of heterogeneity, elasticity to new information, and a causal link to return expectations in the context of beliefs about how valuation ratios predict future returns. At a more general level, our findings are in line with recent literature documenting heterogeneity in individuals' perceptions of macroeconomic relationships in different contexts (Andrade, Crump, Eusepi and Moench, 2016; Andre et al., 2022a; Andre, Haaland, Roth and Wohlfart, 2022b; Armona, Fuster and Zafar, 2019), pointing to the importance of accounting for such heterogeneity in empirical and theoretical research in macroeconomics and finance.

Several previous studies have provided evidence on the role of recent return realizations in individuals' return expectations. Some papers document that average return expectations reported in household surveys increase following high return realizations (Greenwood and Shleifer, 2014; Vissing-Jorgensen, 2003). Other papers use panel data to classify individuals according to how they update their return expectations following changes in realized returns (Dominitz and Manski, 2011; Heiss, Hurd, van Rooij, Rossmann and Winter, 2022; von Gaudecker and Wogrolly, 2022), and find that beliefs in persistence, beliefs in mean reversion, and beliefs that the stock market follows a random walk with drift are all fairly prevalent among households. A key advantage of our approach of measuring individuals' perceived autocorrelation directly is that we can hold constant beliefs about the return in the previous period. This allows us to shut down information frictions regarding the current state of the economy as a key alternative driver of disagreement about expected returns. To the best of our knowledge, ours is the first paper to provide direct causal evidence on the role of beliefs about the autocorrelation of returns in trading decisions.

A number of papers have used survey data to study the link between stock market beliefs and investor behavior (Ameriks, Kézdi, Lee and Shapiro, 2020; Amromin and Sharpe, 2013; Arrondel, Calvo-Pardo, Giannitsarou and Haliassos, 2022; Beutel and Weber, 2022; Das, Kuhnen and Nagel, 2020; Dominitz and Manski, 2007; Drerup, Enke and Von Gaudecker, 2017; Kézdi and Willis, 2011; Malmendier and Nagel, 2011). Only few studies have linked survey data on beliefs with administrative account data on investment decisions (Andersen, Hanspal, Martinez-Correa and Nielsen, 2021; Hoffmann, Post and Pennings, 2015; Merkle and Weber, 2014). For instance, Giglio et al. (2021a) show that the return expectations of Vanguard clients measured in surveys correlate significantly with their investment decisions as measured in administrative data, but the relationship is an order of magnitude smaller than implied by standard models. Giglio,

Maggiori, Stroebel and Utkus (2021b) study the joint dynamics of stock return expectations and trading decisions of Vanguard clients during the Covid-19 crash. Meeuwis, Parker, Schoar and Simester (2021) study relative changes in investment decisions among households with different party affiliation around the 2016 presidential election, which are most likely driven by changes in beliefs. We add to this literature by exploiting experimental variation to study the causal effect of beliefs on investment decisions in the field.

Our paper also contributes to a literature that uses information provision experiments to study macroeconomic expectation formation of households (Armantier, Nelson, Topa, van der Klaauw and Zafar, 2016; Binder and Rodrigue, 2018; Cavallo et al., 2017; Coibion, Gorodnichenko and Weber, 2021; D'Acunto, Fuster and Weber, 2022; Hanspal, Weber and Wohlfart, 2021; Roth and Wohlfart, 2020).[2] Closely related to our study, Armona et al. (2019) use an information experiment to show that US households under-estimate the long-run mean reversion in local house prices. Beutel and Weber (2022) examine how return expectations and choices in an investment game respond to various theoretically relevant pieces of information. We make two key contributions to this literature. First, other studies provide respondents with information about past realizations or expert forecasts. Respondents' belief updating then provides indirect evidence on their beliefs about the underlying data generating process. By contrast, we directly measure and shift respondents' beliefs about statistical relationships between variables. This allows us to provide causal evidence on how these beliefs affect expectation formation and decisions. Second, to the best of our knowledge, ours is the first study to link an information experiment with administrative data on actual trading decisions.[3] Our findings highlight that simple information interventions can change economic decisions months later. From a methodological perspective, our results demonstrate the relevance of information provision experiments as a method to study belief formation and the effects of beliefs on real-world behaviors.

2 Experimental design and data

2.1 Framework

In this section we discuss how heterogeneous beliefs about the predictiveness of state variables may shape disagreement in return expectations and highlight potential sources of such heterogeneity. Moreover, we motivate our focus on the realized return as predictor variable.

Beliefs about predictiveness Our object of interest are agents' beliefs about the predictiveness of the realization of a state variable – such as the return over the last period – for next period's return. Generally, it is plausible that an agent considers multiple state variables to be predictive

[2] See Haaland et al. (2021) for a review of the literature using information provision experiments.

[3] A few other papers link information experiments shifting macroeconomic expectations with non-self-reported data on decisions, e.g., Coibion et al. (2021), Coibion, Georgarakos, Gorodnichenko and Weber (2022) and Galashin, Kanz and Perez-Truglia (2022) for inflation expectations and spending, and Bottan and Perez-Truglia (2022) in the context of home selling decisions.

of future returns. We denote the full vector of the N state variables in the economy by $\mathbf{X_t}$. The function $\hat{f}^i$ describes agent i's perceived relationship between the state vector and conditional expected returns:

$$E_t^i[R_{t+1}|\mathbf{X_t}] = \hat{f}^i(\mathbf{X_t}) \tag{1}$$

Beliefs about the relationship between different state variables and future returns, $\hat{f}^i$, do not need to coincide with the true relationship, f, and may vary across agents. Specifically, agents may hold different views about the extent to which specific state variables have predictive power for future returns, including which subset of state variables have any predictive power at all.

One source of heterogeneity in beliefs about predictiveness could be differences in the mental models agents rely on in their expectation formation. It is illustrative to think of agents who believe in a canonical macro-finance model. For instance, an agent who believes in the Bansal and Yaron (2004) model would consider long-run consumption growth and consumption volatility as relevant state variables. An agent who believes in the Campbell and Cochrane (1999) model would think that expected return variation is solely determined by the surplus consumption ratio. Other sources of heterogeneity in beliefs about predictiveness could be agents using different heuristics (Barberis et al., 2015), varying degrees of familiarity with empirical regularities detected by research in finance (such as the countercyclicality of expected returns documented in Fama and French (1989)), or agents relying on their (heterogeneous) experiences when forming their views on predictiveness (Malmendier and Nagel, 2011). In our paper we mostly focus on the role of beliefs about predictiveness in driving respondents' return expectations and trading and do not take a stance on the exact sources of these beliefs.[4]

Agents' beliefs about the relationship between different state variables and future returns, $\hat{f}^i$, will plausibly affect their return expectations at any given point in time. Specifically, heterogeneity in the perceived relationships across agents will lead to differences in how incoming information about realizations of state variables is processed, and thereby contribute to disagreement about expected returns and trade. Agents will likely not only differ in their beliefs about predictiveness, but also in their beliefs about the current realizations of different state variables, so they will base their return expectations on a perceived state vector, $\hat{\mathbf{X}}_{\mathbf{i,t}}$, which may deviate from the actual realization, $\mathbf{X_t}$.[5]

Eliciting beliefs about predictiveness in a survey To facilitate a parsimonious elicitation, we ask survey participants about their return expectations conditional on just one state variable, the recently realized return. In some models, agents use forecasting rules based directly on past return realizations, such as the agents in Barberis et al. (2015). However, agents may

[4]We provide some evidence on the role of memory and experiences in Section 3.2 below.

[5]Moreover, if agents have limited cognitive capacity, they may not take into account all N state variables when forming return expectations but instead restrict their attention to a subset, potentially even neglecting state variables they believe to have some predictive power.

have a multidimensional state space in mind when forming expectations. Focusing on just one predictor variable implies that we are asking the agent for a projection of future returns onto a one-dimensional state space. This necessarily falls short of fully representing the up to N-dimensional state space that agents may consider, irrespective of what component x_k of $\mathbf{X}$ is used as a conditioning variable. In our case, using the recent return as the single state variable picks up beliefs about the predictability of returns by any state variable that is related to realized returns. To give a stylized example, when observing a lower realized return, an agent who believes in the Campbell and Cochrane (1999) model may believe that the consumption surplus ratio has dropped and future returns are somewhat higher in expectation. We explore the possibility that investors' reported beliefs about the predictiveness of recent returns reflect their beliefs about the predictiveness of other state variables later in the analysis. We also discuss the implications of measuring beliefs about returns conditional on just one variable for many of our findings throughout the paper. Further, some agents may not find the conditioning variable useful when forming expectations. For instance, an agent who believes in the Lucas (1978) model would think that expected returns are constant, irrespective of any component x_k. This is unproblematic since our elicitation method described below allows respondents to express the belief that the conditioning variable is unrelated to expected returns.

We focus on recent realized returns as conditioning variable for three main reasons. First, recent returns seem to play a central role in households' return expectations and trading behavior. For instance, previous literature documents a tendency to extrapolate recent returns (Greenwood and Shleifer, 2014; Vissing-Jorgensen, 2003) or beliefs in mean reversion among groups of investors (Dominitz and Manski, 2011; Heiss et al., 2022). Similarly, households' and experts' average return expectations strongly co-move with recent return realizations, but are largely uncorrelated with business cycle variables or aggregate asset valuation measures (Nagel and Xu, 2022b). Second, in an additional descriptive survey conducted with clients of the same bank, respondents report higher levels of familiarity with returns than with other financial concepts, such as volatility or valuation ratios (Appendix Figure A.2). In line with this, respondents to the same survey and to an additional experimental investor survey are more confident in their beliefs about the recent return (64% are "confident" or "very confident") than in their beliefs about the current price-dividend ratio (33% are "confident" or "very confident").[6] Focusing on the recent return as predictor variable should thus facilitate a relatively straightforward elicitation of beliefs, providing us with meaningful belief data. Finally, focusing on the autocorrelation of annual returns offers an empirical benchmark of a yearly autocorrelation close to zero - which has been documented for the US (Fama and French, 1988; Nagel and Xu, 2022b) and which also applies in our German setting (see Appendix A.2). The empirical benchmark is less clear for other state variables. For instance, while the price-dividend ratio is a predictor of future returns in the US, the price-dividend ratio of the German stock market mostly predicts variation in

[6]Appendix Table A.1 provides an overview of our different data collections.

future dividend growth rather than returns (Appendix A.2 and Rangvid, Schmeling and Schrimpf (2014)). Nevertheless, in Appendix A.8 we use a complementary experiment to show that many of our take-aways carry over to beliefs about return predictability based on valuation ratios.

In our experiment, we elicit our respondents' beliefs about the autocorrelation of returns during the past 50 years. This allows for a comparison to a factual benchmark and to shock these beliefs by providing information on the muted relationship between recent and future returns over this time period. The resulting variation in investors' beliefs about return predictability allows us to study the causal effect of these beliefs on investors' return expectations and trading decisions. Naturally, the current, forward-looking relationship between recent and future returns may differ to some extent from its historical counterpart. Importantly, our empirical strategy does not require our respondents to fully adopt the view that there is a stable zero-relationship between recent return realizations and future returns, and allows respondents to believe that the relationship is time-varying. For our intervention to generate exogenous variation in beliefs we merely require respondents to consider the information on the historical empirical autocorrelation somewhat relevant for the dynamics of stock returns at the time of our survey and afterwards.

2.2 Main survey

Our main experiment consists of three stages: (i) a baseline stage eliciting respondents' prior beliefs; (ii) a treatment stage in which respondents receive information; and (iii) a final stage eliciting posterior beliefs and a set of background characteristics. Appendix B provides the survey instructions translated to English.

Baseline stage: Prior beliefs We first elicit respondents' point beliefs about the return of the German stock market index (DAX) over the 12 months before the survey and over the 12 months after the survey. To measure respondents' prior beliefs about the autocorrelation of returns, we then present participants with six different intervals of 12-month return realizations of the DAX, which are mutually exclusive and collectively exhaustive.[7] For each interval, starting from the lowest one, we instruct respondents to think of all points in time over the past 50 years at which the return of the DAX over the preceding 12 months had fallen into the respective interval, and ask them to estimate the average return of the DAX over the subsequent 12 months for these cases. For each return interval, the prediction is elicited on a separate screen. A graph displays respondents' estimates for the current and for all previous scenarios in real time as blue bars. Figure 1 Panel A displays an example survey screen after forecasts for all six scenarios have been submitted. If a respondent believes that, historically, the return of the stock market was predictable by the realized return over the previous year, this should show up as non-constant estimates entered across the six bins. For instance, an upward sloping pattern in the displayed graph would indicate extrapolative beliefs, while a downward sloping pattern would

[7]The intervals are "less than -20%", "between -20% and -10%", "between -10% and 0%", "between 0% and 10%", "between 10% and 20%", and "above 20%".

indicate a belief in mean reversion.[8] An advantage of this way of eliciting beliefs about the autocorrelation of returns is that it requires no knowledge of statistical concepts beyond averages from respondents.

Treatment stage: Non-informativeness of recent return realizations In the second stage, a random half of the respondents are assigned into the treatment group, while the other half are assigned to the control group. Respondents in the treatment group receive information on the actual historical average realizations of 12-month-ahead returns for each of the six bins of returns over the preceding 12 months. The actual mean realized returns displayed to respondents vary narrowly between 7.4% and 9.5% across the six intervals, and there is no clear monotonic relationship between past 12-month returns and returns over the next 12 months. This illustrates that, historically, recent realized returns of the DAX have not been informative for future returns at the one-year horizon.[9]

The treatment information is communicated as follows: respondents are again shown the graph displaying their prior estimates, illustrated as six blue bars. Respondents have to repeatedly click on a button and learn about the actual historical mean return realization over the next 12 months one-by-one for each interval of previous returns. Actual historical values are displayed as orange bars next to participants' priors. In addition, for each case, a written sentence is displayed above the graph that reminds participants of their corresponding prior and informs them about the actual historical average return realization. Figure 1 Panel B displays an example screen of the treatment graph once all six actual realizations are displayed. On the next screen, respondents are again shown the complete graph with both their own estimates and the actual historical values. In addition, we provide them with a short text summarizing the content of the treatment.[10]

Control group respondents receive no information on how informative returns over the previous 12 months were for returns over the next 12 months, but are merely informed about the unconditional historical average annual return on the DAX over the last 50 years of 8.5%. We

[8] In line with previous literature (Amromin and Sharpe, 2013; Dominitz and Manski, 2011; Giglio et al., 2021a), we focus on nominal stock returns to make our survey questions easy to understand for participants. One concern could be that longer-run trends in the risk-free rate or inflation could give rise to a positive autocorrelation of nominal stock returns. However, as can be seen in Figure 1, this is not the case for the German stock market, and also does not seem to hold more generally (Fama and French, 1988).

[9] These returns are calculated comparing weekly averages of aggregate stock prices over 12-month periods using data on the German stock market index (DAX) over the past 50 years. For the time before 1988, when the DAX was established, we use data from Thomson Reuters, which tracks back constituents until 1956. One of the values, a next-year average return, of 9.58% for previous returns between -10% and 0%, was accidentally rounded to 9.5% instead of 9.6% in the information displayed to respondents.

[10] Among others, this summary contains a sentence stating that *"any return predictability would be quickly exploited and removed by large institutional investors"*. Given that time-varying risk aversion or changes in risk perceptions could in principle give rise to a form of return predictability that would not be exploited, one could consider this sentence as problematic. However, the statement appears in the specific context of the autocorrelation of returns, so it likely does not appear as a general negation of any type of predictability in the stock market. Moreover, the sentence is less salient than other aspects of the information treatment, such as the dynamic figure, and therefore likely does not play a major role in driving treatment effects. Consistent with this intuition, Appendix A.8 describes a complementary experiment in which the treatment does not contain a statement of this kind, which yields qualitatively similar results as our main experiment.

provide this information to the control group because respondents' beliefs about the unconditional average historical return could also be affected by the treatment. By comparing respondents in the treatment and the control group we can therefore identify the effect of a change in beliefs about how future returns correlate with past realizations, holding constant beliefs about the unconditional average return.

Final stage: Posterior beliefs After the information treatment, we elicit participants' agreement with verbal statements describing different patterns of autocorrelation of aggregate stock returns, which serve as manipulation checks. We then re-elicit respondents' expectations about the 12-month-ahead return of the DAX, both as a point forecast (as for the prior) and as a subjective probability distribution. At the end of the survey, participants answer a series of questions on their financial behavior and background characteristics.

2.3 Follow-up survey

We invite respondents to a follow-up survey approximately four weeks after they completed the main survey. We choose a four-week gap to trade off between testing for persistence of treatment effects and maximizing the re-contact rate and therefore statistical power in the follow-up. The follow-up survey starts by re-eliciting respondents' beliefs about past and future 12-month returns and the historical autocorrelation.

Our prior before running the experiment was that changes in beliefs would fade quickly, as it is suggested by previous literature (Haaland et al., 2021). To achieve a more persistent first-stage effect on respondents' beliefs, which we could then use to study the causal effect of beliefs on trading decisions, we therefore decided to use the follow-up survey to again present respondents in the treatment group with the information. We do so *after* the block of questions measuring persistence of changes in beliefs due to the initial intervention, and use the same treatment design as in the main survey. Participants in the control group again receive the information on the unconditional historical average return of the DAX. After that, we elicit respondents' agreement with two additional verbal statements describing patterns of autocorrelation of stock returns.

2.4 Institutional background and survey administration

We administered the survey to clients of a German online bank in September and October 2019. The bank is among the top five online banks in terms of market share in Germany as measured by the number of clients. The bank provides full bank services offering savings and credit products in addition to its brokerage entity, and is hence used as principal bank by many clients. In a different data collection based on the same sample selection procedure at the same bank, 71% of respondents state that the portfolio they hold with the bank is their main investment account. Clients at the bank trade financial securities online in a self-directed manner. The broker does not offer any financial advice to these clients. This is important as an intermediary would likely reduce the direct impact of an individual's subjective expectations on her choices.

We sent e-mail invitations to 14,000 individuals randomly selected from the bank's client pool. To eliminate deserted accounts, we only invited clients that had conducted at least one equity transaction with the broker over the previous 12 months. We offered invitees 10 EUR for completing the main survey and 5 EUR for the shorter follow-up. All payoffs were paid in the form of online shopping vouchers and distributed via e-mail.

Overall, 2,083 individuals completed the main survey. This corresponds to a comparatively high response rate of 14.9%. 80.9% of respondents agreed to be invited for a second survey when asked at the end of the main survey. 987 investors ultimately completed the follow-up, corresponding to a re-contact rate of 58.5% among those who got invited to the follow-up. At the median, recontacted respondents completed the follow-up 26 days after the main survey. The mean (median) response time was 22.1 minutes (17.8 minutes) for the main survey and 14.2 minutes (10.2 minutes) for the follow-up.

We conducted several data collections with additional samples, which we introduce when relevant throughout the paper. Appendix Table A.1 provides an overview.

2.5 Data

Sample definition We take two steps to screen out participants who likely did not take the survey seriously or just quickly "clicked" through the questions to obtain the shopping voucher. First, we follow a similar procedure as Armona et al. (2019) and drop respondents who in the main survey report prior or posterior point expectations about the return of the DAX over the 12 months after the survey lower than -20% or higher than 20%, roughly corresponding to the first and 98th percentiles of the response distributions. This step also ensures that our OLS estimates are not driven by outliers. Second, we drop participants who take less than 8 minutes or more than 60 minutes to complete the main survey. These steps leave us with 1,961 respondents in our baseline sample for the main survey, out of which 903 respondents form the follow-up sample.[11] Our results are robust to varying the cutoffs for distributions of point forecasts or for response time used to define the sample.

Sample characteristics Columns 2-6 of Table 1 display summary statistics of our sample. Column 1 shows population benchmarks from the 2017 wave of the Bundesbank's Panel of Household Finances (PHF), which is restricted to individuals participating in the stock market. Our respondents are predominantly male (84% vs 51% in the population). The average age is 45.2 years, slightly younger than the average investor in the population (50.6 years). Sample participants are relatively highly educated, with 54% holding a university degree (36% in the population). Our respondents report an average net monthly household income of 3,914 EUR and a net household wealth of 300,488 EUR, fairly similar to the population.

[11] The follow-up sample excludes participants that are not part of the baseline sample used in the main survey and those who report expectations in the follow-up survey outside the interval $[-20\%; 20\%]$.

Administrative account data We obtain data on our respondents' month-end holdings and daily executed transactions of securities from December 2014 until March 2020 (including security identifiers, volume, and price). We merge information on the securities' asset classes and market prices from Thomson Reuters Datastream. Investors in our sample on average hold financial wealth of 55,272 EUR with the sample bank, of which 39,405 EUR are invested in equity (including direct holdings and holdings through mutual funds). Throughout our analysis, we focus on transactions in equity. The average number of equity trades per month is 1.73.[12]

Selection into the survey We also use the administrative account data to examine which clients of the online bank select themselves into our survey. Unfortunately, we do not have administrative account data for all 14,000 clients who were invited to participate. However, we have access to a sample of 3,701 clients that were randomly selected from the bank's client pool based on the same criteria as the 14,000 invited clients (at least one equity transaction with the broker over the previous 12 months). Appendix Table A.3 compares our main survey sample with this random sample. As it is common in surveys, participation in our experiment is correlated with investors' characteristics. Investors in our sample are less wealthy and trade less often compared to the average client at the bank. In addition, our respondents are somewhat younger and more likely to be male and to be employed. They are very similar to the random sample in terms of their equity share held at the bank and in terms of their risk attitude as measured by the bank. In Appendix Table A.6 we show that there are no significant differences in investors' average trading responses to stock market fluctuations between the two samples.

Integrity of the randomization Our sample is well-balanced between the treatment and the control group for a set of key demographic and financial characteristics as well as a set of pre-treatment beliefs (Table 1 Columns 7 and 8). There are a few exceptions, such as slight imbalances by education and age. To rule out any concerns, we include a set of control variables in all our estimations.

3 Descriptive evidence

3.1 Prior beliefs

Prior perceived autocorrelation We start by describing our respondents' prior beliefs about the historical autocorrelation of annual returns of the German stock market. Figure 2 Panel A shows respondents' mean estimates of the historical conditional average 12-month-ahead returns of the DAX for the six past-return intervals in our belief elicitation task. On average, respondents believe that high returns tend to be followed by low returns and vice versa, consistent with a

[12]Throughout the analysis on the administrative account data, we set observations in the top percentiles of number of purchases and number of sales to missing. We also drop observations in the top percentiles of equity purchases and sales relative to total financial wealth, as such patterns may reflect abnormal trading patterns, e.g., due to investors shifting their portfolio away from the online bank. None of our findings are sensitive to the choices of cutoffs.

belief in mean reversion. Specifically, respondents on average estimate a mean 12-month-ahead return of 13.5% for cases in which realized returns were in the lowest bin (less than -20%), and a mean 12-month-ahead return of 3.8% for instances in which previous returns were in the highest bin (more than 20%). Over the intermediate intervals, respondents' average estimates of the historical mean 12-month-ahead return monotonically decrease in the level of the previous 12-month return. Averaging over the six bins, respondents perceive a historical return of the DAX of 8.4%, almost identical to the actual unconditional historical average of 8.5%.[13]

The means conceal substantial heterogeneity in respondents' beliefs. Figure 2 Panel B displays box plots illustrating the distributions of respondents' estimates of the historical conditional mean 12-month-ahead returns for the six past-return intervals. Disagreement is highest for the two most extreme return bins. For instance, the interquartile range is three times as high for the highest bin (15 percentage points (pp)) as for moderately positive returns between 0% and 10% (5 pp).

We next study the perceived autocorrelation of returns at the individual level. First, we calculate the individual-specific standard deviation of each respondent's estimates of the 12-month-ahead returns over the six scenarios (see Figure 2 Panel C for a histogram). This measure captures any form of perceived predictability of future returns based on recent returns, and should be close to zero for those perceiving no systematic relationship. On average respondents perceive a standard deviation of 7.1 pp over the six intervals (median: 6.4 pp), while the standard deviation is 0.8 pp based on the true historical values. For part of the remaining analysis we classify investors as perceiving a high or a low degree of predictability based on previous returns by splitting the sample at the median of the individual-level perceived standard deviation.

Second, we calculate the individual-specific difference between a respondent's average estimated 12-month-ahead return across the three intervals of positive previous-year returns and the respondent's average estimate for the three negative previous return intervals. As shown in Figure 2 Panel D, the majority of our respondents (70.5%) believe that returns over the following year were systematically higher when returns in the previous year were negative than when they were positive. Thus, a belief in mean reversion seems to be most common among the investors in our sample. We classify investors as "mean reverters" if the difference in average estimated returns for the following year between positive and negative previous return scenarios is lower than -4 pp (52.5% of our sample), as "neutral" if this differences lies between -4 and 4 pp (31.9%), and as "extrapolators" if it exceeds 4 pp (15.6%). None of our findings are sensitive to the exact choice of cutoffs, as we demonstrate for our main results throughout the paper.

How are the different types distributed across the population? In Table 2 we show results of a regression of different belief measures on a set of covariates. For instance, higher education is associated with a greater standard deviation of return forecasts over the six intervals, indicating

[13] If we weight the six bins by their historical relative frequency, the average perceived unconditional return is slightly lower at 7.2%.

a higher perceived predictability, while older individuals perceive less predictability (Columns 1-2). As shown in Columns 3-6, higher financial literacy, higher investment experience, higher financial wealth, and higher attention to the DAX are associated with a significantly stronger tendency to believe in mean reversion.

Perceived autocorrelation and return expectations Similarly as in other studies, respondents to our survey exhibit substantial disagreement about the expected return over the 12 months after the survey (Appendix Figure A.3 Panel A), which could partially reflect heterogeneous beliefs about return predictability based on state variables such as the recent return. Do investors' beliefs about the historical autocorrelation of returns predict their return expectations at the time of our survey? We first select the past-return interval covering respondents' perceived return over the 12 months before the survey. Respondents on average believe that the return was 5.1% (median: 5%), and there is strong heterogeneity in respondents' return perceptions (Figure A.3 Panel B). We then study the correlation between the respondent's belief about the historical mean 12-month-ahead return in the scenario containing her return perception and the respondent's actual expected return for the 12 months after the survey.

Figure A.4 Panel A displays a binned scatterplot of this relationship that partials out a set of controls that is used throughout the paper.[14] A one pp higher perceived return in the relevant historical scenario is associated with a 0.134 pp higher expected return at the time of the survey, and the relationship is highly statistically significant ($p < 0.01$). There are several potential reasons for the less than one-to-one pass-through to return expectations. First, individuals likely do not exclusively base their return expectations on previous return realizations but may also think of other state variables, and groups of respondents may not consider previous returns at all. Second, respondents may think that the historical autocorrelation of returns in the last 50 years is only partially informative of the autocorrelation of returns at the time of our survey, e.g., due to changes in the economy. Finally, there could be some attenuation bias due to measurement error in respondents' beliefs about recent returns and the historical autocorrelation. Taken together, our first main result is the following:

Result 1. There is substantial heterogeneity in retail investors' beliefs about the autocorrelation of aggregate returns. A majority of investors believe that, historically, returns of the DAX exhibited mean reversion. Respondents' perceived historical autocorrelation has strong predictive power for their expected returns over the 12 months after the survey.

These findings suggest that heterogeneity in investors' beliefs about the predictiveness of recent returns contributes to the empirically documented disagreement in stock return expectations across investors (Giglio et al., 2021a).

[14] We include a set of demographics, survey measures of investor behavior such as trading experience and risk tolerance, measures of the respondent's holdings with the bank such as the equity share, and controls for technical issues such as taking the survey on a mobile phone. The exact definition of the control variables is provided in Appendix A.1.2.

3.2 Sources of beliefs about the autocorrelation

Although our focus lies in understanding how heterogeneity in the perceived autocorrelation translates into disagreement in return expectations and trading, we also provide some evidence on potential sources of investors' beliefs about the autocorrelation.

Beliefs about return predictability by valuation ratios One possible explanation for why many of our respondents believe in mean reversion is that they are familiar with results from research in finance pointing to return predictability based on the price-dividend ratio (Campbell and Shiller, 1988; Fama and French, 1989). According to the Campbell and Shiller (1988) decomposition, variation in the price-dividend ratio necessarily reflects changes in expected future cash flow growth or changes in expected future returns. Thus, observing high recent returns could make investors conclude that the price-dividend ratio is currently high, which in turn would lead them to predict lower future returns. This is an unlikely explanation for our findings, for at least three reasons.

First, past-12-months returns are only weakly correlated with current valuation ratios in the German stock market (see Appendix A.2 including Table A.4 Panel A), consistent with 12-month returns mostly capturing higher frequency variation and not longer-term swings in valuation ratios. Second, variation in the price-dividend ratio is mostly driven by variation in future cash flow growth in the German context (Rangvid et al., 2014), which is reflected in only weak predictability of future returns based on current valuation ratios (Appendix Table A.4 Panel B). Investors' *perceived* relationship between future returns and the current PD ratio is even weaker than the actual relationship, as we demonstrate using an additional experimental survey on a comparable sample of investors from the same bank (see Appendix A.8). Finally, in an additional descriptive survey we elicit investors' beliefs about the autocorrelation of returns and on the next survey screen ask them which of the factors on a list presented to them contributed to their estimates. Only few respondents indicate that their knowledge of academic research in finance (8.7%) or their memory of the development of other financial variables such as valuation ratios (11.5%) played a role in their estimates (see Appendix Figure A.5 Panel A). Moreover, these groups do not exhibit a significantly higher tendency to believe in mean reversion (see Table 3 Columns 1 and 2). Similarly, believing in mean reversion is unrelated to respondents' self-reported knowledge of financial market theories (Column 3). These patterns are consistent with other evidence showing that recent returns and current valuation ratios affect investors' return expectations in a largely orthogonal manner (Nagel and Xu, 2022b). Together, these points suggest that believing in a negative autocorrelation of returns is not driven by familiarity with the theory-based link between current valuation ratios and future returns.[15]

[15] In our additional descriptive survey, half of the investors report whether they also considered relationships between past and future returns of longer horizons when estimating the historical autocorrelation of 12-month returns. Longer-horizon returns should be more likely to capture swings in valuation ratios than 12-month returns. 28.5% of respondents indicate considerations of autocorrelation between longer-horizon returns. However, beliefs in mean reversion are only slightly more prevalent among this group (60% vs. 55.7%, $p = 0.620$). Similarly, only

Memory and experiences An alternative driver of beliefs is investors' memory. When investors think about the dynamic properties of stock returns, they may selectively retrieve memories of specific episodes that involved persistence or mean reversion. To shed light on this possibility, we ask respondents to our additional descriptive survey to explain in open text which past episodes – if any – they thought of in particular when reporting their perceived autocorrelation. We hand-code the resulting text data and identify nine episodes in the last decades that are mentioned by respondents and that unambiguously refer to specific stock market developments. All of these episodes are linked to salient global events and involved major market turbulences. 55.8% of investors mention at least one of them. As shown in Figure A.5 Panel B, the most frequently mentioned episodes are the Covid-19 crash in 2020 (27.9%), the Global Financial Crisis 2007-9 (35.1%), and the burst of the "dot-com bubble" in the early 2000s (18.3%). Table A.5 highlights that investors particularly retrieve those historical episodes that occurred while they were already participating in the stock market or while they had already reached adulthood. Investors' memory database thus seems to be strongly shaped by their own experiences (Malmendier and Nagel, 2011; Nagel and Xu, 2022a).[16]

While seven of these historical episodes – including the Global Financial Crisis – were associated with reversals of returns, returns did not exhibit a clear tendency to revert during the two remaining episodes - including the early 2000s recession associated with the end of the "dot-com bubble".[17] As shown in Table 3 Column 4, retrieving at least one reversal episode is associated with a 20.4 pp higher tendency to believe in mean reversion ($p < 0.01$), conditional on controls. The effect size is substantial in light of an overall fraction of mean reverters of 49% in our additional descriptive investor survey. By contrast, retrieving at least one non-reversal episode is unrelated to whether a respondent believes in mean reversion (Column 5). These patterns remain unchanged when we include various proxies for knowledge of research results from finance (Column 6). These findings suggest that thinking about the dynamic properties of returns may trigger memories of salient past stock market episodes, which in turn shape investors' perceived autocorrelation, consistent with growing evidence on the role of associative memory in belief formation and financial decisions (Andre et al., 2022a; Bordalo, Conlon, Gennaioli, Kwon and Shleifer, 2022; Charles, 2021; Enke et al., 2022; Fan, Liang and Peng, 2021).

17% of respondents report that they thought about the return development of foreign indices, which may feature a stronger predictability of returns by valuation ratios than the DAX, when reporting their perceived autocorrelation (Appendix Figure A.5 Panel A). Finally, only 24% thought about "other economic variables", suggesting that our measure of respondents' perceived autocorrelation is unlikely to capture beliefs about return predictability by, e.g., GDP growth.

[16]Moreover, our investors do not mention major events that occurred during the earlier part of the reference period (the past 50 years), consistent with recency being key to the recall of experiences (Malmendier and Nagel, 2011; Nagel and Xu, 2022a).

[17]We classify the historical episodes as follows: For each week during an episode, we compute the return over the past and the subsequent 12 months. Whenever the two returns have the opposite sign, we classify this as a reversal observation. When during a specific episode, such as the Covid-19 crash, there are more than 50% of weeks classified as reversal observations, we classify the episode as a reversal episode.

3.3 Beliefs about the autocorrelation across groups and countries

Several previous studies document that individuals on average extrapolate previous returns when forming stock market expectations (Amromin and Sharpe, 2013; Greenwood and Shleifer, 2014; Malmendier and Nagel, 2011; Vissing-Jorgensen, 2003). Our findings highlight that the focus on average beliefs conceals substantial heterogeneity in how investors adjust their expectations in response to realized returns, and that beliefs in mean reversion are widespread among retail investors.

What explains the difference in the average expectation adjustment in response to realized returns between our setting and previous literature? First, most other studies rely on time-series variation in realized returns and return expectations. However, many individuals may not track the development of realized returns, while in our measure all respondents observe the previous return in each of the six scenarios. Second, the tendency to extrapolate recent returns may vary across groups of agents. We focus on a sample of active and wealthy retail investors and, within our sample, those with more exposure or with more attention to the stock market are more likely to believe in mean reversion.[18] Third, while most of the previous literature focuses on the US, beliefs could vary across economic environments.

To better understand how beliefs about the autocorrelation of returns differ across groups and countries, we conduct additional surveys on samples that are representative of the full population in Germany and the US and on another sample of German retail investors. All three surveys were run in July and August 2022 and are described in more detail in Appendix A.1.1. Appendix Figure A.6 Panels A and B highlight that, similarly as in our main survey, respondents to the additional investor survey tend to perceive a negative relationship between realized and future returns. By contrast, as shown in Panels C-F, respondents to the German and US general population surveys on average perceive a positive relationship.

These patterns corroborate our finding that beliefs about the autocorrelation of stock returns are highly heterogeneous across groups. Moreover, this exercise suggests that differences between our findings and previous literature could originate in the different group of agents studied, while the different economic environment seems to matter less. We believe that our investor sample is of particular relevance, as our respondents actively invest in the stock market, while large fractions of the general population do not hold stocks. Examining the drivers of differences in the perceived autocorrelation across groups is beyond the scope of this paper. However, in light of the evidence presented in Section 3.2 it seems plausible that they may originate in differences in memories between investors and the general population.

[18] Nagel and Xu (2022b) show that households' return expectations are positively related to recent returns, while the return expectations of professionals in the Livingston survey co-move negatively with recent returns. Greenwood and Shleifer (2014) find a smaller response to realized returns among CFOs compared to individual investors. Older literature points to a weaker tendency to extrapolate past stock price trends among experts than among laypeople (De Bondt, 1993; Fisher and Statman, 2000).

3.4 Correlational evidence on beliefs and investment choices

In this section we examine how investors' prior beliefs about return predictability based on recent returns are correlated with their portfolio decisions as measured in the administrative account data. For this analysis, we make use of the entire history of transactions and security holdings of survey respondents with the broker since December 2014 – a period of almost five years preceding the survey. We include control group respondents until the end of January 2020, while investors in the treatment group are only part of the sample until the month before they took the survey (between September and November 2019).[19]

Equity purchases and sales We start by examining how the monthly trading activity of our respondents varies with the return of the DAX over the preceding 12 months, focusing on the average response across all belief types.[20] Appendix Table A.6 Panel A displays regressions of different measures of a respondent's buying and selling activity on a dummy variable indicating whether the return of the DAX over the last 12 months has been negative, as well as a set of macroeconomic and individual-level control variables including individual fixed effects. Compared to periods following positive return realizations, respondents exhibit a somewhat higher buying frequency and volume and a somewhat lower selling frequency and volume when returns have been negative. These patterns are mostly statistically insignificant, but are reflected in a significantly higher net log buying volume following stock market downturns ($p < 0.05$). Thus, consistent with a large fraction of our respondents believing in mean reversion, recent return realization are not positively associated with net buying of equity in our sample – different to previous evidence, e.g., based on fund flows in the US (Greenwood and Shleifer, 2014).

While our respondents' trading activity is on average consistent with their beliefs, the interpretation of these average patterns is difficult. First, realized returns may be correlated with other macroeconomic variables that could affect trading activity. Second, realized returns may affect trading through channels other than beliefs, such as through portfolio rebalancing motives. Finally, the average patterns likely conceal substantial heterogeneity in the reaction to realized returns across different belief types.

In line with our focus on heterogeneity in beliefs and trading, we therefore examine whether investors of different belief types respond differently to market downturns as measured by the previous 12-months return. We estimate specifications of the following form:

$$\begin{aligned} Y_{i,t} = \alpha_0 &+ \alpha_1 \text{DAXdown}_t \times \text{Extrapolator}_i + \alpha_2 \text{DAXdown}_t \times \text{Neutral}_i \\ &+ \alpha_3 \log(\text{Financial wealth})_{i,t-1} + \mu_i + \mu_t + \varepsilon_{i,t} \end{aligned} \tag{2}$$

[19] We obtain very similar results if we also exclude control group respondents beginning in the month they took the survey, or if we include them until the end of March 2020, which includes the Covid-19 stock market crash. We analyze trading responses to the crash separately in Section 4.2.

[20] Appendix Figure A.1 depicts the return of the DAX over the previous 12 months for each month in our sample period.

where $Y_{i,t}$ is a measure of respondent i's trading activity during month t. DAXdown$_t$ is an indicator whether the return of the DAX over the previous 12 months has been negative. Extrapolator$_i$ and Neutral$_i$ are dummies indicating whether the investor's perceived difference of historical 12-month-ahead returns between positive and negative previous returns is at least 4 pp or between -4 pp and 4 pp, respectively, as defined in Section 3.1. Mean reverters are the omitted base group. We also include lagged log financial wealth held with the bank, log(Financial wealth)$_{i,t-1}$, month-year fixed effects, μ_t, which control for all observed and unobserved macroeconomic variables as well as effects of realized returns on trading that should be common across belief types (such as portfolio rebalancing), and investor fixed effects, μ_i, which control for time-invariant cross-sectional differences in trading activity. We report standard errors that are two-way clustered by investor and time period.

Panel A of Table 4 presents the results for the full sample. Compared to mean reverters, extrapolators exhibit a 2.7 pp lower probability of making any equity purchase in response to negative returns of the DAX conditional on permanent differences across groups (Column 1 of Panel A, $p < 0.05$). This effect is sizable, given that on average 39.5% of investors conduct at least one equity purchase in a given month. Moreover, relative to mean reverters, and relative to times of positive realized returns, extrapolators conduct 0.1 fewer equity purchases (Column 2 of Panel A, $p < 0.05$, compared to an average number of 1) and exhibit a 0.185 smaller log equity purchase volume (Column 3 of Panel A, $p < 0.05$, compared to an average log volume of 2.4) when returns have been negative.[21] The estimated coefficients remain very similar when we exclude investors that we observe for only half of our sample period or less, for whom the available variation in stock market returns is more limited (Panel B). Moreover, the estimated effects increase in size and statistical significance when we focus on a sample of active investors, which excludes the lowest quartile in terms of the number of trades executed in the twelve months prior to the observation month (Panel C). Panel D presents estimates of the differential adjustment among mean reverters to negative returns compared to the pooled group of neutrals and extrapolators, which increases precision of the coefficient estimates. We find no differential responses in selling decisions across belief types (Columns 4 to 6). Finally, different belief types differentially adjust their net buying volume to negative returns, although the effects are more noisily measured when focusing on the small group of extrapolators (Column 7).

Equity share Moreover, we examine whether beliefs about the autocorrelation of stock returns are reflected in fluctuations of the equity share of investors' holdings with the bank. In Column 1 of Table 5 we report estimations of equation 2 using the equity share in the respondent's total financial wealth as outcome. Panel A focuses on the full sample, Panel B excludes those with short observation periods and Panel C focuses on active investors. Conditional on permanent differences in the equity share across belief types (accounted for by the individual fixed effects),

[21] We add the value one to the purchase and the sales volume before taking logs to include observations with a volume of zero.

and conditional on changes in the equity share that are common across types (controlled for by the time fixed effects), extrapolators hold a 2.4 pp lower equity share than mean reverters when the stock market return was negative over the previous twelve months, which is stable across samples ($p < 0.01$ or $p < 0.05$). The magnitude of these within-investor fluctuations in the equity share is substantial, given an average within-investor standard deviation of the equity share over the sample period of 12.9 pp when focusing on the full sample from Panel A. Column 2 demonstrates qualitatively similar results when comparing adjustments of the equity share between mean reverters and the pooled group of extrapolators and neutrals.

We also use the respondents' beliefs elicited across the six historical realized return scenarios and the actual return over the previous twelve months to more directly predict a respondent's expected return at any given point in time in our sample period. In Column 3 of Table 5 we report pooled OLS estimates of the relationship between the equity share of a respondent's total financial wealth with the bank and the return that the respondent would expect based on this prediction, conditional on a set of controls. A one pp higher predicted expected return is associated with a between 0.1 and 0.2 pp higher equity share ($p < 0.05$ or $p < 0.1$ depending on the sample). This relationship also holds if we control for the respondent's unconditional average perceived return across the six historical scenarios (Column 4) or if we include investor fixed effects (Column 5), although the effect size and significance are reduced in the last case. This implies that the effects of return expectations as predicted by the respondents' beliefs about historical return realizations are not purely driven by differences in perceived unconditional average historical returns across investors. In fact, respondents' beliefs about whether a given return realization is associated with above- or below-average returns over the following year seem to matter for their portfolio decisions.

The association of predicted return expectations with the equity share in our data is substantially smaller than theory benchmarks, similarly as documented by Giglio et al. (2021a) for Vanguard clients in the US. In Appendix A.6 we show that our estimated relationship is of remarkably similar magnitude as the estimates in Giglio et al. (2021a) once we account for the fact that we predict investors' expectations based on their perceived historical autocorrelation and the realized return over the preceding 12 months. Our second main result is the following:

Result 2. Mean reverters are significantly more likely to purchase equity in response to negative returns compared to extrapolators. Beliefs about the autocorrelation of returns are also reflected in the equity share of respondents' portfolios.

These findings validate our main survey measure and provide correlational evidence that heterogeneous beliefs about the dynamic properties of returns are reflected in differences in trading decisions across investors.[22]

[22] In Appendix A.5 we demonstrate robustness of the correlational evidence on beliefs and investment choices to using different cutoffs of the perceived gain-loss difference to define mean reverters, neutrals and extrapolators and to using a continuous past return variable instead of a dummy indicating negative returns.

4 Experimental evidence

4.1 Updating of beliefs

Manipulation check We start by examining whether the information treatment changes respondents' beliefs about the autocorrelation of aggregate stock returns. After the treatment, we ask respondents to rate their agreement with three verbal statements capturing different beliefs about how informative recent past returns are for 12-month-ahead returns on 7-point scales. Table 6 reports OLS estimates of the effect of the treatment on respondents' agreement with these statements (z-scored using the mean and standard deviation in the sample), including the same set of controls as previously. We also report specifications in which the treatment indicator is interacted with dummies for groups who report different prior beliefs for the historical return intervals. We report robust standard errors for all estimations of treatment effects on beliefs.

First, the treatment significantly increases agreement with the statement *"With an investment in stocks one can expect a positive return, independently of how the stock market has developed in the recent past."* by 9.3% of a standard deviation in the full sample (Column 1, $p < 0.05$). In the control group, those respondents who perceive a higher standard deviation over the six return intervals before the intervention (indicating a higher perceived informativeness of recent for future returns), agree less with this statement (Column 2, $p < 0.10$). In line with this difference, the increase in agreement among treated respondents is fully driven by those with a higher prior perceived standard deviation (Column 2, $p < 0.01$).

Second, the treatment does not significantly change respondents' agreement that *"When the stock market has recently increased it makes no sense to buy stocks"* in the full sample (Column 3). However, those who initially believe in mean reversion reduce their agreement by 15.5% of a standard deviation in response to the information (Column 4, $p < 0.01$). This implies that the treatment fully offsets the higher baseline agreement with this statement among mean reverters compared to neutrals, as indicated by the difference in the control group (Column 4, $p < 0.05$).

Third, treated respondents agree 14.7% of a standard deviation less that *"When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased."* (Column 5, $p < 0.01$). In the control group, extrapolators agree more with this statement than neutrals (Column 6, $p < 0.01$). In line with this, the information reduces agreement significantly more for extrapolators than for neutrals or mean reverters (Column 6, p-values of these differences < 0.05).

We find similar patterns of average and heterogeneous treatment effects using two additional statements that were included after treated respondents were shown the information for a second time in the follow-up survey (Column 7-10).

Taken together, these results indicate that the treatment substantially reduces beliefs in return predictability based on recent returns among respondents, and it does so differentially and in the

expected directions across groups with different priors.[23]

Updating of return expectations We next turn to respondents' updating of their expectations about the return over the 12 months after the survey in response to the information. Depending on (i) respondents' prior beliefs about the return over the 12 months *before* the survey and (ii) respondents' prior beliefs about the historical autocorrelation, our treatment implies an information shock that should be relevant for respondents' expectations about the return over the 12 months after the survey.

We define a respondent's perception gap as follows: First, out of the six intervals of realized returns we select the one into which the respondent's perceived realized return over the 12 months before the survey falls, interval(Perceived ret 12m before survey$_i$). Second, we calculate the difference between the actual historical conditional mean 12-month-ahead return for the relevant interval and the respondent's corresponding prior:

$$\begin{aligned}&\text{Perception gap}_i\\ =&\text{Actual hist 12m ahead ret}[\text{interval}(\text{Perceived ret 12m before survey}_i)]\\ -&\text{Prior perceived hist 12m ahead ret}_i[\text{interval}(\text{Perceived ret 12m before survey}_i)]\end{aligned} \tag{3}$$

If respondents form their return expectations at least partially based on their beliefs about the historical predictiveness of last period's return, a larger perception gap should lead to a stronger updating of expectations about the return over the 12 months after the survey among respondents in the treatment group. We estimate specifications of the following form:

$$\begin{aligned}\text{Updating}_i = \alpha_0 &+ \alpha_1 \text{Perception gap}_i \times \text{Treatment}_i\\ &+ \alpha_2 \text{Perception gap}_i + \alpha_3 \text{Treatment}_i + \mathbf{X_i} + \varepsilon_i\end{aligned} \tag{4}$$

where Updating$_i$ is the difference between a respondent's posterior and prior beliefs about the return over the 12 months after the survey.[24] Our main coefficient of interest is α_1, which captures to what extent respondents update their expectations towards the treatment information. α_2 captures differential changes in expectations across respondents with different perception gaps independently of the treatment, while α_3 captures any updating in response to the treatment that is independent of the perception gap. $\mathbf{X_i}$ includes the same control variables as used previously.

Table 7 presents the results. Column 1 shows a simple OLS estimation. In Column 2 we instrument the perception gap and the interaction term, which are calculated based on the respondents' subjective return perception over the last 12 months, with versions of the gap and

[23] Appendix Table A.10 demonstrates robustness of the estimations by group in Columns 4, 6, 8 and 10 of Table 6 to using different cutoffs of the perceived gain-loss difference to define mean reverters, neutrals and extrapolators.

[24] As explained in Section 2.5, we drop participants who report prior or posterior expectations lower than -20% or higher than 20%, which should reduce the influence of outliers to a large extent. To account for the few remaining outliers, we winsorize both perception gap and updating variables at -20% and 20%. None of our findings are sensitive to the exact choice of cutoffs.

the interaction term that are based on the actual realized return over the 12 months before taking the survey (which varies over the survey period), in order to mitigate attenuation bias due to measurement error in subjective beliefs. Columns 3 and 4 show OLS and IV estimations in which the posterior is based on the mean of the respondent-level subjective distribution over 12-month-ahead returns instead of the point belief. Across specifications, we estimate coefficients between 0.09 and 0.14 on the interaction term ($p < 0.01$ or $p < 0.05$). The change in beliefs about return predictability thus causes our respondents to update their 12-month-ahead return expectations in the expected direction. Respondents adjust their return expectations only partially towards the information, consistent with the less than one-to-one relationship between respondents' prior return expectation and the prediction implied by their perceived autocorrelation (Appendix Figure A.4 Panel A). This suggests that investors consider also other factors than realized returns when forming return expectations or that they view the historical autocorrelation as only partially informative for the relevant autocorrelation at the time of the survey. That said, our estimated learning rates are within the range of estimates from previous information provision experiments on macroeconomic expectation formation (Haaland et al., 2021). We also find some updating in response to the treatment that is independent of a respondent's perception gap, which could be due to salience effects or priming.

Moreover, we find a decline in disagreement about expected 12-month-ahead returns in response to the treatment. The difference between the 90th and the 10th percentile across respondents' posterior point forecasts is 15 pp in the control group and 10.6 pp in the treatment group. Thus, greater agreement about the dynamic properties of returns causes a decline in the dispersion of return expectations. Taken together, our third main result is the following:

Result 3. Our information intervention removes notions of return predictability based on recent returns among our respondents. Moreover, respondents significantly adjust their expectations about the return over the 12 months after the survey in response to the information, which results in a reduction in disagreement in expectations.

These results highlight that beliefs about the dynamic properties of returns are a causal driver of disagreement in stock return expectations. In Appendix A.7 we demonstrate that changes in beliefs in response to the information persist in the four-week follow-up survey, which mitigates concerns related to numerical anchoring or experimenter demand effects (Haaland et al., 2021).

4.2 Changes in investment behavior

Finally, we investigate whether changes in investors' beliefs about the dynamic properties of returns in response to the treatment affect their trading behavior. For this analysis, we use transaction data until including March 2020 – five to six months after the intervention. This period provides a unique setup to study effects of beliefs about the autocorrelation of returns on trading decisions, as it includes the stock market crash that was triggered by the Covid-19

pandemic. Specifically, the German stock market dropped by about 30% between mid-February and mid-March 2020, which was reflected in a change in past 12-month realized returns from about 17% to about -23%. Depending on a respondent's prior beliefs, we would expect our intervention to lead to changes in trading decisions during the crash. We focus on the same outcomes as in our correlational analysis on beliefs and trading decisions in Section 3.4. To increase power, we study treatment effects on mean reverters and on non-mean reverters, which includes both neutrals and extrapolators, giving us two groups of roughly equal size.

Trading behavior in the control group We start by describing trading responses to the crash among control group respondents. To understand how mean reverters differentially adjust their trading behavior compared to non-mean reverters, we estimate specifications of the following form, using the full sample period from December 2014 until March 2020:

$$\begin{aligned} Y_{i,t} = {} & \alpha_0 + \alpha_1 \text{Covid-19}_t \times \text{post}_{i,t} \times \text{Mean reverter}_i + \alpha_2 \text{post}_{i,t} \times \text{Mean reverter}_i \\ & + \sum_{s=1}^{9} \beta_s \text{pre-period s}_{i,t} \times \text{Mean reverter}_i + \gamma \text{post}_{i,t} + \sum_{s=1}^{9} \delta_s \text{pre-period s}_{i,t} \\ & + \eta \log(\text{Fin. wealth})_{i,t-1} + \mu_i + \mu_t + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where $Y_{i,t}$ is a measure of respondent i's trading activity during month t. Covid-19$_t$ is an indicator for February and March 2020 – the time of the Covid-19 stock market downturn. post$_{i,t}$ is an indicator for all months from (including) the survey month (September, October or November 2019) until including March 2020. To make the specification comparable to specification 6 below analyzing treatment effects, we also include interactions of dummies for six-months intervals for the time before our survey with a dummy for mean reverters. The period directly preceding the survey (months -6 until -1) is omitted. All specifications control for individual fixed effects, μ_i, month-year fixed effects, μ_t, and lagged log financial wealth, log(Fin. wealth)$_{i,t-1}$. The coefficient α_1 captures how mean reverters differentially adjust their trading from the preceding months to the Covid-19 shock compared to non-mean reverters. The period including the survey but before the crash featured realized 12-month returns of 13.6% on average. α_2 captures the differential change in trading among mean reverters from the 6 months preceding the survey, featuring average realized 12-month returns of -4.2%, to the period including the survey but before the crash. We cluster standard errors by investor and month.

Table 8 Panel A presents the results on trading adjustments in the control group, focusing on the sample of active investors.[25] Mean reverters increase their buying significantly more strongly in response to the crash than non-mean reverters, consistent with a relative upward adjustment in their expectations in response to the shock. Specifically, mean reverters display a significantly stronger increase in the number of overall purchases (Column 2, $p < 0.05$) compared to non-mean reverters. The estimated coefficients for the probability to buy (Column 1, $p = 0.126$)

[25]The results are qualitatively similar but more noisily measured in the full sample.

and the log buying volume (Column 3, $p = 0.110$) are also positive, but more noisily measured. We also find relative increases in equity sales in response to the crash among mean reverters (Table 8 Columns 4-6), but the magnitudes of these effects are mostly much smaller than for buying decisions, such that they still result in a noisily measured relative increase in the net log buying volume (Column 7). Differences in trading responses to the crash across belief types are similar in magnitude to the differences in adjustments to earlier downturns documented in Section 3.4 (Table 4 Panel D). Thus, heterogeneity in the perceived historical autocorrelation of returns across investors is strongly reflected in differential trading responses to the crash.

Appendix Figure A.7 plots the estimated coefficients on the monthly time fixed effects included in specification 5, where August 2019 is omitted, which highlight the development of trading activity among the base group of non-mean reverters in the control group. As can be seen, the Covid-19 crash is associated with an increase in buying activity also among non-mean reverters (even though the increase is smaller than for mean reverters). Potential drivers of the increase in equity purchases even among non-mean reverters include (i) that return expectations are only partially driven by beliefs about the historical autocorrelation of returns (see Appendix Figure A.4) and also reflect beliefs about predictability by other state variables, some of which may have pointed to higher expected returns after the crash, and (ii) that buying decisions may also reflect motives other than changes in expected returns, such as, e.g., rebalancing motives.[26]

Treatment effects We next turn to the effect of our intervention on respondents' trading behavior. We estimate the following investor-month level specification separately for mean reverters and for non-mean reverters:

$$\begin{aligned} Y_{i,t} = {} & \alpha_0 + \alpha_1 \text{Covid-19}_t \times \text{post}_{i,t} \times \text{treatment}_i + \alpha_2 \text{post}_{i,t} \times \text{treatment}_i \\ & + \sum_{s=1}^{9} \beta_s \text{pre-period s}_{i,t} \times \text{treatment}_i + \gamma \text{post}_{i,t} + \sum_{s=1}^{9} \delta_s \text{pre-period s}_{i,t} \\ & + \eta \log(\text{Fin. wealth})_{i,t-1} + \mu_i + \mu_t + \varepsilon_{i,t} \end{aligned} \tag{6}$$

where treatment_i is an indicator equal to one if a respondent belongs to the group receiving the information treatment. Here, the coefficient α_1 captures how treated respondents differentially adjust their trading decisions from the preceding months to the Covid-19 shock compared to non-treated respondents. α_2 captures treatment effects on trading decisions in the time including the survey month until just before the crash. The inclusion of interaction terms between the treatment indicator and dummies for six-month pre-periods allows us to examine whether treated

[26] Other studies point to significant heterogeneity of investors' trading responses to the Covid-19 crash across groups. Giglio et al. (2021b) find that wealthy Vanguard clients on average reduced their equity holdings in response to the crash. Welch (2022) and Ortmann, Pelster and Wengerek (2020) document increases in buying activity among retail investors in response to the crash. In our paper, we focus on *differential* changes in trading activity between mean reverters and non-mean reverters.

and non-treated respondents were on similar trends before the treatment.[27]

Panel B of Table 8 displays estimated treatment effects among those believing in mean reversion before our intervention. Experimentally induced changes in beliefs only cause minor adjustments in respondents' purchasing behavior over the first months after the survey. However, treated mean reverters display a significantly smaller increase in their probability to buy (Column 1, $p < 0.05$), a smaller increase in the overall number of buys (Column 2, $p < 0.01$) and a lower increase in the log buying volume (Column 3, $p < 0.05$) than non-treated mean reverters in response to the crash. The treatment also somewhat reduces the number of sales among mean reverters (Columns 4-6). Together, the effects still result in a reduction of the net log buying volume (Column 7), although this effect is noisily measured. Figure 3 displays the implied treatment effects on the number of buys (Panel A) and the log buying volume (Panel B) among mean reverters by period. The figure highlights the insignificant treatment effects in the first months after the intervention, and the significant effects on respondents' reactions to the Covid-19 shock. The figure also illustrates that there are no differential pre-trends in the trading decisions of treated and non-treated respondents before the intervention.

Across outcomes, our treatment closes between 65% and 100% of the control-group gap in the reaction to the crash between mean reverters and non-mean reverters (see Table 8 Panel A). For instance, the treatment reduces the buying volume among mean reverters by about 29%, while in the control group non-mean reverters reduce their buying volume by 32% relative to mean reverters in response to the crash. Thus, the treatment causes substantial adjustments in trading decisions four to five months after the intervention, in line with a persistent change in respondents' beliefs about return predictability based on recent returns.

Panel C of Table 8 shows our estimated treatment effects for respondents that are not classified as mean reverters (neutrals and extrapolators). Consistent with the smaller average implied change in expectations caused by the treatment within this group, we find no strong adjustments in trading decisions in response to the treatment among non-mean reverters, even though estimated treatment effects go – as expected – in most cases in the opposite direction compared to mean reverters. We lack the power to study adjustments in behavior for neutrals and extrapolators separately.[28] Our final result is the following:

Result 4. Changes in beliefs about the autocorrelation of aggregate returns induced by the experimental intervention significantly reduce equity purchases during the Covid-19 crash among

[27] We control for lagged log financial wealth to make the results comparable to specification 5 and the correlational evidence presented in Table 4. Our results hardly change if we exclude financial wealth, which may be affected by the treatment and therefore be a "bad control".

[28] In Appendix A.5 we show that our results on trading behavior during the crash are robust to using different cutoffs of the perceived gain-loss difference to define mean reverters, neutrals and extrapolators. Moreover, in unreported regressions we also studied potential short-term adjustments (within four weeks after the treatment) in investment decisions proportional to respondents' perception gap based on specifications similar to equation 4. In line with the results reported in Table 8, we found no evidence of systematic short-term adjustments in investment decisions in response to the intervention based on those specifications.

those who believe in mean reversion before the intervention. This highlights that respondents' beliefs about the dynamic properties of returns causally shape their trading decisions.

Discussion Our intervention changes respondents' beliefs about return predictability with respect to one state variable – the recent return realization –, which in turn reduces their buying activity during the crash. Other state variables may have pointed to higher expected returns in the aftermath of the crash, e.g., high risk perceptions or low risk tolerance among market participants. This raises the question of whether treated investors over-react to the information indicating no predictability based on recent returns in their trading response to the crash. We cannot directly speak to this issue (i) because we do not observe how investors adjust their return expectations during the downturn and (ii) because the exact rational expectations benchmark for changes in expected returns around the crash is unknown. However, our previous evidence highlights that respondents only partially update their expectations about the return over the 12 months after the survey in response to the information (see Section 4.1), consistent with respondents understanding that a prediction based on the historical autocorrelation provides only a noisy signal about future returns.

How did the intervention affect respondents' longer-term investment outcomes? Given that our account data only covers the time until the end of March 2020, we cannot study investment outcomes beyond the time of the crash. The recovery of the stock market from the beginning of April implies that treated mean reverters, who increased their stock purchases less during the crash, may eventually have performed worse than mean reverters in the control group. Given that we only observe one realization of aggregate returns, this difference in *ex-post* outcomes is not adequate to assess the quality of participants' decisions from an *ex-ante* perspective. That said, answering our research question of whether beliefs about the dynamic properties of returns causally affect trading does not require our intervention to improve respondents' investment outcomes – it is sufficient to show that an exogenous change in these beliefs shifts investors' trading responses to realized returns, which is clearly confirmed by our evidence.

5 Implications and conclusion

We study beliefs about the dynamic properties of aggregate stock returns and the causal effect of these beliefs on investment decisions using a field experiment with a sample of German retail investors. There is substantial heterogeneity in beliefs about the predictability of future returns based on recent return realizations. Prior to our intervention, a majority of investors believe in mean reversion, i.e., that high returns tend to be followed by low returns and vice versa. Beliefs about the autocorrelation of returns predict the timing of investors' trading decisions over the five years before the intervention. Our respondents significantly update their beliefs in response to information about the low historical degree of predictability of the stock market based on recent returns. While there are no strong adjustments in trading decisions in the short-term, treated respondents that initially believe in mean reversion increase their equity purchases significantly

less in response to the Covid-19 crash four to five months after the intervention, consistent with the change in their perceived autocorrelation of returns.

Our paper speaks to a recent literature that incorporates realistic belief formation mechanisms into macro-finance models (Adam and Nagel, 2022). Our findings imply that heterogeneity in beliefs about the predictive power of specific state variables for future returns causally contributes to the disagreement about expected returns across households detected in previous literature (Giglio et al., 2021a). Moreover, our findings provide causal evidence on the role of subjective beliefs in trading decisions, underlining the importance of incorporating the empirical evidence on investors' subjective beliefs into models of asset prices.

We also speak to previous evidence suggesting that individuals on average extrapolate past return movements, thereby making systematic forecasting errors (Greenwood and Shleifer, 2014; Vissing-Jorgensen, 2003). Our paper highlights that investors' expectation adjustments in response to realized returns are highly heterogeneous, and that beliefs in mean reversion are widespread among retail investors. Previous literature poses the question of who accommodates the higher demand for equity among extrapolators following high return realizations. Our findings suggest that part of this demand could be matched by a decline in equity demand among groups of retail investors believing in mean reversion.

Taken together, our findings lend support to theories in which trade in asset markets occurs because agents relying on heterogeneous forecasting rules arrive at different expectations about the future even when they observe the same new piece of information (Dumas et al., 2009; Harrison and Kreps, 1978; Scheinkman and Xiong, 2003). Our results are most supportive of asset pricing models with heterogeneous agents that adjust their expectations differently in response to realized returns (Barberis et al., 2015; Cutler, Poterba and Summers, 1991; De Long, Shleifer, Summers and Waldmann, 1990). For instance, in the model by Barberis et al. (2015), one group of investors extrapolate recent returns, while another group of investors anticipate the actions of extrapolators and therefore believe in mean reversion. In light of our finding that wealthier investors are more likely to believe in mean reversion, a fruitful avenue for future theoretical work could be to build asset pricing models that account for the joint distribution of beliefs about stock returns and investor characteristics that drive risk-bearing capacity. For instance, if wealthier investors with arguably higher risk-bearing capacity tend to believe in mean reversion – as it is the case in our sample –, one can expect such investors to buy more aggressively and stabilize asset prices during a downturn.

At a more general level, our paper adds to recent evidence on heterogeneity in individuals' beliefs about the functioning of the economy (Andre et al., 2022a,b; Armona et al., 2019). Such heterogeneity can give rise to differences in how new information is processed, which in turn contributes to disagreement in expectations about future outcomes and differences in decisions. Our evidence points to the importance of accounting for such heterogeneity in theoretical and empirical research in macroeconomics and finance.

References

Adam, Klaus, Albert Marcet, and Johannes Beutel, "Stock Price Booms and Expected Capital Gains," *American Economic Review*, 2017, *107* (8), 2352–2408.

_ and Stefan Nagel, "Expectations Data in Asset Pricing," *Handbook of Economic Expectations*, 2022.

Ameriks, John, Gábor Kézdi, Minjoon Lee, and Matthew D Shapiro, "Heterogeneity in Expectations, Risk Tolerance, and Household Stock Shares: The Attenuation Puzzle," *Journal of Business & Economic Statistics*, 2020, *38* (3), 633–646.

Amromin, Gene and Steven A Sharpe, "From the Horse's Mouth: Economic Conditions and Investor Expectations of Risk and Return," *Management Science*, 2013, *60* (4), 845–866.

Andersen, Steffen, Tobin Hanspal, Jimmy Martinez-Correa, and Kasper Meisner Nielsen, "Beliefs and the Disposition Effect," *Working Paper*, 2021.

Andrade, Philippe, Richard K Crump, Stefano Eusepi, and Emanuel Moench, "Fundamental Disagreement," *Journal of Monetary Economics*, 2016, *83*, 106–128.

Andre, Peter, Carlo Pizzinelli, Christopher Roth, and Johannes Wohlfart, "Subjective Models of the Macroeconomy: Evidence from Experts and Representative Samples," *Review of Economic Studies*, 2022.

_ , Ingar Haaland, Chrisotpher Roth, and Johannes Wohlfart, "Narratives about the Macroeconomy," *CEPR Discussion Paper No. DP16758*, 2022.

Armantier, Olivier, Scott Nelson, Giorgio Topa, Wilbert van der Klaauw, and Basit Zafar, "The Price Is Right: Updating Inflation Expectations in a Randomized Price Information Experiment," *Review of Economics and Statistics*, 2016, *98* (3), 503–523.

Armona, Luis, Andreas Fuster, and Basit Zafar, "Home Price Expectations and Behavior: Evidence from a Randomized Information Experiment," *Review of Economic Studies*, 2019, *86* (4), 1371–1410.

Arrondel, Luc, Hector Calvo-Pardo, Chryssi Giannitsarou, and Michael Haliassos, "Informative Social Interactions," *Journal of Economic Behavior and Organization*, 2022.

Banerjee, Snehal and Ilan Kremer, "Disagreement and Learning: Dynamic Patterns of Trade," *Journal of Finance*, 2010, *65* (4), 1269–1302.

Bansal, Ravi and Amir Yaron, "Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles," *Journal of Finance*, 2004, *59* (4), 1481–1509.

Barberis, Nicholas, Robin Greenwood, Lawrence Jin, and Andrei Shleifer, "X-CAPM: An Extrapolative Capital Asset Pricing Model," *Journal of Financial Economics*, 2015, *115* (1), 1–24.

Beutel, Johannes and Michael Weber, "Beliefs and Portfolios: Causal Evidence," *Working Paper*, 2022.

Binder, Carola and Alex Rodrigue, "Household Informedness and Long-Run Inflation Expectations: Experimental Evidence," *Southern Economic Journal*, 2018, *85* (2), 580–598.

Bordalo, Pedro, John J Conlon, Nicola Gennaioli, Spencer Yongwook Kwon, and Andrei Shleifer, "Memory and Probability," *Quarterly Journal of Economics*, 2022.

Bottan, Nicolas L and Ricardo Perez-Truglia, "Betting on the House: Subjective Expectations and Market Choices," *Working Paper*, 2022.

Campbell, John Y and John H Cochrane, "By Force of Habit: A Consumption-based Explanation of Aggregate Stock Market Behavior," *Journal of Political Economy*, 1999, *107* (2), 205–251.

_ **and Robert J Shiller**, "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors," *Review of Financial Studies*, 1988, *1* (3), 195–228.

Cavallo, Alberto, Guillermo Cruces, and Ricardo Perez-Truglia, "Inflation Expectations, Learning and Supermarket Prices: Evidence from Field Experiments," *American Economic Journal: Macroeconomics*, 2017, *9* (3), 1–35.

Charles, Constantin, "Memory and Trading," *Available at SSRN 3759444*, 2021.

Cochrane, John H, "The Dog that Did not Bark: A Defense of Return Predictability," *Review of Financial Studies*, 2008, *21* (4), 1533–1575.

_ , "Presidential Address: Discount Rates," *The Journal of finance*, 2011, *66* (4), 1047–1108.

Coibion, Olivier, Dimitris Georgarakos, Yuriy Gorodnichenko, and Michael Weber, "Forward Guidance and Household Expectations," *Working Paper*, 2022.

_ **, Yuriy Gorodnichenko, and Michael Weber**, "Monetary Policy Communications and Their Effects on Household Inflation Expectations," *Journal of Political Economy*, 2021.

Cutler, David M, James M Poterba, and Lawrence H Summers, "Speculative Dynamics," *Review of Economic Studies*, 1991, *58* (3), 529–546.

D'Acunto, Francesco, Andreas Fuster, and Michael Weber, "A Diverse Fed Can Reach Underrepresented Groups," *Working Paper*, 2022.

Das, Sreyoshi, Camelia M Kuhnen, and Stefan Nagel, "Socioeconomic Status and Macroeconomic Expectations," *Review of Financial Studies*, 2020, *33* (1), 395–432.

De Bondt, Werner PM, "Betting on Trends: Intuitive Forecasts of Financial Risk and Return," *International Journal of Forecasting*, 1993, *9* (3), 355–371.

Dominitz, Jeff and Charles F Manski, "Expected Equity Returns and Portfolio Choice: Evidence from the Health and Retirement Study," *Journal of the European Economic Association*, 2007, *5* (2-3), 369–379.

_ **and** _ , "Measuring and Interpreting Expectations of Equity Returns," *Journal of Applied Econometrics*, 2011, *26* (3), 352–370.

Drerup, Tilman, Benjamin Enke, and Hans-Martin Von Gaudecker, "The Precision of Subjective Data and the Explanatory Power of Economic Models," *Journal of Econometrics*, 2017, *200* (2), 378–389.

Dumas, Bernard, Alexander Kurshev, and Raman Uppal, "Equilibrium Portfolio Strategies in the Presence of Sentiment Risk and Excess Volatility," *Journal of Finance*, 2009, *64* (2), 579–629.

Enke, Benjamin, Frederik Schwerter, and Florian Zimmermann, "Associative Memory and Belief Formation," *NBER Working Paper*, 2022.

Fama, Eugene F and Kenneth R French, "Permanent and Temporary Components of Stock Prices," *Journal of Political Economy*, 1988, *96* (2), 246–273.

_ and _, "Business Conditions and Expected Returns on Stocks and Bonds," *Journal of Financial Economics*, 1989, *25* (1), 23–49.

Fan, Tony Q, Yucheng Liang, and Cameron Peng, "The Inference-Forecast Gap in Belief Updating," *Working Paper*, 2021.

Fisher, Kenneth L and Meir Statman, "Investor Sentiment and Stock Returns," *Financial Analysts Journal*, 2000, *56* (2), 16–23.

Galashin, Mikhail, Martin Kanz, and Ricardo Perez-Truglia, "Macroeconomic Expectations and Credit Card Spending," *Working Paper*, 2022.

Giglio, Stefano, Matteo Maggiori, Johannes Stroebel, and Stephen Utkus, "Five Facts About Beliefs and Portfolios," *American Economic Review*, 2021, *111* (5), 1481–1522.

_ , _ , _ , and _, "The Joint Dynamics of Investor Beliefs and Trading During the COVID-19 Crash," *Proceedings of the National Academy of Sciences*, 2021, *118* (4).

Greenwood, Robin and Andrei Shleifer, "Expectations of Returns and Expected Returns," *Review of Financial Studies*, 2014, *27* (3), 714–746.

Haaland, Ingar, Christopher Roth, and Johannes Wohlfart, "Designing Information Provision Experiments," *Journal of Economic Literature*, 2021.

Hanspal, Tobin, Annika Weber, and Johannes Wohlfart, "Exposure to the COVID-19 Stock Market Crash and its Effect on Household Expectations," *Review of Economics and Statistics*, 2021, *103* (5), 994–1010.

Harris, Milton and Artur Raviv, "Differences of Opinion Make a Horse Race," *Review of Financial Studies*, 1993, *6* (3), 473–506.

Harrison, J Michael and David M Kreps, "Speculative Investor Behavior in a Stock Market with Heterogeneous Expectations," *The Quarterly Journal of Economics*, 1978, *92* (2), 323–336.

Heiss, Florian, Michael Hurd, Maarten van Rooij, Tobias Rossmann, and Joachim Winter, "Dynamics and Heterogeneity of Subjective Stock Market Expectations," *Journal of Econometrics*, 2022, *231* (1), 213–231.

Hoffmann, Arvid, Thomas Post, and Joost Pennings, "How Investor Perceptions Drive Actual Trading and Risk-taking Behavior," *Journal of Behavioral Finance*, 2015, *16* (1), 94–103.

Huang, Dashan, Jiangyuan Li, Liyao Wang, and Guofu Zhou, "Time Series Momentum: Is It There?," *Journal of Financial Economics*, 2020, *135* (3), 774 – 794.

Kézdi, Gábor and Robert J Willis, "Household Stock Market Beliefs and Learning," *Working Paper*, 2011.

Long, J Bradford De, Andrei Shleifer, Lawrence H Summers, and Robert J Waldmann, "Positive Feedback Investment Strategies and Destabilizing Rational Speculation," *Journal of Finance*, 1990, *45* (2), 379–395.

Lucas, Robert E, "Asset Prices in an Exchange Economy," *Econometrica*, 1978, pp. 1429–1445.

Malmendier, Ulrike and Stefan Nagel, "Depression Babies: Do Macroeconomic Experiences Affect Risk-taking?," *The Quarterly Journal of Economics*, 2011, *126* (1), 373–416.

Meeuwis, Maarten, Jonathan A Parker, Antoinette Schoar, and Duncan I Simester, "Belief Disagreement and Portfolio Choice," *Journal of Finance*, 2021.

Merkle, Christoph and Martin Weber, "Do Investors Put Their Money Where Their Mouth Is? Stock Market Expectations and Investing Behavior," *Journal of Banking and Finance*, 2014, *46*, 372–386.

Nagel, Stefan and Zhengyang Xu, "Asset Pricing with Fading Memory," *Review of Financial Studies*, 2022, *35* (5), 2190–2245.

_ **and** _ , "Dynamics of Subjective Risk Premia," *NBER Working Paper*, 2022.

Ortmann, Regina, Matthias Pelster, and Sascha Tobias Wengerek, "COVID-19 and Investor Behavior," *Finance Research Letters*, 2020, *37*, 101717.

Rangvid, Jesper, Maik Schmeling, and Andreas Schrimpf, "Dividend Predictability Around the World," *Journal of Financial and Quantitative Analysis*, 2014, *49* (5-6), 1255–1277.

Roth, Christopher and Johannes Wohlfart, "How Do Expectations About the Macroeconomy Affect Personal Expectations and Behavior?," *Review of Economics and Statistics*, 2020, *102* (4), 731–748.

Scheinkman, Jose A and Wei Xiong, "Overconfidence and Speculative Bubbles," *Journal of Political Economy*, 2003, *111* (6), 1183–1220.

Vissing-Jorgensen, Annette, "Perspectives on Behavioral Finance: Does "Irrationality" Disappear with Wealth? Evidence from Expectations and Actions," *NBER Macroeconomics Annual*, 2003, *18*, 139–194.

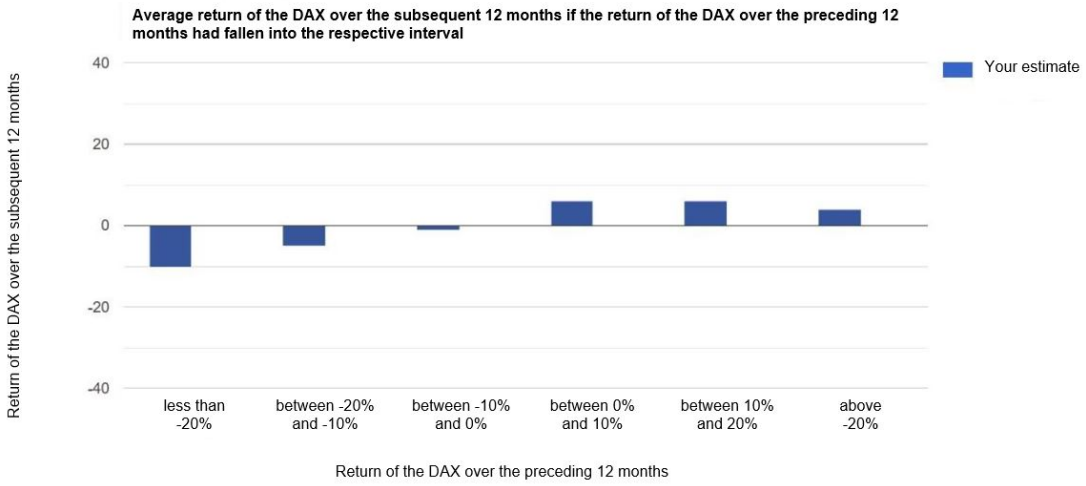
von Gaudecker, Hans-Martin and Axel Wogrolly, "Heterogeneity in Households' Stock Market Beliefs: Levels, Dynamics, and Epistemic Uncertainty," *Journal of Econometrics*, 2022, *231* (1), 232–247.

Welch, Ivo, "The Wisdom of the Robinhood Crowd," *Journal of Finance*, 2022, *77* (3), 1489–1527.

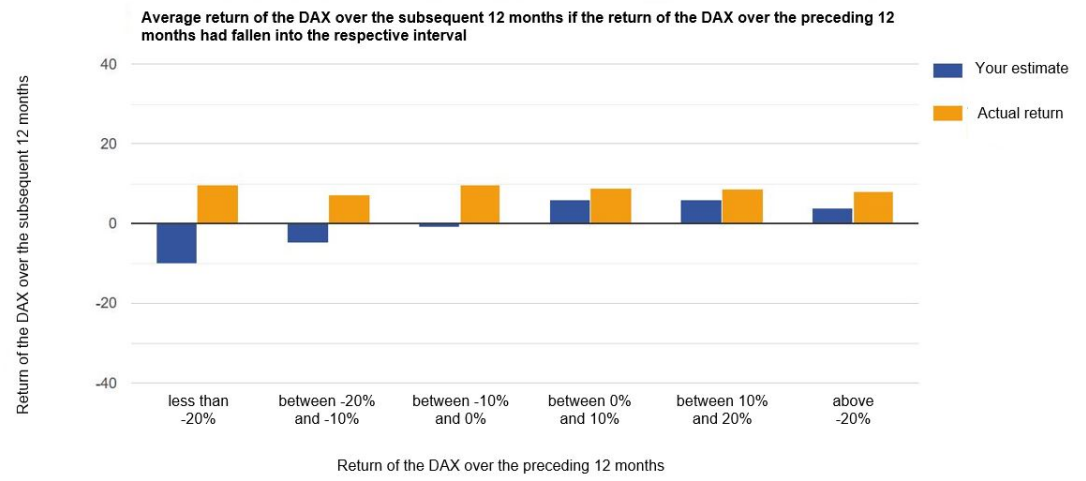
_ **and Amit Goyal**, "A Comprehensive Look at the Empirical Performance of Equity Premium Prediction," *Review of Financial Studies*, 2008, *21* (4), 1455–1508.

Main figures

Figure 1: Elicitation of prior perceived autocorrelation and information treatment



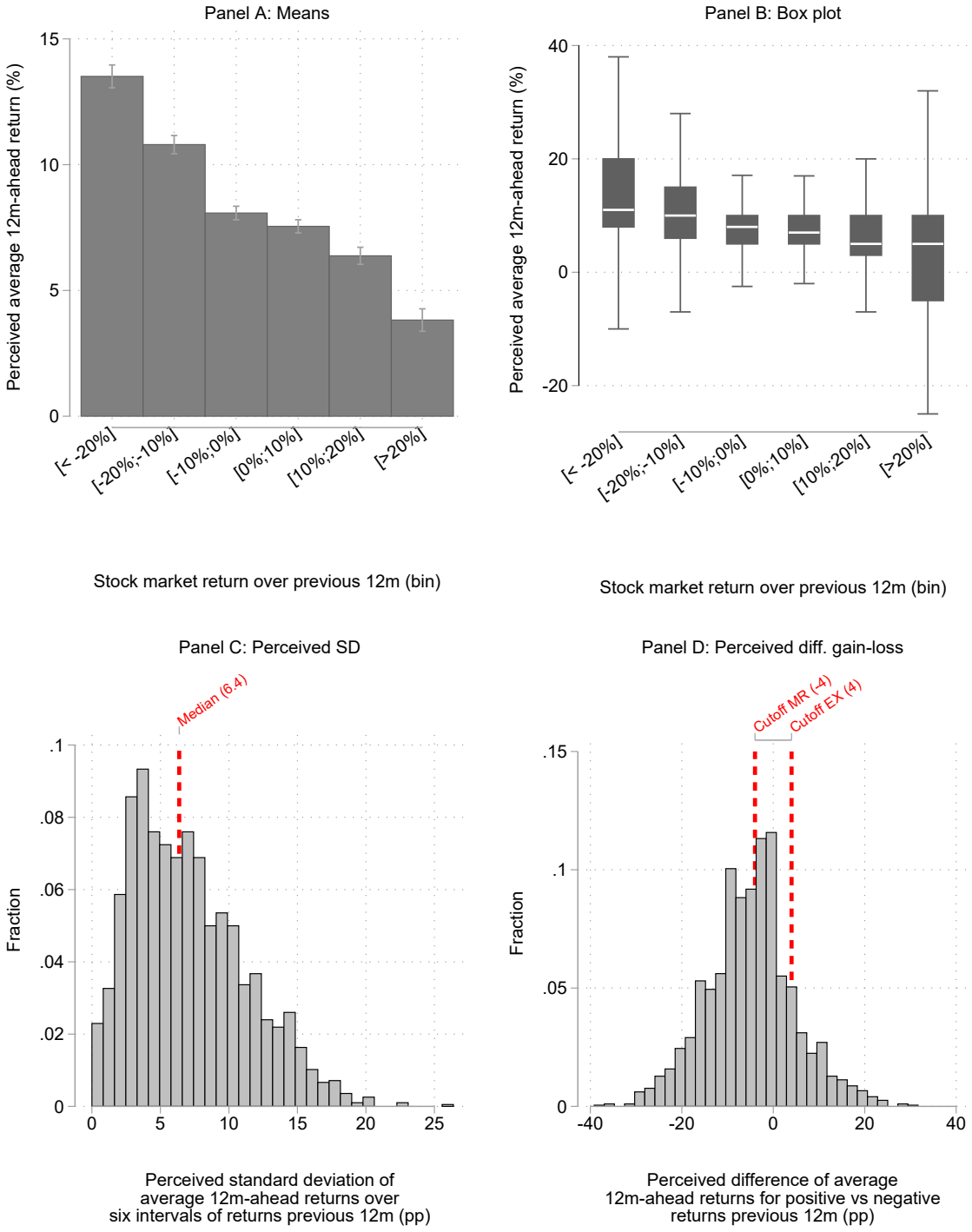
(a) Panel A: Priors



(b) Panel B: Information treatment

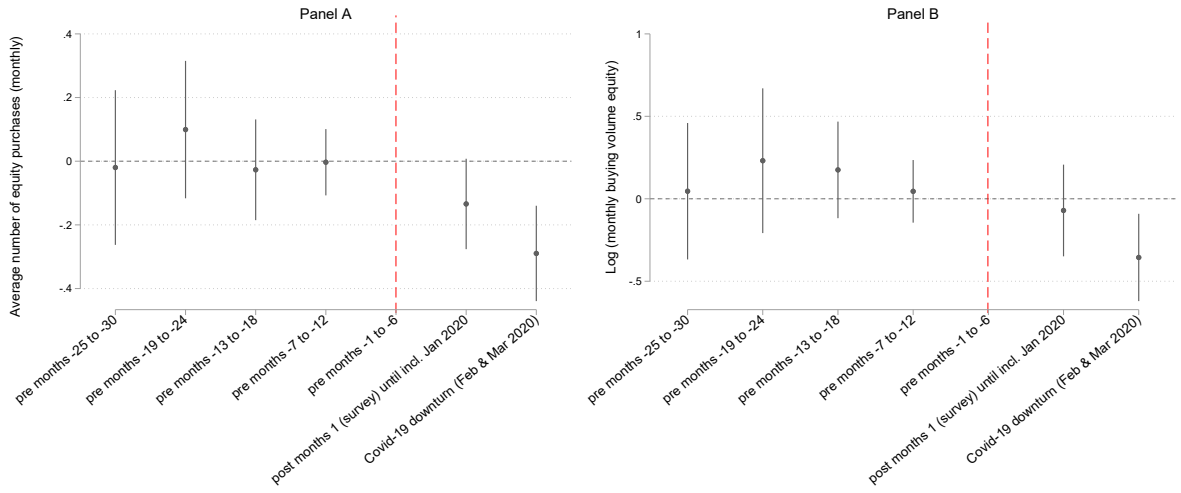
Notes: This figure presents example survey screens (translated from German to English) of the elicitation of priors and the information treatment in our main survey. Panel A illustrates the elicitation of prior beliefs about the historical autocorrelation of aggregate stock returns. For each of the six intervals on the horizontal axis, starting with the lowest one on the left, respondents are instructed to think of all points in time over the past 50 years at which the return of the DAX over the preceding 12 months had fallen into the respective interval, and ask them to estimate the conditional average return of the DAX over the subsequent 12 months. Each interval is asked about on a separate screen. On each screen, the graph displays the respondent's entry for the current interval as well as his or her estimates for previous intervals (blue bars). Panel B displays the information treatment screen shown to respondents in the treatment group. The orange bars illustrate the actual historical conditional mean 12-month-ahead returns in the six past-return intervals, respectively. Initially, the screen only shows the participants' entries previously made in all six scenarios. Participants are instructed to repeatedly click on a button to receive information on the actual values interval-by-interval. In addition, for each bin, we display a sentence above the figure comparing the respondent's prior with the actual value for the respective bin.

Figure 2: Prior beliefs about the autocorrelation of aggregate returns



Notes: This figure summarizes prior beliefs about the autocorrelation of returns of the German stock market in the last 50 years among respondents to our main survey. Panel A shows the sample means of respondents' beliefs about average 12-month-ahead stock returns for six intervals of realized returns over the previous 12 months. Panel B displays box plots of respondents' prior beliefs about average 12-month-ahead stock returns for the six intervals of realized return over the previous 12 months, including median, 25th and 75th percentile for each interval. Panel C shows a histogram of respondents' perceived standard deviation of 12-month-ahead returns over the six realized return intervals. Panel D shows a histogram of respondents' perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios, including the cutoffs we use to define mean reverters, neutrals and extrapolators.

Figure 3: Buying behavior during the Covid-19 downturn: Prior mean reverters



Notes: This figure displays treatment effects on different measures of the buying behavior of respondents to our main survey during different periods implied by investor-month level estimations of specification 6. The period spanning the 6 months preceding the survey is omitted. The "post months" are the time from including the survey month (September-November 2019) until including January 2020, and the displayed coefficient is the estimate on the term "Post x Treatment" in specification 6. The "Covid-19"-period includes February and March 2020, and the displayed coefficient is the sum of the estimates on the terms "Post x Treatment" and "Covid-19 x Post x Treatment" in specification 6. The displayed coefficients on the different pre-periods are the estimates on the interaction terms of dummies for these periods with the treatment dummy. The outcomes are the monthly number of equity purchases (Panel A) and the log of the monthly equity buying volume, where the value one is added to the volume before taking logs (Panel B). The sample is restricted to those who believe in mean reversion before the treatment (for whom the perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is less than -4 pp), and is restricted to active investors, i.e., those in the lowest quartile of number of trades over the 12 months before the survey are excluded. All specifications control for month-year as well as individual fixed effects, non-interacted dummies for event periods, and lagged log financial wealth held at the broker. 95-% confidence bands are obtained using standard errors that are two-way clustered by investor and trading-month.

Main tables

Table 1: Summary statistics and balance check

	PHF	Online brokerage sample							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2017 Mean	Mean	Median	SD	p25	p75	Treatment Group: Mean	Control Group: Mean	p-value (7) = (8)
Female	0.49	0.16	0.00	0.37	0.00	0.00	0.17	0.16	0.511
Age	50.55	45.24	45.00	14.15	34.00	55.00	45.84	44.66	0.067
University	0.36	0.54	1.00	0.50	0.00	1.00	0.52	0.56	0.079
Employed	0.65	0.77	1.00	0.42	1.00	1.00	0.75	0.78	0.150
Household net income	3,808	3,914	4,000	2,769	2,000	5,250	3,927	3,902	0.837
Household net wealth	361,783	300,488	125,000	458,044	12,500	375,000	307,809	293,294	0.483
Total financial wealth at bank		55,272	22,082	98,312	5,581	65,752	55,073	55,468	0.929
Portfolio value at bank		43,970	14,872	87,671	3,726	47,620	43,438	44,489	0.795
Equity holdings at bank		39,405	13,381	78,678	3,437	42,458	38,318	40,467	0.553
Average monthly equity trades		1.73	0.67	3.29	0.00	2.00	1.75	1.71	0.812
Risk tolerance (1-7)		4.56	5.00	1.17	4.00	5.00	4.54	4.58	0.403
Trading experience (years)		14.13	15.00	10.87	4.00	20.00	14.38	13.89	0.309
Financial literacy score (0-3)		1.82	2.00	0.78	1.00	2.00	1.81	1.83	0.543
Follow DAX developments (1-7)		4.76	5.00	1.81	3.00	6.00	4.78	4.75	0.737
Investment horizon $\geq$ 5 years		0.49	0.00	0.50	0.00	1.00	0.48	0.50	0.373
Perceived return last 12 months		5.09	5.00	6.07	2.00	8.00	4.99	5.19	0.475
Confident in perceived return		0.64	1.00	0.48	0.00	1.00	0.64	0.64	0.855
Expected return next 12 months		3.21	4.00	6.28	1.50	6.00	3.32	3.09	0.423
Confident in expected return		0.54	1.00	0.50	0.00	1.00	0.54	0.53	0.494
Perceived mean hist. ret. intervals		8.36	7.83	4.62	5.17	11.17	8.39	8.32	0.739
Perceived SD hist. ret. intervals		7.05	6.37	4.16	3.78	9.82	7.10	7.01	0.629
High perceived SD		0.50	0.00	0.50	0.00	1.00	0.52	0.48	0.099
Perceived diff. gain-loss historical		-4.88	-4.67	9.64	-10.67	0.50	-4.68	-5.08	0.360
Extrapolator (diff. $\geq$ 4)		0.16	0.00	0.36	0.00	0.00	0.16	0.15	0.725
Mean-reverter (diff. $<$ -4)		0.53	1.00	0.50	0.00	1.00	0.53	0.52	0.789
In follow-up sample		0.46	0.00	0.50	0.00	1.00	0.46	0.46	0.886
Observations		1,961					972	989	

Notes: This table shows summary statistics for the sample of retail investors at the online bank that responded to our main survey (Columns 2-6), as well as benchmarks from the German population of individuals participating in the stock market as measured in the 2017 wave of the Bundesbank's Panel of Household Finance (Column 1). Columns 7-9 provide a check of balance of means between treatment and control group. Variables on income, wealth and wealth components are expressed in euro terms. Financial wealth at the bank, portfolio value at the bank, and equity holdings at the bank are measured in the month prior to the survey. Average monthly equity trades are measured over the three months preceding the survey. All belief variables reported in the table refer to respondents' priors elicited before the information treatment.

Table 2: Correlates of beliefs

	Perceived SD	Perceived SD $\geq$ Median	Perceived diff. gain-loss	Extra-polator (diff. $\geq$ 4)	Neutral (-4 $\leq$ diff. $<$ 4)	Mean-reverter (diff. $<$ -4)
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.445*	-0.000	2.534***	0.097***	-0.013	-0.084***
	(0.238)	(0.031)	(0.590)	(0.025)	(0.029)	(0.030)
Age	-0.038***	-0.004***	-0.006	-0.002**	0.004***	-0.002**
	(0.008)	(0.001)	(0.019)	(0.001)	(0.001)	(0.001)
Employed	-0.289	-0.027	-0.542	-0.043**	0.041	0.002
	(0.227)	(0.028)	(0.534)	(0.021)	(0.025)	(0.027)
University	0.629***	0.066***	-1.556***	-0.016	-0.036*	0.053**
	(0.192)	(0.023)	(0.440)	(0.017)	(0.022)	(0.023)
Log(Household income)	0.009	0.002	-0.120	-0.002	-0.006	0.008**
	(0.033)	(0.004)	(0.077)	(0.003)	(0.004)	(0.004)
Log(Fin. wealth with bank)	-0.034	-0.006	-0.208	-0.008	-0.011	0.018***
	(0.056)	(0.007)	(0.129)	(0.005)	(0.007)	(0.007)
Invest. experience $\geq$ Median	0.467**	0.069**	-1.299**	-0.038*	-0.056**	0.094***
	(0.232)	(0.028)	(0.524)	(0.021)	(0.027)	(0.028)
Full financial literacy score	0.203	0.067**	-0.654	-0.022	-0.052**	0.074***
	(0.224)	(0.028)	(0.513)	(0.019)	(0.025)	(0.028)
Follow DAX $\geq$ Median	0.405**	0.050**	-0.942**	-0.004	-0.067***	0.070***
	(0.203)	(0.024)	(0.469)	(0.017)	(0.022)	(0.024)
Mean dep. var.	7.05	0.50	-4.88	0.16	0.32	0.52
SD dep. var.	4.16	0.50	9.64	0.36	0.47	0.50
Observations	1,961	1,961	1,961	1,961	1,961	1,961
R-squared	0.02	0.02	0.04	0.03	0.02	0.04

Notes: This table shows multivariate regressions of beliefs on covariates among respondents to our main survey. The outcomes are the standard deviation of a respondent's perceived historical average 12-month-ahead returns across the six intervals of realized returns (Column 1), a dummy indicating whether this standard deviation is at least at the sample median (Column 2), the perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios (Column 3), a dummy for extrapolators (for which this difference is at least 4 pp, Column 4), a dummy for being neutral (difference at least -4 pp and less than 4 pp, Column 5), and a dummy for mean reverters (difference less than -4 pp, Column 6). Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 3: Sources of beliefs: Memory and return predictability by valuation ratios

	Mean-reverter (diff. $<$ -4)					
	(1)	(2)	(3)	(4)	(5)	(6)
Knowledge of research contributed to estimates	0.031					0.043
	(0.138)					(0.144)
Other financial variables contributed to estimates		-0.187*				-0.190*
		(0.106)				(0.105)
High knowledge of financial market theories			-0.002			-0.001
			(0.092)			(0.098)
Thought of specific reversal episode				0.204***		0.204***
				(0.068)		(0.070)
Thought of specific non-reversal episode					0.079	0.015
					(0.085)	(0.086)
Observations	208	208	208	208	208	208
R-squared	0.13	0.15	0.13	0.17	0.14	0.19

Notes: This table examines memory and beliefs about return predictability by valuation ratios as two potential sources of beliefs in mean reversion among German retail investors participating in an additional descriptive survey. The outcome is a dummy variable indicating whether the respondent is classified as a mean reverter (perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios lower than -4 pp). The main independent variables are the following: dummy variables indicating whether the respondent reports that knowledge of results from finance research or memory of past developments of financial variables other than the return (such as valuation ratios) contributed to her estimate of the historical autocorrelation (Columns 1 and 2); a dummy indicating whether the respondent reports a relatively high level of knowledge of financial market theories (Column 3); a dummy indicating whether the respondent thought of at least one specific past reversal episode when estimating the historical autocorrelation as measured in an open-ended question (Column 4); and a dummy indicating whether the respondent thought of at least one specific past non-reversal episode (Column 5). We classify the historical episodes as explained in the main text, giving us the following classification: reversal episodes: the Covid-19 downturn (2020), the downturn associated with Brexit (2018), the euro crisis (2011), the Global Financial Crisis (2007-9), the downturn associated with the Iraq War (2003), the downturn associated with the Gulf War (1990), and the downturn following the Black Monday (1987); non-reversal episodes: the downturn associated with the terror attacks on 9/11 (2001) and the burst of the dot-com bubble (2000-3). All estimations include a parsimonious set of controls (gender, age, employment status, education, household income, financial wealth, investment experience, financial literacy, and attention to DAX developments). Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 4: Perceived autocorrelation and trading decisions

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Full Sample							
DAX down ×	-0.027**	-0.104**	-0.185**	-0.007	-0.008	-0.058	-0.127
Extrapolator (diff. $\geq$ 4)	(0.012)	(0.042)	(0.085)	(0.008)	(0.013)	(0.061)	(0.096)
DAX down ×	-0.012	-0.049*	-0.120**	-0.002	0.001	0.003	-0.123**
Neutral (-4 $\leq$ diff. < 4)	(0.009)	(0.028)	(0.058)	(0.006)	(0.009)	(0.044)	(0.060)
Observations	76,008	76,008	76,008	76,008	76,008	76,008	76,008
R-squared	0.49	0.618	0.361	0.114	0.121	0.123	0.249
Panel B: Excl. short oberservation periods							
DAX down ×	-0.031**	-0.106**	-0.214**	-0.011	-0.011	-0.079	-0.135
Extrapolator (diff. $\geq$ 4)	(0.014)	(0.042)	(0.092)	(0.008)	(0.013)	(0.066)	(0.104)
DAX down ×	-0.014	-0.047*	-0.128**	-0.001	0.005	0.019	-0.147**
Neutral (-4 $\leq$ diff. < 4)	(0.009)	(0.027)	(0.060)	(0.006)	(0.010)	(0.047)	(0.062)
Observations	67,108	67,108	67,108	67,108	67,108	67,108	67,108
R-squared	0.481	0.596	0.352	0.111	0.116	0.121	0.237
Panel C: Active Investors							
DAX down ×	-0.045**	-0.165***	-0.306**	-0.016	-0.019	-0.127	-0.178
Extrapolator (diff. $\geq$ 4)	(0.017)	(0.060)	(0.115)	(0.010)	(0.017)	(0.084)	(0.129)
DAX down ×	-0.019*	-0.064*	-0.179**	-0.007	-0.004	-0.025	-0.154**
Neutral (-4 $\leq$ diff. < 4)	(0.011)	(0.037)	(0.075)	(0.008)	(0.013)	(0.059)	(0.074)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Panel D: Active Investors							
DAX down ×	0.027***	0.094***	0.217***	0.009	0.008	0.056	0.161**
Mean Reverters (diff. < -4)	(0.010)	(0.034)	(0.067)	(0.007)	(0.012)	(0.054)	(0.069)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the association between beliefs about the autocorrelation of aggregate returns and trading activity at the online bank among respondents to our main survey based on investor-month level estimations of specification 2. Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. Extrapolators are those investors for whom the prior perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is at least 4 pp, those with a difference of at least -4 pp and less than 4 pp are classified as neutral, and those with a difference lower than -4 pp are classified as mean reverters. DAX down is a dummy indicating whether the return of the DAX over the preceding 12 months was negative. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group. Panel A reports results for the full sample, Panel B focuses on investors that we observe for more than half of our sample period, and Panels C and D focus on a subsample of active investors, where the lowest quartile in terms of the number of trades over the previous 12 months is excluded. All estimations include individual and month-year fixed effects and control for lagged log financial wealth held with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 5: Beliefs about the stock market and the equity share

	Equity Share				
	(1)	(2)	(3)	(4)	(5)
Panel A: Full Sample					
DAX down × Extrapolator (diff. ≥ 4)	-2.432***				
	(0.907)				
DAX down × Neutral (-4 ≤ diff. < 4)	-0.181				
	(0.586)				
DAX down × Mean Reverter (diff. < -4)		0.882			
		(0.530)			
Perceived conditional historical return			0.146**	0.156**	0.034
			(0.066)	(0.060)	(0.024)
Perceived mean historical return				-0.028	
				(0.162)	
Observations	76,008	76,008	76,032	76,032	76,008
R-squared	0.756	0.756	0.06	0.06	0.756
Panel B: Excl. short oberservation periods					
DAX down × Extrapolator (diff. ≥ 4)	-2.496**				
	(0.959)				
DAX down × Neutral (-4 ≤ diff. < 4)	-0.506				
	(0.612)				
DAX down × Mean Reverter (diff. < -4)		1.120**			
		(0.548)			
Perceived conditional historical return			0.171**	0.187***	0.052**
			(0.071)	(0.065)	(0.025)
Perceived mean historical return				-0.047	
				(0.179)	
Observations	67,108	67,108	67,108	67,108	67,108
R-squared	0.757	0.757	0.065	0.065	0.757
Panel C: Active Investors					
DAX down × Extrapolator (diff. ≥ 4)	-2.403**				
	(0.972)				
DAX down × Neutral (-4 ≤ diff. < 4)	-0.145				
	(0.650)				
DAX down × Mean Reverter (diff. < -4)		0.821			
		(0.593)			
Perceived conditional historical return			0.126*	0.147**	0.017
			(0.063)	(0.057)	(0.026)
Perceived mean historical return				-0.062	
				(0.159)	
Observations	53,746	53,746	53,918	53,918	53,746
R-squared	0.737	0.737	0.075	0.075	0.737
Time FE	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	No	No	Yes

Notes: This table examines the association between beliefs and the equity share held with the bank among respondents to our main survey based on investor-month level estimations. Extrapolators are those investors for whom the prior perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is at least 4 pp, those with a difference of at least -4 pp and less than 4 pp are classified as neutral, and those with a difference lower than -4 pp are classified as mean reverters. DAX down is a dummy indicating whether the return of the DAX over the preceding 12 months was negative. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The perceived conditional historical return is the return an investor would expect if he or she based her return expectations exclusively on her beliefs about the historical autocorrelation of returns (taken from the survey) assuming accurate beliefs about the realized return over the previous 12 months. The perceived mean historical return is the average of respondents' historical 12-month-ahead return perceptions over the six intervals of previously realized returns. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group. Panel A reports results for the full sample, Panel B focuses on investors that we observe for more than half of our sample period, and Panel C focuses on a subsample of active investors, where the lowest quartile in terms of the number of trades over the previous 12 months is excluded. All specifications control for month-year fixed effects and lagged log financial wealth with the bank. The pooled OLS estimations in Columns 3 and 4 also include the baseline set of controls measured at the time of the survey described in Appendix A.1.2, excluding the variables relating to portfolio shares and trading activity. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 6: Manipulation check

	Positive return irrespective of previous return		No sense to buy after high return		Positive return more likely after high return		Above average return after negative return		Negative return likely to continue next year	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	0.093**		-0.054		-0.147***		-0.326***		-0.452***	
	(0.044)		(0.044)		(0.045)		(0.067)		(0.065)	
Treatment × Perceived SD ≥ Median (a)		0.166***								
		(0.062)								
Treatment × Perceived SD < Median (b)		0.020								
		(0.062)								
Perceived SD ≥ Median	-0.049	-0.121*								
	(0.044)	(0.063)								
Treatment × Extrapolator (diff. ≥ 4) (a)				0.021		-0.375***		-0.382**		-0.916***
				(0.114)		(0.115)		(0.176)		(0.189)
Treatment × Neutral (-4 ≤ diff. < 4)				0.075		-0.084		0.088		-0.274**
				(0.080)		(0.081)		(0.123)		(0.115)
Treatment × Mean-reverter (diff. < -4) (b)				-0.155***		-0.114*		-0.556***		-0.428***
				(0.060)		(0.062)		(0.087)		(0.086)
Extrapolator (diff. ≥ 4)			-0.018	0.008	0.143**	0.288***	-0.053	0.172	0.165	0.469***
			(0.071)	(0.098)	(0.072)	(0.102)	(0.109)	(0.131)	(0.115)	(0.159)
Mean-reverter (diff. < -4)			0.046	0.160**	-0.127**	-0.113	0.031	0.340***	-0.076	-0.007
			(0.051)	(0.070)	(0.053)	(0.072)	(0.076)	(0.098)	(0.073)	(0.100)
p-value (a=b)		0.098		0.174		0.047		0.379		0.019
Observations	1,961	1,961	1,961	1,961	1,961	1,961	903	903	903	903
R-squared	0.10	0.10	0.08	0.08	0.04	0.04	0.11	0.13	0.12	0.13

Notes: This table shows estimations of the effect of the information treatment on posterior agreement with verbal statements describing beliefs about the autocorrelation of aggregate returns among respondents to our main survey and the four-week follow-up survey. Agreement with the statements is elicited on 7-point categorical scales, and is z-scored using the means and standard deviations in the sample. The statements are: "With an investment in stocks one can expect a positive return, independently of how the stock market has developed in the recent past." (Columns 1-2); "When the stock market has recently increased it makes no sense to buy stocks." (Columns 3-4); "When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased." (Columns 5-6); "When the stock market has fallen in the previous year one can expect above-average returns for the next year." (Columns 7-8); "When the stock market has fallen over the previous 12 months there is a high probability that this trend will continue in the following 12 months." (Columns 9-10). The outcomes in Columns 1-6 are elicited in the main survey and the outcomes in Columns 7-10 are elicited in the follow-up survey after the repeated information treatment. Column 2 shows heterogeneous treatment effects by holding an above or below median prior perceived standard deviation of 12-month-ahead returns over the six historical realized return intervals. Columns 4, 6, 8 and 10 show heterogeneous treatment effects for prior extrapolators (perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios at least 4 pp), neutrals (difference at least -4 pp and less than 4 pp), and mean reverters (difference less than -4 pp). All estimations include the baseline set of controls described in Appendix A.1.2. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 7: Updating of 12-month-ahead return expectations

	Updating (point belief)		Updating (mean distr.)	
	(1) OLS	(2) IV	(3) OLS	(4) IV
Treatment × Perception gap	0.086**	0.138***	0.115***	0.142**
	(0.038)	(0.051)	(0.044)	(0.060)
Perception gap	-0.004	-0.019	0.022	0.044
	(0.025)	(0.033)	(0.028)	(0.038)
Treatment	1.077***	1.007***	0.047	0.019
	(0.212)	(0.219)	(0.263)	(0.266)
First stage F-stat		1020.48		1020.48
Observations	1,961	1,961	1,961	1,961
R-squared	0.05	0.04	0.04	0.04

Notes: This table examines changes in expectations about aggregate stock returns over the 12 months after the survey in response to the information among respondents to our main survey based on estimations of specification 4. The outcomes are the difference between posterior and prior point expectations about the 12-month-ahead return (Columns 1-2) and the difference between the mean of the respondent-level posterior distribution over 12-month-ahead returns and the prior point expectation (Columns 3-4). The perception gap is based on the respondent's prior belief about the historical autocorrelation of aggregate returns. It is the difference between the actual conditional mean 12-month-ahead return and the respondent's corresponding prior for the relevant scenario of realized returns over the previous 12 months, which is selected based on respondent's perceived return over the 12 months before the main survey. In Columns 2 and 4 the perception gap is instrumented with a version in which the relevant return interval is selected based on the actual realized return of the DAX over the 12 months before the survey. All estimations include the baseline set of controls described in Appendix A.1.2. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table 8: Trading behavior during the Covid-19 downturn

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Sample of non-treated investors							
Covid-19 × Post × Mean Reverter	0.030	0.203**	0.315	0.031*	0.079***	0.188	0.127
	(0.019)	(0.088)	(0.195)	(0.017)	(0.025)	(0.178)	(0.146)
Post × Mean Reverter	-0.039*	-0.065	-0.193	0.015	0.025	0.155	-0.348**
	(0.020)	(0.083)	(0.169)	(0.019)	(0.031)	(0.154)	(0.164)
Observations	29,728	29,728	29,728	29,728	29,728	29,728	29,728
R-squared	0.445	0.585	0.293	0.098	0.097	0.113	0.238
Panel B: Treatment effects - Mean Reverters							
Covid-19 × Post × Treatment	-0.020**	-0.155***	-0.285**	-0.029*	-0.075**	-0.192	-0.093
	(0.009)	(0.049)	(0.127)	(0.017)	(0.033)	(0.137)	(0.188)
Post × Treatment	-0.007	-0.134*	-0.071	0.013	0.022	0.090	-0.161
	(0.016)	(0.071)	(0.139)	(0.017)	(0.031)	(0.122)	(0.131)
Observations	32,859	32,859	32,859	32,859	32,859	32,859	32,859
R-squared	0.462	0.623	0.326	0.104	0.107	0.117	0.242
Panel C: Treatment effects - Non Mean Reverters							
Covid-19 × Post × Treatment	0.016	0.035	0.189	0.005	0.030	0.057	0.132
	(0.021)	(0.059)	(0.157)	(0.017)	(0.034)	(0.151)	(0.179)
Post × Treatment	-0.025	-0.131*	-0.128	0.017	0.008	0.127	-0.255
	(0.020)	(0.071)	(0.168)	(0.016)	(0.028)	(0.115)	(0.201)
Observations	25,155	25,155	25,155	25,155	25,155	25,155	25,155
R-squared	0.451	0.575	0.307	0.123	0.133	0.134	0.235
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the association between beliefs about the autocorrelation of aggregate returns and trading activity during the Covid-19 crash (Panel A) and the effect of our information treatment on trading activity during the crash among different groups (Panels B and C) among respondents to our main survey based on investor-month level estimations of specifications 5 and 6. The samples are restricted to active investors, i.e., those in the lowest quartile of number of trades over the 12 months before the survey are excluded. Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. The transaction data span the period from December 2014 until March 2020. Panel A focuses on respondents in the control group. Panel B includes respondents believing in mean reversion before the intervention from both the treatment and the control group (for whom the prior perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is less than -4 pp), while Panel C focuses on non-mean reverters (difference -4 pp or higher). All specifications control for month-year as well as individual fixed effects and lagged log financial wealth held with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

For online publication only:

Beliefs About the Stock Market and Investment Choices: Evidence from a Field Experiment

Christine Laudenbach Annika Weber Rüdiger Weber Johannes Wohlfart

Overview of the online appendix

Section A.1 provides additional details on the surveys and data.

Section A.2 provides background on returns of the German stock market.

Section A.3 contains additional descriptive evidence on beliefs.

Section A.4 contains additional descriptive evidence on trading behavior.

Section A.5 provides a range of robustness checks of our main results.

Section A.6 compares our results to Giglio, Maggiori, Stroebel and Utkus (2021a).

Section A.7 demonstrates persistence of treatment effects in a four-week follow-up.

Section A.8 describes an additional experiment on beliefs about the PD ratio.

Section B.1 provides the instructions of the main survey.

Section B.2 provides the instructions of the four-week follow-up survey.

A Supplementary details and analyses

A.1 Additional details on surveys and data

A.1.1 Details on other surveys

Next to our main and follow-up surveys conducted between September and November 2019, which are described in detail in Section 2, we ran several additional surveys. Table A.1 provides a complete overview of all our data collections. The additional experimental investor survey run in July and August 2022 is described in detail in Appendix A.8. In the current section we briefly describe our other data collections. The instructions for the additional surveys can be found under `https://drive.google.com/file/d/1IhxTWR5pXyVSROV6tPfr4y06p7UwygmQ/view?usp=sharing`.

Additional descriptive investor survey In July and August 2022 we ran an additional descriptive survey with retail investors from the same online bank we used in our main experiment. We invited 3,000 investors to participate in this survey, who were selected in the same way as invitees to our original survey. Out of these, 227 respondents eventually completed our survey, corresponding to a response rate of 7.6%. Due to changes in the data protection policies at the bank that came into effect after we had run our main survey, we were not allowed to link these new survey data to administrative account data. The survey starts with a question on investors' familiarity with different financial variables. We then elicit respondents' perceived autocorrelation of aggregate stock returns using the same elicitation format as in our main survey, which is followed by questions on respondents' thoughts when reporting their perceived autocorrelation. The survey ends with a measure of respondents' knowledge of research results in finance and questions on a range of background characteristics. As in our main survey, we drop respondents with extreme response times, which results in a sample of 208 respondents. Table A.2 Column 2 provides a range of basic summary statistics for this sample. The composition of the sample is very similar to the sample from our main analysis, the main difference being that respondents are somewhat wealthier and older on average.

Descriptive general population survey Germany We also ran a survey on a general population sample from Germany in collaboration with the survey company Dynata, which is widely used in the social sciences (Haaland et al., 2021). The content and structure of the survey are very similar to the additional descriptive investor survey described above. In total, 504 individuals completed our survey, out of which 490 individuals form the final sample after dropping those with extreme response times. Table A.2 Column 4 provides a range of basic summary statistics. The sample is broadly representative of the adult German population, as can be seen from comparison with benchmarks taken from the 2017 wave of the Bundesbank's Panel of Household Finances (PHF) displayed in Column 3.

Descriptive general population survey US In addition, we ran a survey on a general population sample from the US in collaboration with the survey company Lucid, which is widely used in the social sciences (Haaland et al., 2021). The content and structure of the survey are very similar to the additional descriptive investor survey described above. 508 individuals completed our survey. After dropping those with extreme response times, our final sample consists of 493 individuals. Table A.2 Column 6 provides summary statistics and shows that the sample is broadly representative of the adult US population (see the benchmarks taken from the 2019 American Community Survey in Column 5).

A.1.2 Details on control variables

To account for small imbalances across treatment arms in our main experiment (see Table 1) and to increase power, we include a set of control variables in all our estimations. Our baseline set of control variables used for our main experiment is the following: demographics: a dummy for being female, a dummy for above-median age, dummies for being employed and for holding a university degree, the logs of the respondent's household's net income and net wealth[1]; survey measures of investor behavior: dummies for different levels of trading experience, financial literacy, attention to the DAX, investment horizon, sources of financial information and risk tolerance; administrative measures of holdings with the bank at the time of the survey: the log of total financial wealth held with the bank, the equity share and dummies for holding an equity share of 0% or 100%, the share of other securities, dummies for number of equity trades over the previous three months and length of relationship with the bank; technical controls: dummies for passing an attention screener, self-reported survey difficulty, use of external information in the response, experiencing a technical issue and taking the survey on a mobile phone. None of our results are sensitive to the exact set and construction of control variables included. We use a very similar set of control variables in the estimations based on the additional experimental investor survey described in Appendix A.8, the main difference being that all variables are constructed based on survey measures, as no administrative account data are available for any of our additional data collections. We use a more parsimonious set of control variables in our estimations based on the additional descriptive investor survey described in Appendix A.1.1 above due to its smaller sample size.

A.1.3 Selection into the survey

Table A.3 compares our main survey sample with a random sample of 3,701 investors drawn from the client pool of the same bank using the same criteria as for the main survey sample. Our sample over-represents less wealthy investors and those with lower trading frequency.

[1]We elicit net wealth and income using survey questions with categorical response options, and construct continuous variables based on the mid-points of the corresponding bins. The lowest response categories are "no net wealth" or "no income", for which we assign the value zero. We construct the logs of the variables after adding the value one.

Table A.1: Overview of data collections

Data collection	**Sample**	**Treatments**	**Main variables**
Main survey (September-November 2019): Autocorrelation experiment	Retail investors at German online bank ($n = 1,961$)	Information on empirical autocorrelation of returns and control	Beliefs about autocorrelation, return expectations, trading decisions (account data)
Follow-up survey (September-November 2019)	Retail investors at German online bank from main survey ($n = 903$)	Repeated information on empirical autocorrelation of returns and control	Beliefs about autocorrelation, return expectations, trading decisions (account data)
Additional descriptive investor survey (July-August 2022)	Retail investors at German online bank ($n = 208$)	None	Beliefs about autocorrelation, sources of beliefs, and familiarity with financial variables
Additional experimental investor survey (July-August 2022): PD experiment	Retail investors at German online bank ($n = 693$)	Information on empirical correlation between valuation ratios and subsequent returns and control	Beliefs about link between valuation ratios and subsequent returns, return expectations
Descriptive general population survey Germany (July-August 2022)	Online panel in collaboration with Dynata ($n = 490$)	None	Beliefs about autocorrelation, return expectations
Descriptive general population survey US (July-August 2022)	Online panel in collaboration with Lucid ($n = 493$)	None	Beliefs about autocorrelation, return expectations

Table A.2: Summary statistics other surveys

	Means					
	(1) PHF 2017 stock-holders	(2) Descriptive investor survey 2022	(3) PHF 2017 all	(4) German representative survey 2022	(5) ACS 2019 all	(6) US representative survey 2022
Female	0.49	0.15	0.51	0.50	0.51	0.54
Age	50.55	47.73	50.12	53.25	47.78	48.77
University	0.36	0.55	0.19	0.22	0.31	0.38
Employed	0.65	0.72	0.60	0.55	0.62	0.50
Household income	3,808	4,301	2,790	2,925	8,050	6,944
Household net wealth	361,783	444,172	171,161	156,042		278,942
Stockowner	1.00	1.00	0.17	0.41		0.60
Average monthly equity trades		0.69		0.19		0.34
Risk tolerance (1-7)		4.38		2.64		3.44
Trading experience (years)		14.76		5.50		7.40
Financial literacy score (0-3)		1.82		1.06		1.34
Follow stock market developments (1-7)		4.37		2.92		3.43
Investment horizon $\geq$ 5 years		0.53		0.44		0.30
Perceived return last 12 months		-5.01		4.11		9.05
Confident in perceived return		0.64		0.38		0.43
Expected return next 12 months		6.68		11.47		32.40
Confident in expected return		0.45		0.36		0.43
Perceived mean hist. ret. intervals		9.46		8.30		11.95
Perceived diff. gain-loss historical		-4.31		1.55		1.87
Extrapolator (diff. $\geq$ 4)		0.16		0.30		0.34
Mean-reverter (diff. $<$ -4)		0.49		0.18		0.19
Observations		208		490		493

Notes: This table shows summary statistics for the additional descriptive retail investor survey (Column 2), for the descriptive survey on a representative sample from Germany (Column 4), and for the descriptive survey on a representative sample from the US (Column 6). All three surveys were run in July and August 2022. The table also includes benchmarks from the German population of individuals participating in the stock market as measured in the 2017 wave of the Bundesbank's Panel of Household Finance (PHF, Column 1), the overall German population as measured in the PHF (Column 3), and the overall US population as measured in the 2019 wave of the American Community Survey (Column 5). Variables on income and wealth are expressed in euro terms (Columns 1-4) or in dollar terms (Columns 5-6). "Household income" indicates monthly household income after taxes for the German samples (Columns 1-4) and monthly household income before taxes for the US samples (Columns 5-6), reflecting differences in the availability of benchmark data.

Table A.3: Selection into the survey: Comparison with random sample

	(1) Survey Sample: Mean	(2) Survey Sample: SD	(3) Random Sample: Mean	(4) Random Sample: SD	(5) p-value (1) = (3)
Female	0.16	0.37	0.22	0.41	0.000
Age	45.24	14.15	52.02	15.25	0.000
Employed	0.77	0.42	0.61	0.49	0.000
Risk attitude (1-5)	4.25	1.18	4.37	1.18	0.000
Total financial wealth at bank	55,272	98,312	82,216	142,817	0.000
Portfolio value at bank	43,970	87,671	63,144	117,574	0.000
Equity Share	0.73	0.45	0.70	0.30	0.415
Average monthly trades	1.88	3.50	3.55	10.88	0.000
Average monthly equity trades	1.73	3.29	2.65	7.27	0.000
Observations	1,961	3,701	1,961	3,701	

Notes: This table shows summary statistics for our main survey sample (Columns 1-2) and a sample randomly drawn from the bank's client pool (Columns 3-4). Column 5 provides the p-values for a test for differences in means between the survey and the random sample. Variables on wealth and portfolio holdings are expressed in euro terms. For the survey sample, financial wealth at the bank, portfolio value at the bank, and equity holdings at the bank are measured in the month prior to the survey. Average monthly equity trades are measured over the three months preceding the survey. For the random sample, we measure financial wealth at the bank, portfolio value at the bank, and equity holdings at the bank in August 2019 and report the average monthly equity trades in June, July and August 2019.

A.2 Background on the German stock market

In this appendix we provide some background on the dynamics of returns and return predictability in the German stock market.

Table A.4 Panel A provides evidence on (i) the autocorrelation of aggregate returns and (ii) the correlation of realized past-12-month returns with the current price-dividend ratio for the overall German stock market over the period 1969-2021. We focus on the full German stock market instead of the DAX for this exercise to have a more meaningful measure of the price-dividend ratio than would be available for the DAX with its low number of constituent firms. The table highlights that, historically, 12-month-ahead returns do not vary systematically with realized returns over the previous 12 months. Moreover, realized past-12-month returns are only weakly correlated with the current price-dividend ratio, highlighting that realized 12-month returns reflect short-term fluctuations rather than (the often longer-term) swings in valuation ratios. Thus, observing a high realized 12-month return provides only a weak signal about the level of the current price-dividend ratio.

Panel B analyzes the predictability of future returns based on the current price-dividend ratio over the period 1969-2021. The correlation coefficients shown in Panel B.1 give a first indication that the price-dividend ratio is only weakly negatively related to 12-month-ahead returns while the association of the price-dividend ratio with 12-month-ahead dividend growth is fairly large and positive. Since the price-dividend ratio must necessarily predict future returns or future cash flows (Campbell and Shiller, 1988), we can decompose the variance of the price-dividend ratio into variance explained by future returns and variance explained by future dividend growth. We compute the shares as in Cochrane (2008) using regressions of log returns, r, log dividend growth, Δd, and the log price-dividend ratio, pd, in t on the log price-dividend ratio in $t-1$:

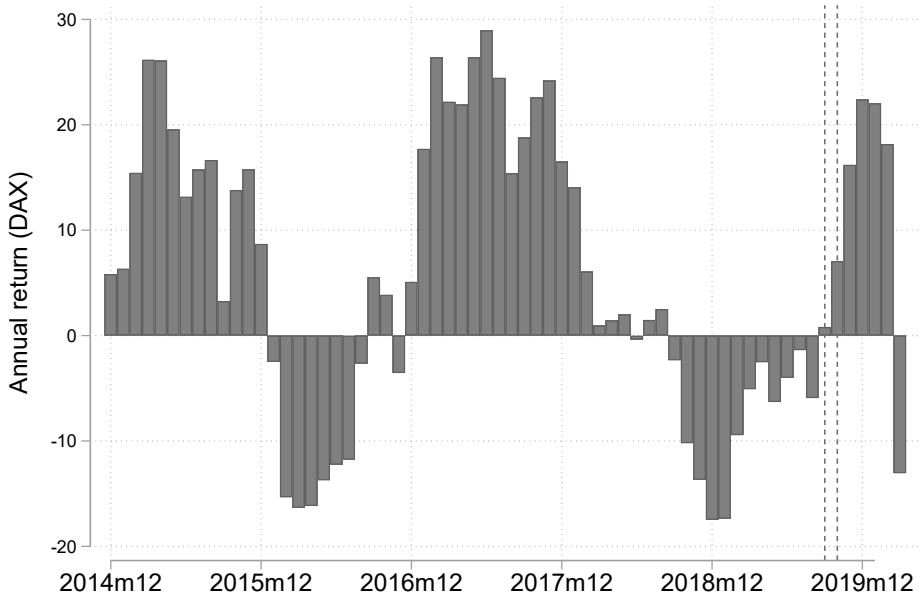
$$
\begin{aligned}
r_t &= \mu_r + \beta_r \; pd_{t-1} \\
\Delta d_t &= \mu_d + \beta_d \; pd_{t-1} \\
pd_t &= \alpha + \rho \; pd_{t-1}
\end{aligned}
$$

The linearized return identity $r_t \approx k_0 + k_1 pd_t - pd_{t-1} + \Delta d_t$ (where $k_1 = \overline{PD}/(1+\overline{PD})$ with $\overline{PD}$ denoting the mean price-dividend ratio) implies that $\beta_r \approx k_1\rho - 1 + \beta_d \Leftrightarrow \frac{\beta_r}{k_1\rho-1} - \frac{\beta_d}{k_1\rho-1} \approx 1$, where the absolute values of the two fractions on the left-hand side can be understood as shares of the variation in the price-dividend ratio that can be explained by variation in either returns or dividend growth. The results are shown in Panel B.2. Most of the variation in the price-dividend ratio (59%) can be explained by variation in future cash flow growth, confirming earlier results for the German context (Rangvid et al., 2014). Running direct regressions of cumulative weighted future returns and dividend growth on the log price-dividend ratio (see Cochrane, 2008) yields similar results.

Figure A.1 presents realized (overlapping) past-12-month returns of the DAX for all months

in the period from December 2014 until March 2020 – the time for which administrative account data for our main investor sample are available.

Figure A.1: 12-month returns of the German Stock index (DAX) over the sample period



Notes: This figure shows the return of the DAX over the previous 12 months for each month (i.e., overlapping periods of 12 months) in the period for which account data for the respondents to our main survey are available. The dashed lines mark the time span in which investors responded to the survey.

Table A.4: Price-dividend ratios and returns in the German stock market

Panel A: Correlation of returns and PD ratio		
Correlation of past 12-month return and PD ratio	$Corr(PD_t, R_t)$	0.0925
		(0.1411)
Correlation of past 12-month return and future 12-month return	$Corr(R_t, R_{t-1})$	-0.1271
		(0.1068)
Panel B: Predictability by the PD ratio		
Panel B.1: Correlation		
Correlation of PD ratio and future 12-month return	$Corr(PD_t, R_{t+1})$	-0.0513
		(0.139)
Correlation of PD ratio and future 12-month dividend growth	$Corr(PD_t, \Delta D_{t+1})$	0.2070
		(0.145)
Panel B.2: Variance decomposition		
PD Ratio Variance decomposition %	returns	dividend growth
	41.60	58.64

Notes: This table shows statistics on the joint dynamics of the price-dividend (PD) ratio, returns and dividend growth in the German stock market. All data are taken from Datastream for a sample from 1969 to 2021. Price-dividend ratios and dividends are computed from returns with and without dividends as in Cochrane (2008). Panel A shows the correlation between the PD ratio at the end of year t with returns in year t as well as the correlation of returns in t and $t-1$. Numbers in parentheses are bootstrapped standard-errors. Panel B.1 shows correlations between the PD ratio and future returns and dividend growth, respectively. Panel B.2 shows the variance decomposition of the PD ratio into variance explained by future returns and future dividend growth, as discussed in Section A.2 above.

A.3 Additional descriptive evidence: Beliefs

In this appendix we present additional descriptive evidence on respondents' beliefs.

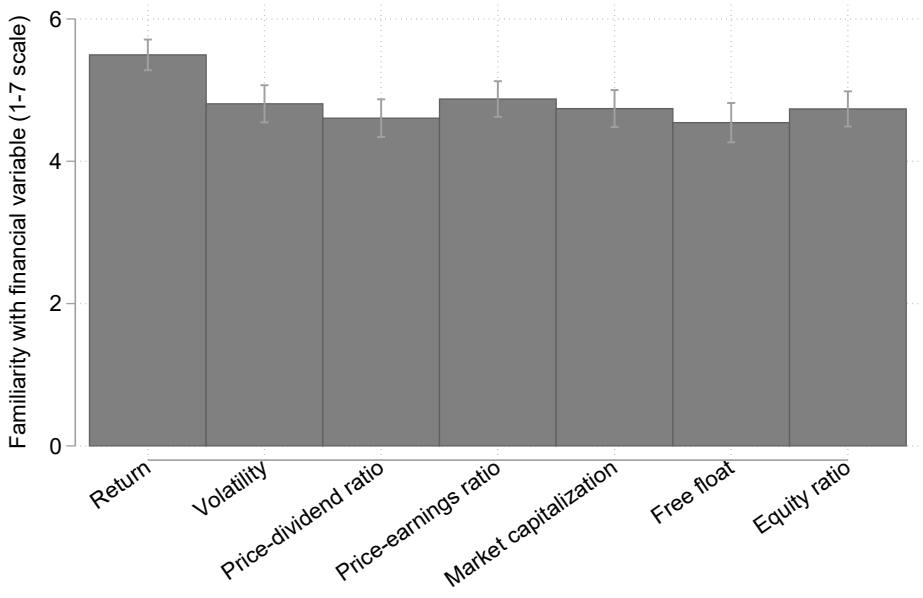
Figure A.2 displays the average degree of familiarity with different financial indicators among respondents to an additional descriptive investor survey.

Figure A.3 presents the distributions of prior beliefs about the returns over the 12 months before and the 12 months after the survey among respondents to the main survey. Figure A.4 correlates main survey respondents' actual 12-month-ahead return expectations with a prediction based on their perceived historical autocorrelation and their perceived return over the 12 months before the survey.

Figure A.5 displays factors contributing to respondents' estimates of the historical autocorrelation of returns among respondents to an additional descriptive investor survey. Figure A.6 displays distributions of beliefs about the autocorrelation of aggregate stock returns across different samples (an additional descriptive survey among German investors as well as general population surveys from Germany and the US).

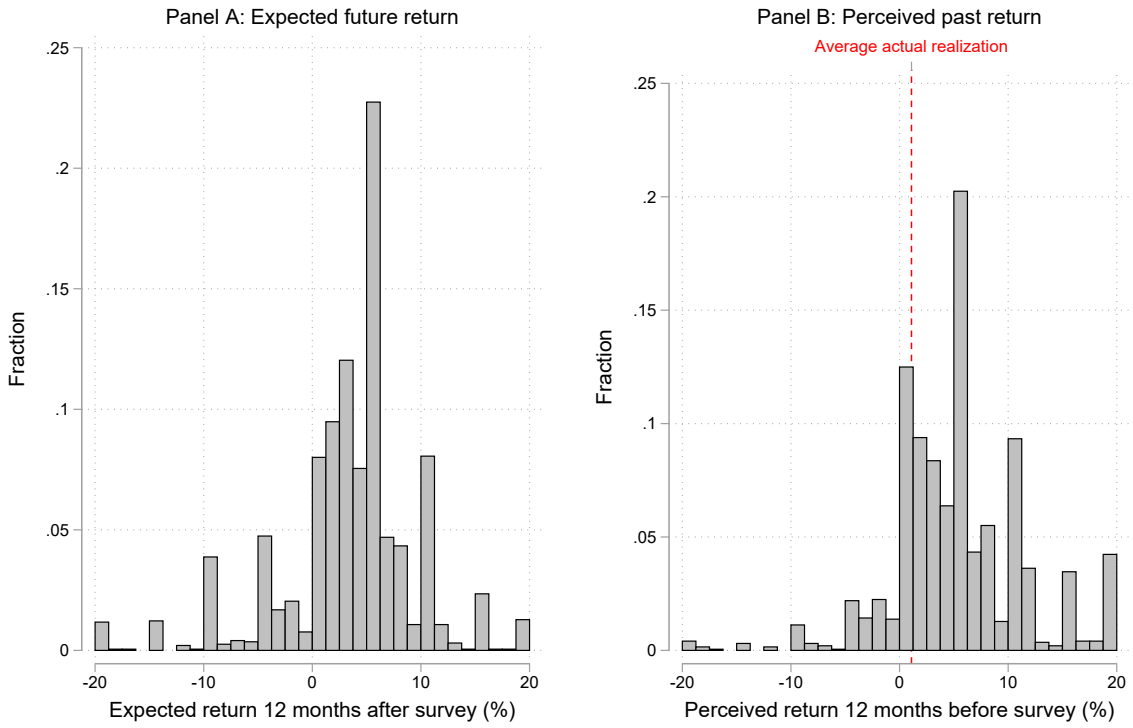
Table A.5 examines how thoughts of specific historical episodes when estimating the historical autocorrelation are related to respondents' lifetime experiences among respondents to an additional descriptive investor survey.

Figure A.2: Familiarity with financial variables



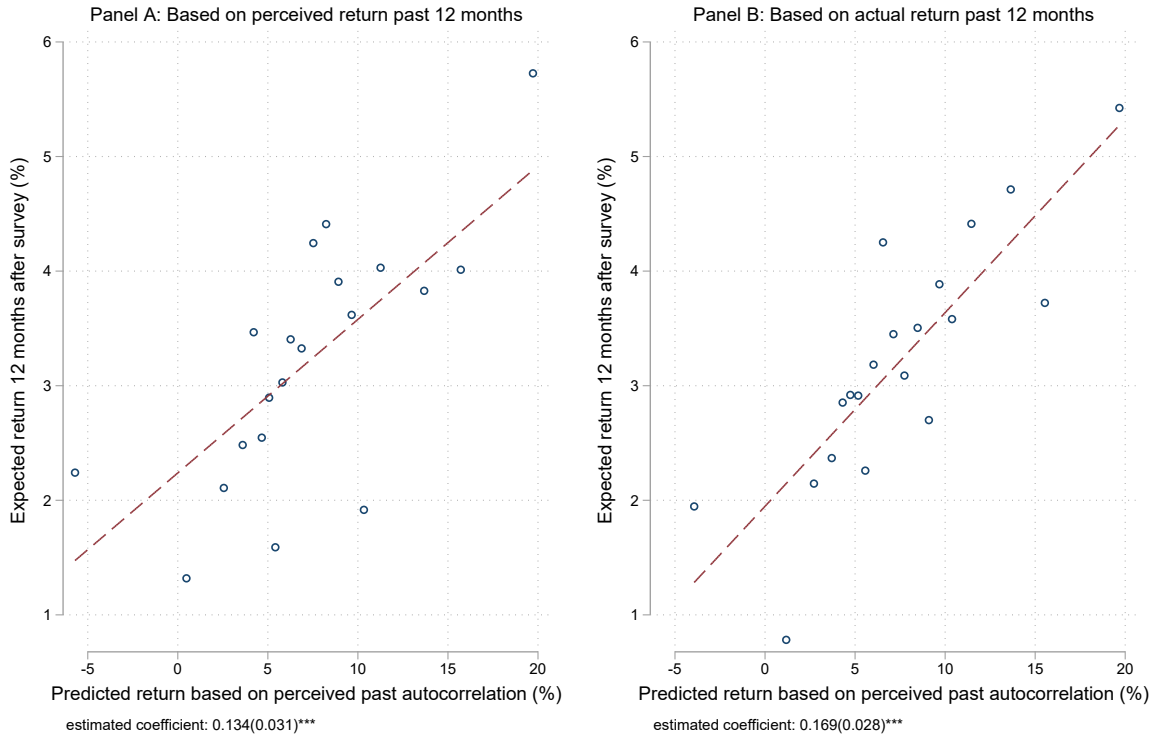
Notes: This figure displays the average degrees of familiarity with different financial concepts as measured on 7-point categorical scales in an additional descriptive survey of German retail investors.

Figure A.3: Prior beliefs about the return 12 months after and before the survey



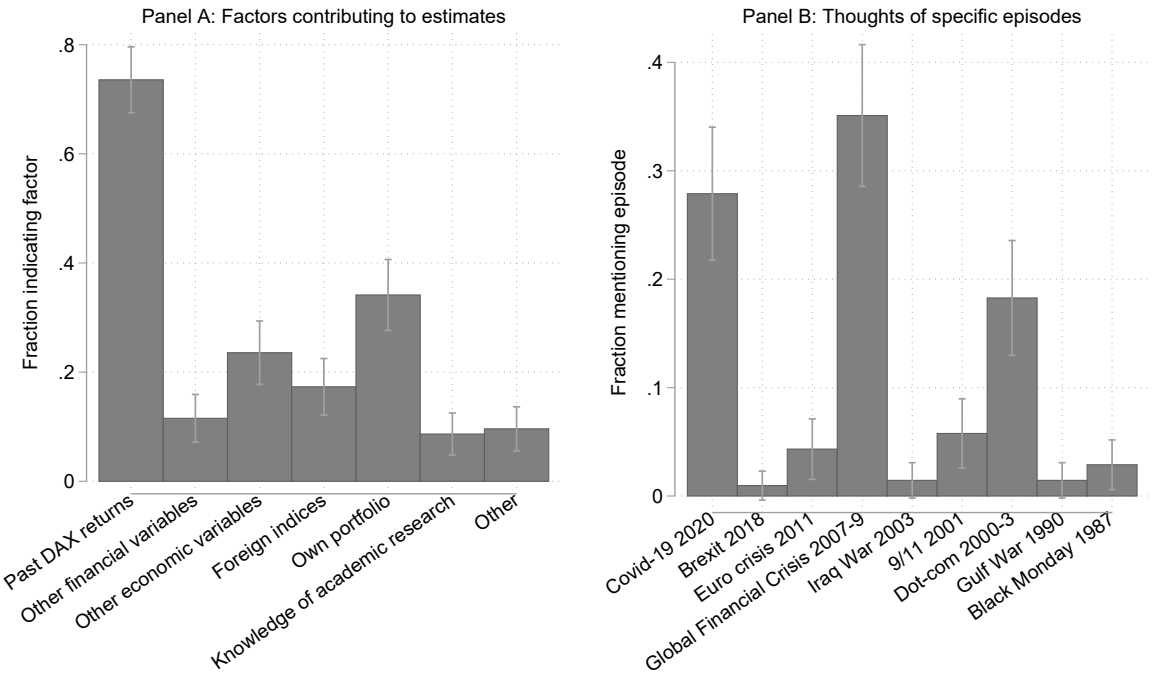
Notes: This figure displays histograms of prior beliefs about the return of the German stock market over the 12 months after (Panel A) and the 12 months before the survey (Panel B) among respondents to our main survey. Our sample focuses on respondents with a prior expected return over the next 12 months between -20% and 20%. The perceived return over the last 12 months is winsorized at -20% and 20%. The dashed red line in Panel B shows the average actual return realization over the sample period of 1.1%.

Figure A.4: Binned scatter plot of prior expected 12-month-ahead return vs predicted return expectation based on perceived historical autocorrelation



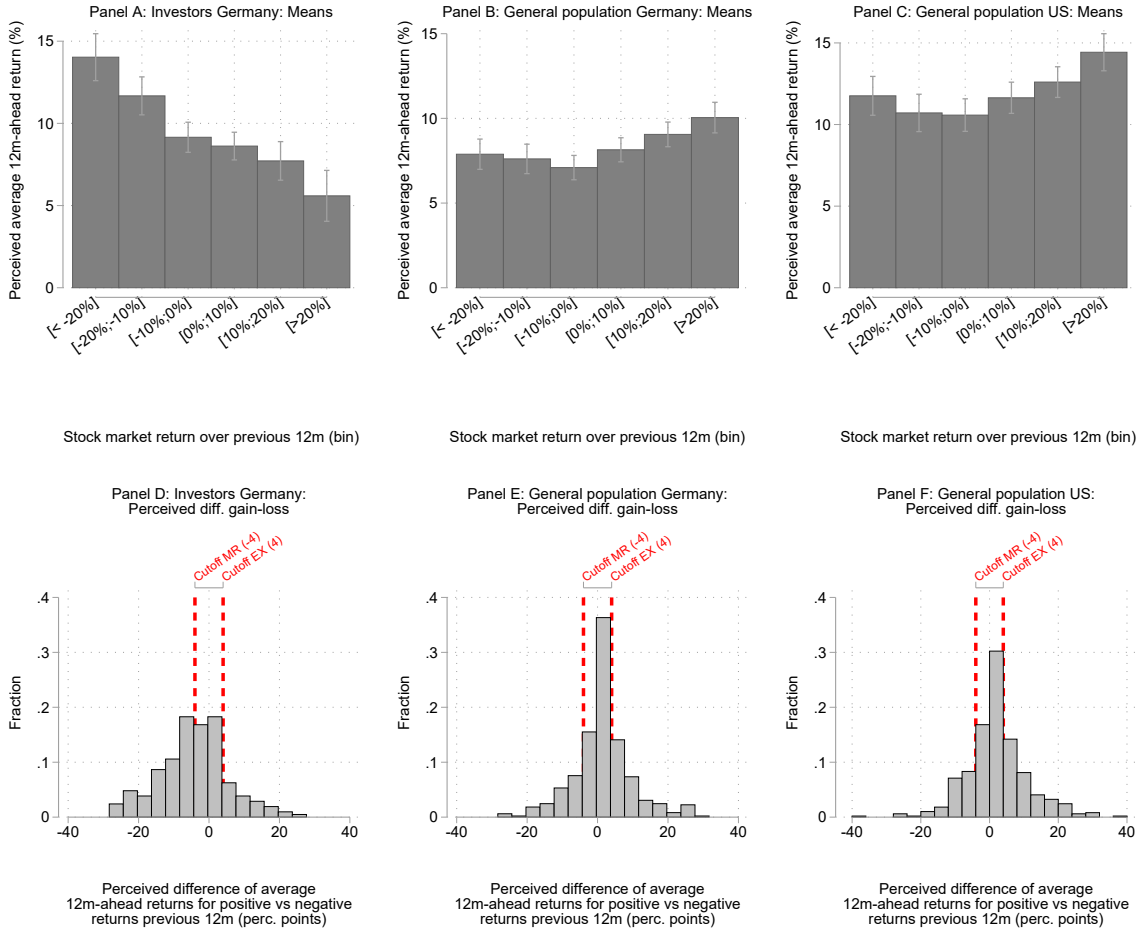
Notes: This figure shows binned scatter plots of respondents' prior expected return over the 12 months after the survey against respondents' perceived average historical 12-month-ahead return in the relevant interval of realized returns, which is selected based on the respondent's perceived return over the 12 months before the survey (Panel A) or based on the actual realized return over the 12 months before the respondent took the survey (Panel B), among respondents to our main survey. The binned scatter plots partial out the baseline set of controls described in Appendix A.1.2.

Figure A.5: Factors contributing to estimates of the historical autocorrelation



Notes: This figure summarizes the factors contributing to respondents' estimates of the historical autocorrelation of returns of the DAX among German retail investors participating in an additional descriptive survey. Panel A displays the fractions of respondents indicating different factors that contributed to their estimates based on a structured survey question. The different factors refer to respondents' memory of the past development of the returns of the DAX, of other financial variables (such as valuation ratios), of other economic variables (such as GDP growth), of the returns of foreign stock market indices, or of their own portfolio, and their knowledge of academic research on financial markets. Panel B displays the fractions of respondents mentioning specific past episodes they thought about when estimating the historical autocorrelation based on an open-ended survey question.

Figure A.6: Beliefs about the autocorrelation of aggregate returns across groups and countries



Notes: This figure summarizes beliefs about the autocorrelation of aggregate stock returns in the last 50 years among German retail investors participating in an additional descriptive survey, respondents to a general population survey from Germany, and respondents to a general population survey from the US. The surveys were all run in July and August 2022. The belief elicitation focused on the DAX (Panels A, B, D and E) or on the overall US stock market (Panels C and F). Panels A-C show the sample means of respondents' beliefs about average 12-month-ahead stock returns for six intervals of realized returns over the previous 12 months. Panels D-F show histograms of respondents' perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios, including the cutoffs we use to define mean reverters, neutrals and extrapolators.

Table A.5: Sources of beliefs: Experiences and memory database

	Thought of specific episode		
	(1)	(2)	(3)
Started investing in stocks before the episode	0.067***		0.051**
	(0.018)		(0.020)
Turned 18 years before the episode		0.063***	0.038**
		(0.015)	(0.017)
Observations	1,872	1,872	1,872
R-squared	0.02	0.02	0.03

Notes: This table examines whether investors' memory databases are shaped by their own lifetime experiences among German retail investors participating in an additional descriptive survey. The dataset is at the investor × episode level. There are 208 investors and the following nine historical episodes: the Covid-19 downturn (2020), the downturn associated with Brexit (2018), the euro crisis (2011), the Global Financial Crisis (2007-9), the downturn associated with the Iraq War (2003), the terror attacks on 9/11 (2001), the burst of the dot-com bubble (2000-3), the downturn associated with the Gulf War (1990), and the downturn following the Black Monday (1987). The outcome is a dummy variable taking value one if an investor thought of the specific event when estimating the historical autocorrelation. The main independent variables are dummies taking value one if the investor had started to invest in stocks before the respective episode (Column 1) or if the investor had turned 18 before the respective episode (Column 2). All estimations include a parsimonious set of controls (gender, employment status, education, household income, financial wealth, financial literacy, and attention to DAX developments). Standard errors clustered at the investor level are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

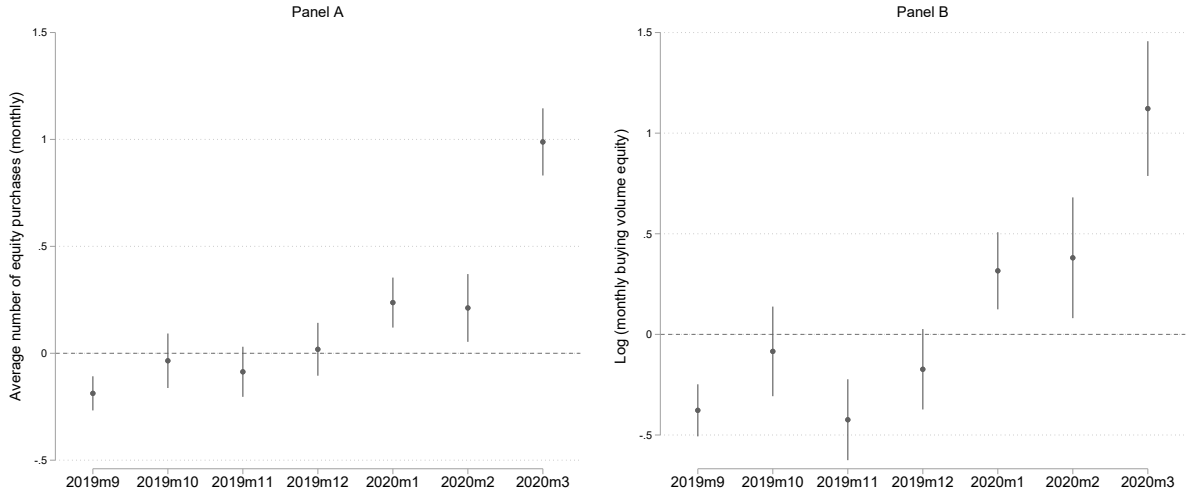
A.4 Additional descriptive evidence: Trading

In this appendix we present additional descriptive evidence on trading behavior among respondents to our main survey.

Figure A.7 plots the estimates on the month-year fixed effects from specification 5, which is described in detail in Section 4.2. These estimates highlight how equity buying evolves among non-mean reverters in the control group during the Covid-19 crash compared to the base month (August 2019).

Table A.6 shows regressions of different measures of investors' trading behavior on a dummy indicating a negative return of the DAX over the previous 12 months among our main investor sample and a random sample of investors from the same subject pool.

Figure A.7: Buying behavior of non-treated non-mean reverters over time



Notes: This figure shows coefficient estimates on the month-year fixed effects based on investor-month level estimations of specification 5 among respondents to our main survey, where August 2019 is omitted. The figure shows the estimates for the subsample of active investors. The effects capture the development of buying activity among non-treated non-mean reverters (for whom the perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is at least -4 pp) over time. The outcomes are the monthly number of equity purchases (Panel A) and the log of the monthly equity buying volume, where the value one is added to the volume before taking logs (Panel B).

Table A.6: DAX development and trading decisions

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Full Sample							
DAX down	0.010	0.036	0.063	-0.006	-0.013	-0.076*	0.139**
	(0.008)	(0.028)	(0.059)	(0.005)	(0.008)	(0.040)	(0.062)
Observations	76,008	76,008	76,008	76,008	76,008	76,008	76,008
R-squared	0.488	0.616	0.358	0.111	0.118	0.12	0.245
Panel B: Random Sample							
DAX down	0.014*	0.074	0.097	-0.006	0.002	-0.076	0.173***
	(0.008)	(0.052)	(0.071)	(0.006)	(0.032)	(0.053)	(0.060)
Observations	185,225	185,225	185,225	185,225	185,225	185,225	185,225
R-squared	0.454	0.688	0.422	0.320	0.749	0.387	0.177
p-value(A=B)	0.293	0.340	0.481	0.956	0.613	0.993	0.362
Macroeconomic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	No	No	No

Notes: This table examines the association between the development of the German Stock Index (DAX) and trading activity at the online bank among respondents to our main survey (Panel A) and a random sample (Panel B) based on investor-month level estimations. Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. DAX down is a dummy indicating whether the return of the DAX over the preceding 12 months was negative. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group and the random sample. The table also provides p-values testing for differences in trading reactions to stock market downturns across the two samples. All estimations include individual fixed effects and control for lagged log financial wealth held with the bank as well as macroeconomic indicators (year-on-year monthly inflation and quarterly, seasonally-adjusted GDP growth). Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

A.5 Robustness checks

This appendix provides a number of robustness checks.

Tables A.7 and A.8 present versions of Tables 4 and 5 that rely on a continuous past 12-month return variable instead of a dummy indicating negative returns.

Tables A.9, A.10 and A.11 demonstrate the robustness of the findings presented in Tables 4, 6 and 8 to varying the cutoffs used to define extrapolators, neutrals and mean reverters.

Table A.7: Perceived autocorrelation and trading decisions: Continuous past return variable

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Full Sample							
DAX return ×	0.001***	0.004***	0.009***	0.000	0.001	0.003	0.006*
Extrapolator (diff. $\geq$ 4)	(0.000)	(0.002)	(0.003)	(0.000)	(0.000)	(0.002)	(0.004)
DAX return ×	0.000	0.001	0.003	-0.000	-0.000	-0.002	0.005**
Neutral (-4 $\leq$ diff. < 4)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)	(0.002)	(0.002)
Observations	76,008	76,008	76,008	76,008	76,008	76,008	76,008
R-squared	0.491	0.618	0.361	0.114	0.121	0.123	0.249
Panel B: Excl. short oberservation periods							
DAX return ×	0.001***	0.004***	0.010***	0.000	0.001	0.003	0.006*
Extrapolator (diff. $\geq$ 4)	(0.000)	(0.002)	(0.003)	(0.000)	(0.000)	(0.002)	(0.004)
DAX return ×	0.000	0.001	0.003	-0.000	-0.000	-0.003	0.006**
Neutral (-4 $\leq$ diff. < 4)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)	(0.002)	(0.003)
Observations	67,108	67,108	67,108	67,108	67,108	67,108	67,108
R-squared	0.481	0.596	0.352	0.111	0.116	0.121	0.237
Panel C: Active Investors							
DAX return ×	0.002***	0.007***	0.015***	0.001**	0.001*	0.006**	0.009*
Extrapolator (diff. $\geq$ 4)	(0.001)	(0.002)	(0.004)	(0.000)	(0.001)	(0.003)	(0.005)
DAX return ×	0.000	0.002	0.005	-0.000	-0.000	-0.001	0.006**
Neutral (-4 $\leq$ diff. < 4)	(0.000)	(0.001)	(0.003)	(0.000)	(0.001)	(0.002)	(0.003)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Panel D: Active Investors							
DAX return ×	-0.001**	-0.003**	-0.008***	-0.000	-0.000	-0.001	-0.007**
Mean Reverters (diff. < -4)	(0.000)	(0.001)	(0.003)	(0.000)	(0.000)	(0.002)	(0.003)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the association between beliefs about the autocorrelation of aggregate returns and trading activity at the online bank among respondents to our main survey based on investor-month level estimations analogous to specification 2. Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. Extrapolators are those investors for whom the prior perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is at least 4 pp, those with a difference of at least -4 pp and less than 4 pp are classified as neutral, and those with a difference lower than -4 pp are classified as mean reverters. DAX return is the return of the DAX over the preceding 12 months. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group. Panel A reports results for the full sample, Panel B focuses on investors that we observe for more than half of our sample period, and Panels C and D focus on a subsample of active investors, where the lowest quartile in terms of the number of trades over the previous 12 months is excluded. All estimations include individual and month-year fixed effects and control for lagged log financial wealth held with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.8: Beliefs about the stock market and the equity share: Continuous past return variable

	Equity Share	
	(1)	(2)
Panel A: Full Sample		
DAX return × Extrapolator (diff. ≥ 4)	0.090**	
	(0.034)	
DAX return × Neutral (-4 ≤ diff. < 4)	0.013	
	(0.023)	
DAX return × Mean Reverter (diff. < -4)		-0.037*
		(0.021)
Observations	76,008	76,008
R-squared	0.756	0.756
Panel B: Excl. short oberservation periods		
DAX return × Extrapolator (diff. ≥ 4)	0.088**	
	(0.035)	
DAX return × Neutral (-4 ≤ diff. < 4)	0.027	
	(0.023)	
DAX return × Mean Reverter (diff. < -4)		-0.046**
		(0.021)
Observations	67,108	67,108
R-squared	0.757	0.757
Panel C: Active Investors		
DAX return × Extrapolator (diff. ≥ 4)	0.089**	
	(0.039)	
DAX return × Neutral (-4 ≤ diff. < 4)	0.010	
	(0.027)	
DAX return × Mean Reverter (diff. < -4)		-0.033
		(0.024)
Observations	53,746	53,746
R-squared	0.737	0.737
Time FE	Yes	Yes
Individual FE	Yes	Yes

Notes: This table examines the association between beliefs and the equity share held with the bank among respondents to our main survey based on investor-month level estimations. Extrapolators are those investors for whom the prior perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios is at least 4 pp, those with a difference of at least -4 pp and less than 4 pp are classified as neutral, and those with a difference lower than -4 pp are classified as mean reverters. DAX return is the return of the DAX over the preceding 12 months. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group. Panel A reports results for the full sample, Panel B focuses on investors that we observe for more than half of our sample period, and Panel C focuses on a subsample of active investors, where the lowest quartile in terms of the number of trades over the previous 12 months is excluded. All specifications control for month-year fixed effects and lagged log financial wealth with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.9: Perceived autocorrelation and trading decisions: Alternative type definitions

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Active Investors - Baseline							
DAX down ×	-0.045**	-0.165***	-0.306**	-0.016	-0.019	-0.127	-0.178
Extrapolator (diff. ≥ 4)	(0.017)	(0.060)	(0.115)	(0.010)	(0.017)	(0.084)	(0.129)
DAX down ×	-0.019*	-0.064*	-0.179**	-0.007	-0.004	-0.025	-0.154**
Neutral (-4 ≤ diff. < 4)	(0.011)	(0.037)	(0.075)	(0.008)	(0.013)	(0.059)	(0.074)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Panel B: Active Investors - Narrow frame for neutral types							
DAX down ×	-0.045***	-0.166***	-0.309***	-0.012	-0.018	-0.098	-0.211*
Extrapolator (diff. ≥ 3)	(0.016)	(0.052)	(0.106)	(0.010)	(0.017)	(0.078)	(0.120)
DAX down ×	-0.008	-0.021	-0.100	-0.009	-0.011	-0.055	-0.046
Neutral (-3 ≤ diff. < 3)	(0.013)	(0.042)	(0.085)	(0.008)	(0.014)	(0.063)	(0.088)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Panel C: Active Investors - Broad frame for neutral types							
DAX down ×	-0.036**	-0.145**	-0.259**	-0.022**	-0.025	-0.169*	-0.090
Extrapolator (diff. ≥ 5)	(0.018)	(0.065)	(0.120)	(0.011)	(0.018)	(0.086)	(0.134)
DAX down ×	-0.014	-0.055	-0.150**	-0.001	0.008	0.014	-0.163**
Neutral (-5 ≤ diff. < 5)	(0.010)	(0.037)	(0.070)	(0.007)	(0.012)	(0.052)	(0.070)
Observations	53,746	53,746	53,746	53,746	53,746	53,746	53,746
R-squared	0.461	0.612	0.317	0.112	0.119	0.124	0.24
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the association between beliefs about the autocorrelation of aggregate returns and trading activity at the online bank among respondents to our main survey based on investor-month level estimations of specification 2 for alternative definitions of belief types. Panel A repeats the results based on the baseline type definition from Table 4 Panel C. In Panel B, we use a more narrow cutoff to define neutrals (difference in estimated returns for the following year between positive and negative previous return scenarios of at least -3 pp and lower than 3 pp). In Panel C, we use a broader definition of neutrals (difference at least -5 pp and lower than 5 pp). Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. DAX down is a dummy indicating whether the return of the DAX over the preceding 12 months was negative. For the return calculation, we use the average return compared to 12 months earlier across all trading days in the current month. The transaction data span the period from December 2014 until the month before the survey month (between September and November 2019) for the treatment group and until including January 2020 for the control group. The estimations focus on the subsample of active investors, where the lowest quartile in terms of the number of trades over the previous 12 months is excluded. All estimations include individual and month-year fixed effects as well as lagged log financial wealth held with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.10: Manipulation check: Alternative type definitions

	No sense to buy after high return	Positive return more likely after high return	Above average return after negative return	Negative return likely to continue next year
	(1)	(2)	(3)	(4)
Panel A: Baseline				
Treatment × Extrapolator (diff. $\geq$ 4) (a)	0.021	-0.375***	-0.382**	-0.916***
	(0.114)	(0.115)	(0.176)	(0.189)
Treatment × Neutral (-4 $\leq$ diff. < 4)	0.075	-0.084	0.088	-0.274**
	(0.080)	(0.081)	(0.123)	(0.115)
Treatment × Mean-reverter (diff. < -4) (b)	-0.155***	-0.114*	-0.556***	-0.428***
	(0.060)	(0.062)	(0.087)	(0.086)
p-value (a=b)	0.174	0.047	0.379	0.019
Panel B: Neutral narrow				
Treatment × Extrapolator (diff. $\geq$ 3) (a)	0.076	-0.327***	-0.357**	-0.823***
	(0.109)	(0.112)	(0.170)	(0.179)
Treatment × Neutral (-3 $\leq$ diff. < 3)	-0.041	-0.076	0.129	-0.232*
	(0.091)	(0.092)	(0.137)	(0.130)
Treatment × Mean-reverter (diff. < -3) (b)	-0.101*	-0.117**	-0.504***	-0.437***
	(0.057)	(0.059)	(0.084)	(0.083)
p-value (a=b)	0.151	0.099	0.442	0.051
Panel C: Neutral broad				
Treatment × Extrapolator (diff. $\geq$ 5) (a)	0.024	-0.432***	-0.476**	-0.902***
	(0.123)	(0.119)	(0.188)	(0.201)
Treatment × Neutral (-5 $\leq$ diff. < 5)	0.034	-0.093	0.058	-0.329***
	(0.073)	(0.074)	(0.111)	(0.108)
Treatment × Mean-reverter (diff. < -5) (b)	-0.151**	-0.106	-0.586***	-0.430***
	(0.062)	(0.066)	(0.091)	(0.089)
p-value (a=b)	0.206	0.017	0.602	0.032

Notes: This table shows estimations of the effect of the information treatment on posterior agreement with verbal statements describing beliefs about the autocorrelation of aggregate returns among respondents to our main survey for alternative definitions of belief types. Agreement with the statements is elicited on 7-point categorical scales, and is z-scored using the means and standard deviations in the sample. The statements are: "When the stock market has recently increased it makes no sense to buy stocks." (Column 1); "When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased." (Column 2); "When the stock market has fallen in the previous year one can expect above-average returns for the next year." (Column 3); "When the stock market has fallen over the previous 12 months there is a high probability that this trend will continue in the following 12 months." (Column 4). The outcomes in Columns 1 and 2 are elicited in the main survey and the outcomes in Columns 3 and 4 are elicited in the follow-up survey after the repeated information treatment. The estimations show heterogeneous treatment effects for prior extrapolators, neutrals, and mean reverters. Panel A repeats the results based on the baseline type definition from Table 6. In Panel B, we use a more narrow cutoff to define neutrals (difference in estimated returns for the following year between positive and negative previous return scenarios of at least -3 pp and lower than 3 pp). In Panel C, we use a broader definition of neutrals (difference at least -5 pp and lower than 5 pp). All estimations include the baseline set of controls described in Appendix A.1.2 as well as non-interacted dummies for extrapolators and mean reverters using the relevant definition. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.11: Trading behavior of mean reverters during the Covid-19 downturn: Alternative type definitions

	Purchases			Sales			Net purchases
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Prob (buy)	# of purchases	Log buying volume	Prob (sell)	# of sales	Log selling volume	Net log buying
Panel A: Treatment effects - Mean Reverter (diff. $\leq$ -4)							
Covid-19 × Mean Reverter	-0.020**	-0.155***	-0.285**	-0.029*	-0.075**	-0.192	-0.093
	(0.009)	(0.049)	(0.127)	(0.017)	(0.033)	(0.137)	(0.188)
Post × Mean Reverter	-0.007	-0.134*	-0.071	0.013	0.022	0.090	-0.161
	(0.016)	(0.071)	(0.139)	(0.017)	(0.031)	(0.122)	(0.131)
R-squared	32,859	32,859	32,859	32,859	32,859	32,859	32,859
Observations	0.462	0.623	0.326	0.104	0.107	0.117	0.242
Panel B: Treatment effects - Mean Reverter (diff. $\leq$ -3)							
Covid-19 × Treatment	-0.021**	-0.163***	-0.283**	-0.030*	-0.071**	-0.198	-0.108
	(0.009)	(0.043)	(0.127)	(0.017)	(0.033)	(0.127)	(0.137)
Post × Treatment	-0.006	-0.140**	-0.077	0.007	0.018	0.054	-0.105
	(0.017)	(0.069)	(0.148)	(0.016)	(0.031)	(0.116)	(0.149)
R-squared	36,125	36,125	36,125	36,125	36,125	36,125	29,845
Observations	0.47	0.633	0.336	0.104	0.11	0.12	0.243
Panel C: Treatment effects - Mean Reverter (diff. $\leq$ -5)							
Covid-19 × Treatment	-0.027**	-0.194***	-0.357***	-0.036**	-0.099***	0.087	-0.085
	(0.011)	(0.044)	(0.115)	(0.016)	(0.030)	(0.105)	(0.155)
Post × Treatment	-0.005	-0.110	-0.030	0.009	0.013	0.135	-0.131
	(0.017)	(0.070)	(0.138)	(0.020)	(0.033)	(0.106)	(0.125)
R-squared	29,845	29,845	29,845	29,845	29,845	28,169	36,125
Observations	0.453	0.616	0.319	0.107	0.111	0.128	0.252
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the effect of our information treatment on trading activity of mean reverters among respondents to our main survey during the Covid-19 crash based on investor-month level estimations of specification 6 for alternative definitions of mean reverters. Panel A repeats the results based on the baseline type definition from Table 8 Panel B. In Panel B, we use a wider definition of mean reverters (difference in estimated returns for the following year between positive and negative previous return scenarios lower than -3 pp). In Panel C, we use a more narrow definition of mean reverters (difference lower than -5 pp). The samples are restricted to active investors, i.e., those in the lowest quartile of number of trades over the 12 months before the survey are excluded. Columns 1-3 focus on the buying side, Columns 4-6 on the selling side, and Column 7 on net buying. Specifically, prob(buy) (prob(sell)) is an indicator for whether the respondent conducts one or more equity purchases (sales) during a given month, number of purchases (number of sales) is the number of buying (selling) transactions in equities in a given month, and log buying (selling) volume is the log of the overall transaction value of all equity purchases (sales) in a given month, where the value one is added to the volume before taking logs. The transaction data span the period from December 2014 until March 2020. All specifications control for month-year as well as individual fixed effects and lagged log financial wealth held with the bank. Standard errors are two-way clustered by investor and trading month and are presented in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

A.6 Comparison with Giglio, Maggiori, Stroebel and Utkus (2021a)

In a sample of wealthy Vanguard clients in the US, Giglio et al. (2021a) estimate a relationship between an investor's equity share and her return expectations of between 0.7 and 1.2 depending on the specification – an order of magnitude below theory benchmarks for plausible preference parameters. In Table 5 we regress an investor's equity share in a given month within the period of roughly five years preceding our survey on the investor's subjective return expectation for the next 12 months, which we predict based on (i) the actual realized return over the preceding 12 months, and (ii) a respondent's belief about the historical conditional average 12-month-ahead return when realized returns fell into the interval corresponding to (i). Our estimates based on pooled OLS regressions, which are most directly comparable to the results in Giglio et al. (2021a), range between 0.126 and 0.187 depending on the exact specification and sample used, smaller than the estimates in Giglio et al. (2021a).

One reason for our smaller estimates could be that we predict investors' expectations depending on their beliefs about the historical autocorrelation of aggregate returns and on realized returns over the previous 12 months. Investors' actual return expectations may deviate because (i) other variables than the recent return could influence investors' return expectations at any point in time, (ii) investors may think that the current autocorrelation differs from its historical counterpart, or (iii) actually realized DAX returns are an imperfect proxy for investors' perceived returns over the previous 12 months. The less than one-to-one relationship between return expectations and a prediction based on the perceived autocorrelation shown in Figure A.4 Panel A is consistent with possibilities (i) and (ii).

To make the effect sizes comparable to the results in Giglio et al. (2021a), we first regress investors' 12-month-ahead return expectations at the time of our survey on a measure of investors' predicted 12-month-ahead return expectations based on the respondents' perceived historical autocorrelation of returns and the actual returns realized over the 12 months before the respondent took the survey. As shown in Panel B of Figure A.4, conditional on our baseline set of controls, we obtain an estimated relationship of 0.169, which is highly statistically significant. We adjust our estimates of the elasticity of the equity share to beliefs ranging from 0.126 to 0.187 for the fact that we predict the respondent's expectations by dividing it by 0.169. The resulting adjusted elasticities range between 0.746 and 1.107 – remarkably close to the estimates in Giglio et al. (2021a).

A.7 Persistence in four-week follow-up

How persistent are the changes in beliefs in response to the treatment information documented in Section 4.1? We address this question using data from the follow-up survey, in which respondents participated about four weeks after the main survey. We focus on responses in the follow-up that were given *before* the information was provided for a second time to respondents in the treatment group.

First, we examine respondents' beliefs about historical 12-month-ahead returns for the six intervals of realized returns over the previous 12 months. For each interval we regress the difference between a respondent's follow-up and prior beliefs on the gap between the information and the respondent's prior, a treatment dummy, and the interaction of the two. Table A.12 Columns 1-6 highlight estimated coefficients on the interaction term of about 0.25, indicating that treated respondents adjust their beliefs by about one fourth of the initial gap to the information. We find similar effects for the perceived standard deviation over the six intervals and the perceived difference between positive and negative returns over the previous year (Columns 7-8).

Second, Table A.13 examines agreement with the three verbal manipulation check questions in the follow-up. Since these questions were included in both the main and the follow-up survey, we can quantify the persistence of initial treatment effects. For both the statement capturing beliefs about the absence of any form of predictability by recent returns and the statement capturing a belief in mean reversion, we find that treatment effects strongly persist, and, if anything, increase in size compared to the main survey. While the treatment effects on agreement with the statement capturing a belief in persistence do not persist, this finding should be interpreted in light of the very small group of prior extrapolators in the follow-up sample.

Third, Table A.14 examines persistence of updating of expectations about the return over the 12 months after the survey based on specification 4. Columns 1 and 2 display estimates in the main survey restricted to those who later participate in the follow-up. The outcomes in Columns 3 and 4 are the difference between 12-month-ahead return expectations measured in the beginning of the follow-up survey and the prior elicited in the main survey. In both OLS and IV specifications the estimated effect sizes *increase* compared to the effect sizes in the main survey.

Taken together, these patterns highlight a strong persistence of treatment effects on respondents' beliefs. Previous studies often find that treatment effects on respondents' beliefs persist at a reduced size in follow-up surveys (Armona et al., 2019; Cavallo et al., 2017; Coibion et al., 2021; Roth and Wohlfart, 2020). The higher persistence in our setting could be due to the fact that our information treatment aims to change respondents' beliefs about return predictability – and therefore the way they form return expectations – instead of providing them with information that might lose its relevance over time, such as, e.g., expert forecasts.

Our evidence on persistence mitigates two concerns. First, changes in return expectations

could be driven by unconscious numerical anchoring on the information. Such anchoring is a short-lived phenomenon by definition, so the strong persistence of treatment effects in the follow-up suggests a limited role for numerical anchoring (Cavallo et al., 2017). Second, experimenter demand effects – respondents guessing the experimental hypothesis and trying to conform with it – should be less important in the follow-up (Haaland et al., 2021).[2]

Table A.12: Recall of treatment information in four-week follow-up

	Δ Estimated historical mean return next 12 months conditional on return previous 12 months in interval						Δ Perceived SD	Δ Perceived diff. gain-loss
	(1) $\leq -20\%$	(2) [-20%,-10%]	(3) [-10%,0%]	(4) [0%,10%]	(5) [10%,20%]	(6) >20%	(7)	(8)
Treatment × (Information - Prior)	0.277*** (0.054)	0.132** (0.063)	0.020 (0.076)	0.319*** (0.109)	0.260*** (0.060)	0.252*** (0.054)	0.293*** (0.068)	0.317*** (0.057)
Treatment	-0.594 (0.571)	-0.986* (0.515)	-0.723* (0.401)	-0.766* (0.457)	0.384 (0.427)	0.888* (0.527)	0.575 (0.454)	-0.826 (0.572)
Information - Prior	0.495*** (0.041)	0.610*** (0.043)	0.759*** (0.052)	0.521*** (0.091)	0.567*** (0.046)	0.531*** (0.040)	0.536*** (0.047)	0.420*** (0.043)
Observations	903	899	900	903	903	902	903	903
R-squared	0.45	0.43	0.41	0.30	0.45	0.48	0.46	0.40

Notes: This table examines whether respondents recall the treatment information in the four-week follow-up. The outcomes are differences between respondents' posterior beliefs measured in the four-week follow-up survey and prior beliefs measured in the main survey. The beliefs are the perceived historical average 12-month-ahead return when the return over the previous 12 months fell into one of six intervals (Columns 1-6), the perceived standard deviation of 12-month-ahead returns over the six historical realized return intervals (Column 7), and the perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios (Column 8). Changes in beliefs are regressed on a treatment indicator, the difference between information and prior, and the difference between information and prior interacted with a treatment indicator (indicating whether respondents actually received the information). Changes in beliefs and differences between information and prior are winsorized at -20 and 20 pp. All estimations include the baseline set of controls described in Appendix A.1.2 as well as dummies for the time between main and follow-up survey. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

[2]de Quidt, Haushofer and Roth (2018) show that demand effects seem to be of limited quantitative importance in online experiments.

Table A.13: Manipulation check: Persistence in four-week follow-up

	Main survey		Main survey Follow-up sample		Follow-up survey	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Positive return irrespective of previous return						
Treatment	0.093**		0.107*		0.116*	
	(0.044)		(0.065)		(0.067)	
Treatment ×		0.166***		0.163*		0.209**
Perceived SD ≥ Median		(0.062)		(0.092)		(0.097)
Treatment ×		0.020		0.053		0.025
Perceived SD < Median		(0.062)		(0.089)		(0.091)
Observations	1,961	1,961	903	903	903	903
Panel B: No sense to buy after high return						
Treatment	-0.054		-0.050		-0.135**	
	(0.044)		(0.063)		(0.068)	
Treatment ×		0.021		-0.133		-0.259
Extrapolator (diff. ≥ 4)		(0.114)		(0.174)		(0.177)
Treatment ×		0.075		0.025		0.030
Neutral (-4 ≤ diff. < 4)		(0.080)		(0.112)		(0.118)
Treatment ×		-0.155***		-0.072		-0.199**
Mean-reverter (diff. < -4)		(0.060)		(0.084)		(0.094)
Observations	1,961	1,961	903	903	903	903
Panel C: Positive return more likely after high return						
Treatment	-0.147***		-0.100		0.031	
	(0.045)		(0.069)		(0.067)	
Treatment ×		-0.375***		-0.610***		-0.026
Extrapolator (diff. ≥ 4)		(0.115)		(0.184)		(0.179)
Treatment ×		-0.084		-0.011		0.058
Neutral (-4 ≤ diff. < 4)		(0.081)		(0.119)		(0.120)
Treatment ×		-0.114*		-0.010		0.031
Mean-reverter (diff. < -4)		(0.062)		(0.093)		(0.091)
Observations	1,961	1,961	903	903	903	903

Notes: This table shows persistence of treatment effects on respondents' posterior agreement with verbal statements describing beliefs about the autocorrelation of aggregate returns in the four-week follow-up survey. Agreement with the statements is elicited on 7-point categorical scales, and is z-scored using the means and standard deviations in the sample. The statements are: "With an investment in stocks one can expect a positive return, independently of how the stock market has developed in the recent past." (Panel A); "When the stock market has recently increased it makes no sense to buy stocks." (Panel B); "When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased." (Panel C). Columns 1-2 focus on responses in the main survey using the full sample. Columns 3-4 focus on responses in the main survey using those who later completed the follow-up. Columns 5-6 focus on responses in the four-week follow-up. Panel A Columns 2, 4 and 6 show heterogeneous treatment effects by holding an above or below median prior perceived standard deviation of 12-month-ahead returns over the six historical realized return intervals. Panels B and C Columns 2, 4 and 6 show heterogeneous treatment effects for prior extrapolators (perceived difference in average 12-month-ahead returns between the positive and the negative realized return scenarios at least 4 pp), neutrals (difference at least -4 pp and less than 4 pp), and mean reverters (difference less than -4 pp). All estimations include the baseline set of controls described in Appendix A.1.2. Columns 3-6 additionally control for dummies indicating the time between main and follow-up survey. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.14: Updating of 12-month-ahead return expectations measured in four-week follow-up

	Updating (point belief) main survey follow-up sample		Updating (point belief) follow-up survey	
	(1) OLS	(2) IV	(3) OLS	(4) IV
Treatment × Perception gap main	0.118**	0.134*		
	(0.056)	(0.076)		
Perception gap main	-0.054	-0.020		
	(0.035)	(0.048)		
Treatment × Perception gap follow-up			0.136*	0.276**
			(0.080)	(0.122)
Perception gap follow-up			-0.069	-0.129
			(0.056)	(0.080)
Treatment	1.130***	1.109***	0.482	0.236
	(0.312)	(0.316)	(0.426)	(0.436)
First stage F-stat		534.73		355.35
Observations	903	903	903	903
R-squared	0.07	0.07	0.05	0.04

Notes: This table examines changes in expectations about aggregate stock returns over the 12 months after the survey in response to the information based on estimations of specification 4. The outcomes are the difference between posterior and prior point expectations about the 12-month-ahead return, both measured in the main survey (Columns 1 and 2) and the difference between the posterior point expectation measured at the start of the follow-up survey (*before* the repeated information treatment) and the prior point expectation measured in the main survey (Columns 3-4). The perception gap is based on the respondent's prior belief about the historical autocorrelation of aggregate returns. It is the difference between the actual conditional mean 12-month-ahead return and the respondent's corresponding prior for the relevant scenario of realized returns over the previous 12 months, which is selected based on the respondent's perceived return over the 12 months before the main survey (Columns 1-2) or before the follow-up survey (Columns 3-4). In Columns 2 and 4 the perception gap is instrumented with a version in which the relevant return interval is selected based on the actual realized return of the DAX over the 12 months before the respective survey. All estimations are based on respondents who are part of the follow-up sample. All estimations include the baseline set of controls described in Appendix A.1.2 as well as dummies for the time between main and follow-up survey. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

A.8 Experiment on beliefs about the price-dividend ratio

In our main experiment we demonstrate that retail investors hold highly heterogeneous beliefs about the autocorrelation of aggregate stock returns, which causally drives disagreement about expected returns and trading. While recent returns seem to be central to the formation of investors' expectations about future returns (Dominitz and Manski, 2011; Greenwood and Shleifer, 2014; Heiss et al., 2022; Vissing-Jorgensen, 2003), investors may also consider other state variables when forming return expectations. For instance, the price-dividend ratio (PD ratio) should be negatively related to future returns, even though movements in the PD ratio also reflect changes in expected future cash flow growth (Campbell and Shiller, 1988) and the relative importance of expected returns and cash flows in driving PD ratios differs across markets and time periods (Rangvid et al., 2014; Golez and Koudijs, 2018). In this appendix we use an additional experiment on a separate sample of retail investors to measure and shift respondents' beliefs about return predictability based on the PD ratio, and to study how these beliefs are linked to individuals' return expectations.

A.8.1 PD experiment: Design

We use a very similar design as in our main survey (described in Section 2.2), including three stages (i) measuring priors, (ii) providing a random subset of respondents with information, and (iii) eliciting posteriors. The main difference is that, instead of measuring respondents' perceived return over the last 12 months and their perceived historical autocorrelation, the experiment elicits respondents' perceived current PD ratio and their beliefs about historical return predictability based on the PD ratio. Moreover, due to advantages in terms of data availability for the empirical benchmark and the information treatment, we frame all belief elicitations around the entire German stock market instead of the DAX, which covers only a subset of listed firms. The instructions for the additional experiment can be found under `https://drive.google.com/file/d/1IhxTWR5pXyVSROV6tPfr4y06p7UwygmQ/view?usp=sharing`.

Investors are less familiar with the PD ratio than with returns (Figure A.2). Before eliciting respondents' priors, we therefore provide them with a brief explanation of the PD ratio and anchor them on the range into which the ratio fell in the German stock market over the last 50 years (20 to 75, with an average of 40). This anchor should make it easier for our respondents to meaningfully report their beliefs (Ansolabehere, Meredith and Snowberg, 2013). We use the same type of dynamic figure as in our main survey for the elicitation of beliefs about predictability and the information treatment. We elicit prior beliefs about conditional mean 12-month-ahead returns in the last 50 years for four intervals of the current PD ratio ("lower than 30", "between 30 and 40", "between 40 and 50", "higher than 50") and subsequently display to respondents in the treatment group the actual average realizations. These values indicate a lack of return predictability by the PD ratio across the three lower PD bins (13.4%, 13.3%, and 12.3%, respectively). Merely

in the case of very high PD ratios, subsequent returns are systematically lower (6.7%).[3] We also show treated respondents the following statement: *When the price-dividend ratio was very high, the return of the German stock market over the following 12 months was relatively low on average.* As in the main experiment, respondents in the control group are provided with the unconditional average return of the overall German stock market (11.1%). After the treatment, we elicit respondents' agreement with two verbal statements describing a positive and a negative relationship between the current PD ratio and future returns, respectively, which we use as manipulation check.

A.8.2 PD experiment: Survey administration and sample

Survey administration We administered the survey in July and August 2022 to clients of the same online bank as used in our main experiment. Due to changes in the bank's data protection policies that came into effect after we had conducted the main survey, we were not allowed to link the new survey data to administrative account data on the clients' investment decisions. We therefore focus on investors' belief formation in our analysis.

We sent email invitations to 9,000 individuals from the bank's client pool, which were selected in the same way as done in our main survey. We offered invitees a 5 EUR reward in the form of an Amazon voucher for completing the survey. 772 individuals completed our survey, corresponding to a response rate of 8.6%, lower than in the main survey. Potential reasons for the lower response rate include the lower reward (5 EUR instead 10 EUR), changes in the bank's client pool, and the timing of the survey during holiday season. The mean (median) response time to the survey was 18 (14.7) minutes.

Sample characteristics We select our sample using the same criteria as in our main survey (described in Section 2.5), dropping individuals with extreme response times or prior or posterior return expectations.[4] Again, our results do not hinge on the exact choices of cutoffs used to define the sample. Table A.15 Columns 2-6 display summary statistics of the resulting sample of 693 respondents. The composition of our sample is similar to the sample used in the main experiment, the main differences being that respondents to the additional survey are somewhat older and wealthier on average. Columns 7-9 highlight that the sample is mostly balanced across the treatment and the control group. To address any concern, we include a set of control variables in all estimations.

[3]Thus, predictability of returns by the PD ratio is less pronounced in the German setting than in other markets and time periods, in line with movements in the PD ratio mostly reflecting changes in expected future cash flow growth in the German setting (1.6%, 8.1%, 12.2% and 15.2% 12-month-ahead dividend growth going from the lowest to the highest PD bucket). See also Appendix A.2 and Rangvid et al. (2014).

[4]The only difference compared to the main survey is that we drop respondents with response time below 6 minutes instead of 8 minutes, to account for the shorter survey length.

A.8.3 PD experiment: Prior beliefs

Prior perceived return predictability Figure A.8 Panel A highlights that respondents on average perceive a weak negative historical relationship between the current PD ratio and subsequent returns. For instance, while they on average perceive mean returns of 12.2% over the next year when the PD ratio was in the lowest bin (below 30), they believe subsequent returns were 9.7% when the PD ratio was in the highest bin (above 50). Thus, they perceive a flatter relationship than what is implied by actual historical data (13.4% and 6.7% for the lowest and the highest bin, respectively). The only weakly negative perceived relationship implies that the beliefs in mean reversion of returns documented in our main analysis are unlikely to be driven by beliefs about return predictability based on the PD ratio. Panel B highlights that there is a substantial amount of disagreement in each given bin, which is the lowest for moderate PD ratios between 40 and 50 and more pronounced for very low or very high ratios, similarly as for the perceived relationship between past and future returns measured in the main survey (see Section 3.1).

We next calculate for each respondent the difference between the perceived 12-month-ahead return for the highest PD scenario (above 50) and the average perceived 12-month-ahead return over the three scenarios with lower PD ratios. We focus on this difference because actual historical return realizations are lowest in the highest PD scenario (6.7% on average), while they are very similar and at a higher level across the three lower PD scenarios (13% on average). Panel C shows that there is a high level of heterogeneity in respondents' beliefs about this difference. A majority estimate the difference to be positive (40.8% of respondents) or less negative than the actual difference of -6.3 pp (37.1% of respondents) – i.e., most respondents do not fully account for how much lower historical returns were in cases of very high PD ratios compared to cases of low and moderate PD ratios. Similarly as in our main analysis, we classify respondents into "underestimators", for whom the difference in perceived 12-month-ahead returns between the highest and lower PD bins is more negative than -10 pp (11.4% of our sample), "neutrals" (difference between -10 pp and -2 pp, 33.2% of our sample) and "overestimators" (difference more positive than -2 pp, 55.4% of our sample).

How do beliefs about return predictability by the PD ratio vary across groups? In Table A.16 we regress different belief measures on a set of co-variates. For instance, respondents with higher financial literacy are more likely to be in the "neutral" category and less likely to overestimate the difference in 12-month-ahead returns between high and low PD scenarios.

Perceived return predictability and return expectations We next examine whether beliefs about return predictability based on the price-dividend ratio are related to respondents' return expectations at the time of the survey. We first select the PD ratio interval covering the respondent's perceived PD ratio at the time of the survey. Respondents on average believe that the current PD ratio is 40.4, compared to an actual average PD ratio over the survey period of 27.6, and there is strong heterogeneity in respondents' perceived current PD ratio. We then study

how respondents' expectations about the return over the 12 months after the survey are related to their perceived conditional average historical 12-month-ahead returns from the relevant PD ratio interval. Figure A.9 Panel A shows a binned scatter plot of this relationship, partialling out a set of controls. A one pp higher perceived 12-month-ahead return in the relevant historical scenario is associated with a 0.26 pp higher return expectation at the time of the survey ($p < 0.01$). The relationship is similar when selecting the relevant PD ratio interval based on the actual instead of the respondent's perceived PD ratio (Panel B). Thus, respondents' beliefs about historical return predictability based on the PD ratio are strongly reflected in their return expectations at the time of the survey.

A.8.4 PD experiment: Updating of beliefs

Manipulation check We next examine whether the information indicating a negative relationship between actual historical return realizations and the PD ratio shifts respondents' beliefs about return predictability based on the PD ratio. To do this, we regress respondents' post-treatment agreement with different statements describing the relationship between the current PD ratio and future returns – measured on 7-point categorical scales, which we z-score using the mean and the standard deviation in the sample – on a treatment indicator and a set of controls. We also report specifications in which we interact the treatment indicator with dummies indicating prior underestimators or overestimators of the relationship or with a dummy for neutrals.

As shown in Table A.17 Column 1, the treatment increases respondents' agreement that *"On average, low returns follow high price-dividend ratios"* by 61.9% of a standard deviation ($p < 0.01$). In the control group, those who previously overestimated the relationship are significantly less likely to agree with this statement than neutrals (Column 2, $p < 0.01$). In line with this, the treatment increases agreement with the statement by 74.9% of a standard deviation among prior overestimators and only by 47.1% ($p < 0.01$) and by 44.6% ($p < 0.05$) among prior neutrals and underestimators, respectively (Column 2).

The treatment also significantly reduces respondents' agreement with the statement *"When, at a specific point in time, the price-dividend ratio is high, high returns can be expected over the following time"* by 48.2% of a standard deviation (Column 3, $p < 0.01$). These effects are fully driven by prior overestimators (Column 4, 68.9% of a standard deviation, $p < 0.01$) and neutrals (30% of a standard deviation, $p < 0.05$), while prior underestimators do not respond (0% of a standard deviation, $p = 0.826$). This implies that the treatment approximately offsets the control group differences between prior overestimators on the one hand and prior neutrals and underestimators on the other hand, as can be seen in Column 4.

Taken together, our intervention successfully shifts respondents' beliefs about return predictability based on the PD ratio towards the treatment information. The shifts in beliefs are proportional to respondents' prior mis-perceptions of the historical relationship between the PD

ratio and subsequent returns.

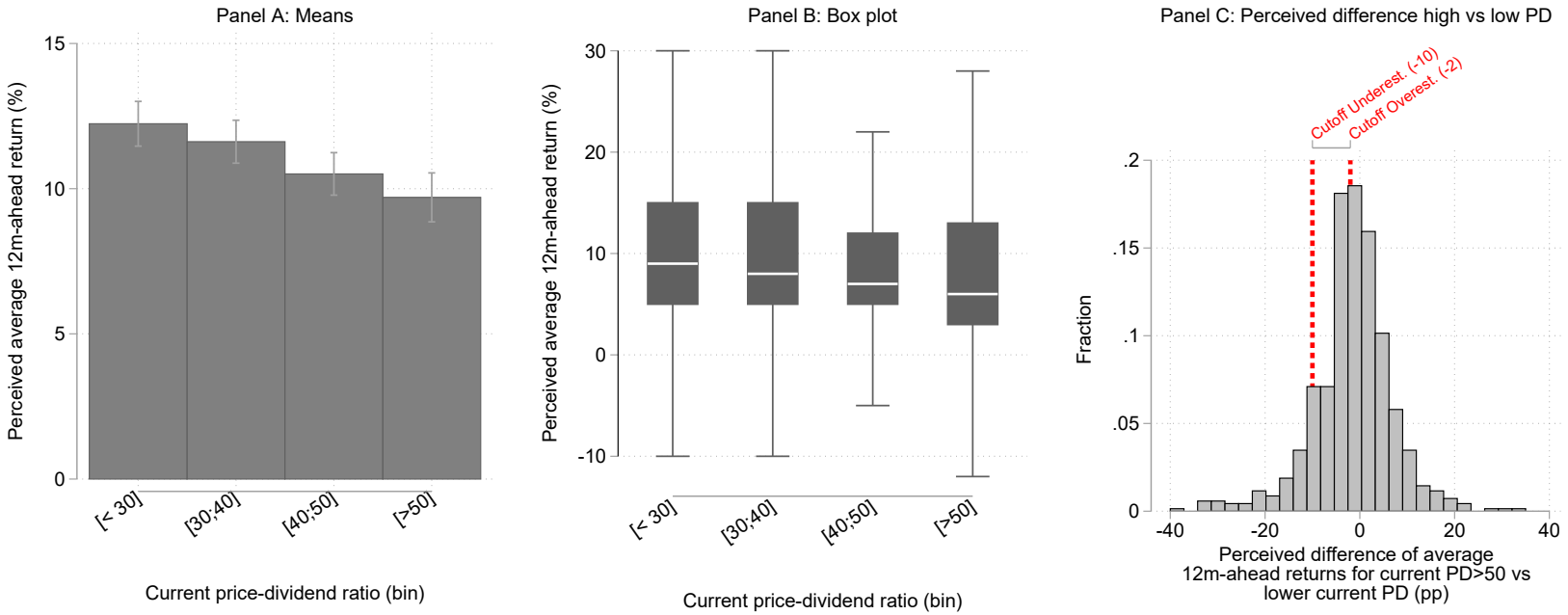
Updating of return expectations If beliefs about return predictability based on the PD ratio are a causal driver of respondents' return expectations, respondents should update their return expectations in response to the treatment information. Similarly as done in our main analysis (Section 4.1), we define a respondent's perception gap as the difference between actual and perceived historical average 12-month-ahead returns in the PD interval that captures the respondent's perceived PD ratio at the time of the survey. We then regress a respondent's belief updating – i.e., the difference between a respondent's posterior and prior return expectation – on a treatment dummy, the perception gap, and the interaction between the two, as described in specification 4 in the main text. Similarly as in our main analysis, we also report specifications in which the perception gap and the interaction term are instrumented with versions that are based on the actual PD ratio at the time of the survey instead of a respondent's perception. This serves the purpose of mitigating measurement error in reported beliefs. We report specifications using the posterior point forecast or using the mean of a respondent's subjective probability distribution over future returns to construct the updating variable.

Table A.18 shows learning rates between 10.9% and 21.2% from the information, as indicated by the estimated coefficient on the interaction term, which are statistically significant at the 10% level or at more precise levels. Similarly as in our main experiment, our estimated learning rates are substantially smaller than one. This is in line with the ideas that (i) respondents do not exclusively rely on their beliefs about predictability by the PD ratio when forming return expectations and (ii) that respondents view the historical relationship between the PD ratio and subsequent returns as an imperfect proxy for the forward-looking relationship at the time of the survey. However, the significant updating of return expectations in response to the information highlights that beliefs about return predictability based on the PD ratio causally shape retail investors' return expectations.

A.8.5 PD experiment: Summary

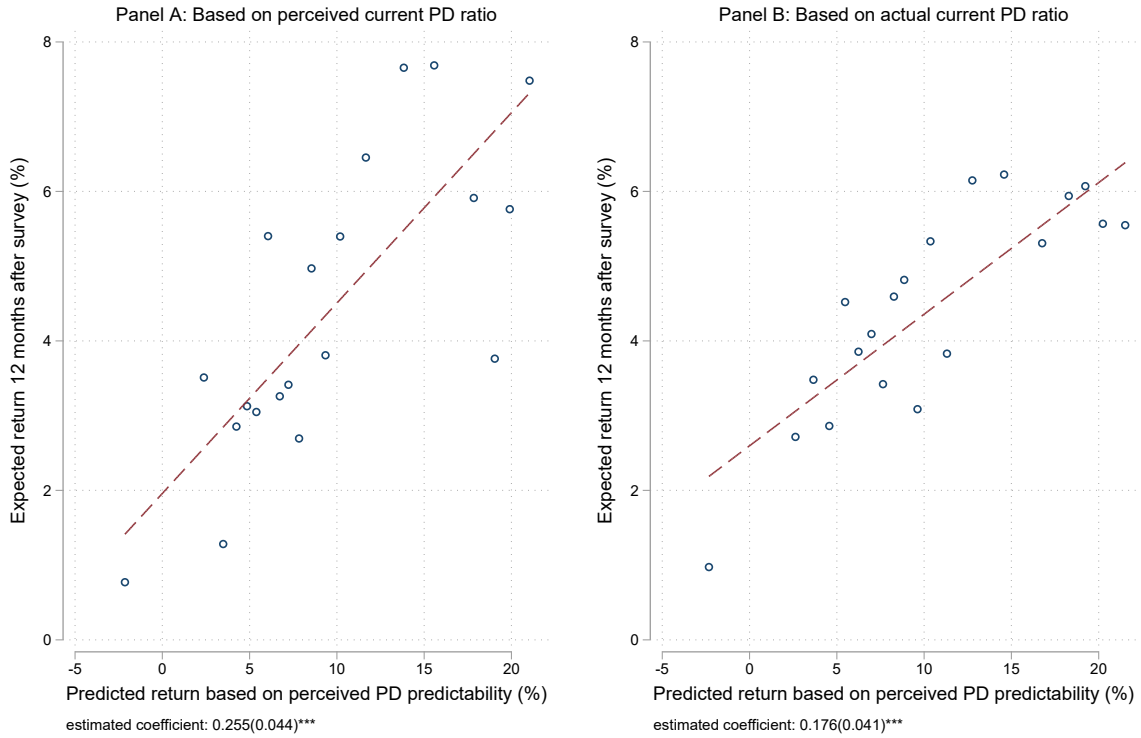
Our additional experiment on beliefs about the PD ratio highlights that many of the take-aways from our main experiment do not exclusively apply to recent returns, but carry over to other state variables that respondents may use to form their return expectations. Specifically, investors' beliefs about the relationship between the PD ratio and subsequent returns are highly heterogeneous, they are responsive to information, and they are causally linked to respondents' return expectations. This corroborates that heterogeneous beliefs about the predictiveness of given state variables for subsequent returns are an important driver of disagreement about expected returns in the stock market.

Figure A.8: Prior beliefs about return predictability based on the price-dividend ratio



Notes: This figure summarizes prior beliefs about future return predictability based on the current price-dividend ratio of the German stock market in the last 50 years among retail investors participating in an additional experimental survey. Panel A shows the sample means of respondents' beliefs about average 12-month-ahead stock returns for four intervals of realized current price-dividend ratios. Panel B displays box plots of respondents' prior beliefs about average 12-month-ahead stock returns for the four intervals of realized current PD ratios, including median, 25th and 75th percentile for each interval. Panel C shows a histogram of respondents' perceived difference in average 12-month-ahead returns between cases where the PD ratio was higher than 50 (the highest bin) and cases where the PD ratio was at most 50 (the three lower bins), including the cutoffs we use to define underestimators and overestimators.

Figure A.9: Binned scatter plot of prior expected 12-month-ahead return vs predicted return expectation based on perceived historical predictability by the price-dividend ratio



Notes: This figure shows binned scatter plots of respondents' prior expected return over the 12 months after the survey against the respondents' perceived average historical 12-month-ahead return in the relevant interval of realized PD ratios, which is selected based on the respondent's perceived current PD ratio (Panel A) or based on the actual current PD ratio at the time when the respondent took the survey (Panel B). The sample consists of retail investors participating in an additional experimental survey. The binned scatter plots partial out a set of controls similar to the ones described in Appendix A.1.2.

Table A.15: Summary statistics and balance check (PD experiment)

	PHF	Online brokerage sample							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2017 Mean	Mean	Median	SD	p25	p75	Treatment Group: Mean	Control Group: Mean	p-value (7) = (8)
Female	0.49	0.17	0.00	0.38	0.00	0.00	0.14	0.20	0.017
Age	50.55	48.02	48.00	14.70	36.00	59.00	47.52	48.54	0.361
University	0.36	0.55	1.00	0.50	0.00	1.00	0.56	0.55	0.736
Employed	0.65	0.73	1.00	0.44	0.00	1.00	0.73	0.73	0.840
Household net income	3,808	3,943	4,000	2,698	2,000	5,250	4,017	3,865	0.461
Household net wealth	361,783	413,384	175,000	563,650	25,000	625,000	438,515	386,682	0.227
Total financial wealth at bank		85,783	42,500	113,146	15,000	112,500	93,950	77,106	0.050
Portfolio value at bank		52,175	25,000	71,210	7,500	62,500	57,143	46,897	0.058
Equity holdings at bank		44,890	17,500	65,553	2,500	56,250	49,433	40,062	0.060
Trades equity at least once per quarter		0.73	1.00	0.44	0.00	1.00	0.74	0.73	0.693
Risk tolerance (1-7)		4.31	4.00	1.23	4.00	5.00	4.28	4.34	0.467
Trading experience (years)		14.24	11.00	11.53	4.00	25.00	14.01	14.49	0.586
Financial literacy score (0-3)		1.84	2.00	0.80	1.00	2.00	1.85	1.83	0.727
Follow stock market developments (1-7)		4.55	5.00	1.85	3.00	6.00	4.51	4.58	0.615
Investment horizon $\geq$ 5 years		0.59	1.00	0.49	0.00	1.00	0.60	0.58	0.613
Perceived current price-dividend ratio		39.08	35.00	16.90	30.00	50.00	39.54	38.58	0.455
Confident in perceived PD ratio		0.33	0.00	0.47	0.00	1.00	0.33	0.32	0.739
Expected return next 12 months		4.41	5.00	6.29	2.00	7.00	4.42	4.40	0.961
Confident in expected return		0.59	1.00	0.49	0.00	1.00	0.63	0.56	0.081
Perceived mean hist. ret. intervals		11.02	8.25	8.61	5.25	13.50	11.00	11.03	0.958
Perceived diff. high vs low PD historical		-1.75	-1.50	9.03	-5.33	2.67	-2.17	-1.31	0.206
Overestimator (diff. $\geq$ -2)		0.55	1.00	0.50	0.00	1.00	0.56	0.55	0.857
Underestimator (diff. $<$ -10)		0.11	0.00	0.32	0.00	0.00	0.12	0.11	0.942
Observations		693					357	336	

Notes: This table shows summary statistics for the sample of retail investors at the online bank that we use in an additional experiment conducted in July and August 2022 (Columns 2-6), as well as benchmarks from the German population of individuals participating in the stock market as measured in the 2017 wave of the Bundesbank's Panel of Household Finance (Column 1). Columns 7-9 provide a check of balance of means between treatment and control group. Variables on income, wealth and wealth components are expressed in euro terms. Financial wealth, portfolio value and equity holdings at the bank as well as trading frequency are elicited in the survey, as no match with administrative account data was feasible. All belief variables reported in the table refer to respondents' priors elicited before the information treatment.

Table A.16: Correlates of beliefs (PD experiment)

	Perceived diff. high vs low PD	Over-estimator (diff. $\geq$ -2)	Neutral (-10 $\leq$ diff. $<$ -2)	Under-estimator (diff. $<$ -10)
	(1)	(2)	(3)	(4)
Female	1.595*	0.093*	-0.068	-0.025
	(0.856)	(0.050)	(0.047)	(0.030)
Age	0.001	0.003*	-0.004***	0.001
	(0.030)	(0.002)	(0.001)	(0.001)
Employed	0.873	0.055	-0.064	0.008
	(0.876)	(0.046)	(0.044)	(0.029)
University	-0.882	-0.034	0.005	0.030
	(0.706)	(0.038)	(0.036)	(0.024)
Log(Household income)	-0.155	-0.004	-0.000	0.004
	(0.128)	(0.007)	(0.007)	(0.005)
Log(Fin. wealth with bank)	0.107	0.001	-0.000	-0.001
	(0.145)	(0.007)	(0.007)	(0.005)
Invest. experience $\geq$ Median	-1.497*	-0.091**	0.084*	0.007
	(0.868)	(0.046)	(0.043)	(0.031)
Full financial literacy score	-1.963**	-0.133***	0.129***	0.003
	(0.777)	(0.046)	(0.045)	(0.030)
Follow stock market $\geq$ Median	-0.172	-0.067	0.085**	-0.018
	(0.792)	(0.043)	(0.041)	(0.027)
Mean dep. var.	-1.75	0.55	0.33	0.11
SD dep. var.	9.03	0.50	0.47	0.32
Observations	693	693	693	693
R-squared	0.03	0.04	0.04	0.01

Notes: This table shows multivariate regressions of respondents' beliefs on covariates. The sample consists of retail investors participating in an additional experimental survey. The outcomes are the perceived difference in historical average 12-month-ahead returns between the highest PD scenario (higher than 50) and lower PD scenarios (Column 1), a dummy for being classified as overestimator of this difference (difference at least -2 pp, Column 2), a dummy for neutrals (differences at least -10 pp and less than -2 pp, Column 3) and a dummy for underestimators (difference less than -10 pp, Column 4). Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.17: Manipulation check (PD experiment)

	Low returns follow high PD		When PD high, high returns can be expected	
	(1)	(2)	(3)	(4)
PD treatment	0.619***		-0.482***	
	(0.073)		(0.074)	
PD treatment ×		0.749***		-0.689***
Overestimator (diff. ≥ -2) (a)		(0.100)		(0.102)
PD treatment ×		0.471***		-0.300**
Neutral (-10 ≤ diff. < -2)		(0.121)		(0.117)
PD treatment ×		0.446**		-0.047
Underestimator (diff. < -10) (b)		(0.199)		(0.214)
Overestimator (diff. ≥ -2)	-0.182**	-0.326***	0.266***	0.469***
	(0.080)	(0.112)	(0.080)	(0.112)
Underestimator (diff. < -10)	-0.062	-0.048	-0.049	-0.181
	(0.115)	(0.163)	(0.120)	(0.191)
p-value (a=b)		0.171		0.007
Observations	693	693	693	693
R-squared	0.20	0.21	0.20	0.22

Notes: This table shows estimations of the effect of the PD information treatment on respondents' posterior agreement with verbal statements describing beliefs about aggregate return predictability based on the current price-dividend ratio. The sample consists of retail investors participating in an additional experimental survey. Agreement with the statements is elicited on 7-point categorical scales, and is z-scored using the means and standard deviations in the sample. The statements are: "On average, low returns follow high price-dividend ratios." (Columns 1-2); "When, at a specific point in time, the price-dividend ratio is high, high returns can be expected over the following time." (Columns 3-4). Columns 2 and 4 show heterogeneous treatment effects for prior overestimators (perceived difference in average 12-month-ahead returns between the highest (PD > 50) and lower current PD scenarios at least -2 pp), neutrals (difference at least -10 pp and less than -2 pp), and underestimators (difference less than -10 pp). All estimations include a set of controls similar to the ones described in Appendix A.1.2. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

Table A.18: Updating of 12-month-ahead return expectations (PD experiment)

	Updating (point belief)		Updating (mean distr.)	
	(1) OLS	(2) IV	(3) OLS	(4) IV
PD treatment × Perception gap	0.116*** (0.044)	0.109* (0.060)	0.099* (0.057)	0.212*** (0.079)
Perception gap	-0.007 (0.028)	-0.016 (0.041)	0.033 (0.041)	-0.087 (0.059)
PD treatment	0.985*** (0.370)	0.993*** (0.362)	0.380 (0.525)	0.299 (0.511)
First stage F-stat		365.15		365.15
Observations	693	693	693	693
R-squared	0.09	0.09	0.08	0.07

Notes: This table examines changes in expectations about aggregate stock returns over the 12 months after the survey in response to the PD information treatment based on estimations of specification 4. The sample consists of retail investors participating in an additional experimental survey. The outcomes are the difference between posterior and prior point expectations about the 12-month-ahead return (Columns 1-2) and the difference between the mean of the respondent-level posterior distribution over 12-month-ahead returns and the prior point expectation (Columns 3-4). The perception gap is based on the respondent's prior belief about the historical return predictability based on the price-dividend ratio. It is the difference between the actual conditional mean 12-month-ahead return and the respondent's corresponding prior for the relevant scenario of current price-dividend ratios, which is selected based on the respondent's perceived current PD ratio. In Columns 2 and 4 the perception gap is instrumented with a version in which the relevant PD ratio interval is selected based on the actual PD ratio at the time of the survey. All estimations include a set of controls similar to the ones described in Appendix A.1.2. Robust standard errors are in parentheses. * denotes significance at 10%-, ** at 5%-, and *** at 1%-level.

B Survey instructions

This appendix provides the survey instructions translated to English for both our main survey conducted between September and November 2019 and the four-week follow-up survey. The instructions of the other surveys we conducted, which are listed in Table A.1, can be found under `https://drive.google.com/file/d/1IhxTWR5pXyVSROV6tPfr4y06p7UwygmQ/view?usp=sharing`.

B.1 Main survey

Welcome screen

Welcome to the survey from Goethe University!

Many thanks for answering our questions on the investment behavior of retail investors.

Completion of the survey takes *about 15 minutes*. Your participation is of course anonymous. Your responses will only be used for scientific research.

In return for completing the survey you will receive an *Amazon voucher of 10 euros*. You will receive more detailed information on this during the survey.

To receive a voucher, please leave your email address at the end of the survey. We will send you your voucher code within the next days by email. Your email address will be saved separately from your responses in the survey, and will be deleted after we have sent out the voucher. You can learn more under our information on data protection.

Hint: The survey contains graphics that cannot be optimally displayed on smartphones. We therefore ask you to complete the survey *using a computer or a tablet* if possible.

Do you have questions? Please contact us under umfrage@finance.uni-frankfurt.de

Attention check

The next question is about the following problem. In questionnaires like ours there are sometimes participants who do not read the questions carefully and only quickly "click" through the questionnaire. This results in many random answers, which compromise the quality of research studies.

To show us that you read our questions carefully, please select "Very interested" and "Not at all interested" as your answer to the next question.

How interested are you in sports?

Very strongly interested - Strongly interested - Somewhat interested - Almost not interested - Not at all interested

Perceived recent stock market return

Let us think about the *last 12 months*.

What do you think, what was the return (in percent) of the DAX over the *last 12 months*?

The return is the percent change in value of an investment in the DAX over the last 12 months. A positive number indicates that the value of the DAX has increased, a negative number indicates that the value has decreased.

__ percent

According to your estimate, an investor who 12 months ago invested 100 euro in the DAX would own X euro today.

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Prior expected future stock market return

Let us now think about the future. What do you think, what will the return (in percent) of the DAX be over the *next 12 months*?

The return is the percent change in value of an investment in the DAX over the next 12 months. A positive number indicates that the value of the DAX increases, a negative number indicates that the value decreases.

__ percent

According to your estimate, an investor who today invests 100 euro in the DAX would own X euro 12 months from now.

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Transition to main belief elicitation

On the following pages we would like to ask you about your estimates of the return of the DAX under *six different scenarios*.

Please take a moment to read the questions carefully. High attention in responding to the questions is essential for the quality of the results of this study.

Hint: Each question will be shown to you only once, and you will not be able to go back to previous questions later on.

Prior belief about historical autocorrelation of stock returns (quantitative): Return below -20 percent

First think about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *less than -20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

The blue bar in the figure below illustrates your response.

__ percent

Prior belief about historical autocorrelation of stock returns (quantitative): Return between -20 and -10 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between -20 and -10 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Prior belief about historical autocorrelation of stock returns (quantitative): Return between -10 and 0 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between -10 and 0 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Prior belief about historical autocorrelation of stock returns (quantitative): Return between 0 and 10 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between 0 and 10 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Prior belief about historical autocorrelation of stock returns (quantitative): Return between 10 and 20 percent

Think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between 10 and 20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Prior belief about historical autocorrelation of stock returns (quantitative): Return above 20 percent

Think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *above 20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Transition to information treatment [Treatment group only]

On the next screen we will provide you with information on the *actual average returns* of the DAX in the different cases.

Please take a moment to read the information carefully.

Hint: The information will be shown to you only once and you will not be able to go back to the information.

Information treatment screen 1 [Treatment group only]

The figure below shows you the *actual average returns* of the DAX over the *following 12 months*, depending on what the return was over the *preceding 12 months*.

The figure is based on the returns of the DAX over the last 50 years.

Through repeated clicking on the button below you will be shown the actual average returns in the different scenarios. *Only when you have seen the actual average returns in all six scenarios will you be allowed to proceed with the survey.*

Information treatment screens 1a-1f [Treatment group only]

The figure below shows you the *actual average returns* of the DAX over the *following 12 months*, depending on what the return was over the *preceding 12 months*.

The figure is based on the returns of the DAX over the last 50 years.

Through repeated clicking on the button below you will be shown the actual average returns in the different scenarios. *Only when you have seen the actual average returns in all six scenarios will you be allowed to proceed with the survey.*

When the return over the preceding 12 months was below -20%, the return over the following 12 months was *9.5%* on average (your estimate: *A%*).

When the return over the preceding 12 months was between -20% and -10%, the return over the following 12 months was *7.4%* on average (your estimate: *B%*).

When the return over the preceding 12 months was between -10% and 0%, the return over the following 12 months was *9.5%* on average (your estimate: *C%*).

When the return over the preceding 12 months was between 0% and 10%, the return over the following 12 months was *8.8%* on average (your estimate: *D%*).

When the return over the preceding 12 months was between 10% and 20%, the return over the following 12 months was *8.7%* on average (your estimate: *E%*).

When the return over the preceding 12 months was above 20%, the return over the following 12 months was *8.1%* on average (your estimate: *F%*).

Information treatment screen 2 [Treatment group only]

Independently of the interval in which the return over the preceding 12 months was, the return of the DAX over the following 12 months was on average always between 7.4% and 9.5%.

This means that *regardless of the return of the DAX* over a particular year the *best forecast* of the return over the following year is close to the long-run historical mean return of *8.5%*.

High or low stock market returns over a particular year hence do not allow to make a prediction about stock market returns over the following year.

Imagine one could predict at which point stock prices would increase by more than on average. Large institutional investors would then buy securities in large amounts. This would put stock prices under upward pressure. The possibility to predict higher-than-average returns would vanish immediately.

Control group information screen [Control group only]

Think now about the development of the DAX in the last 50 years. The average annual return of the DAX over this time period was

8.5 percent per year.

Posterior beliefs about autocorrelation of stock returns (qualitative)

To what extent do you agree with the following statements?

"With an investment in stocks one can expect a positive return, independently of how the stock market has developed in the recent past."

"When the stock market has recently increased it makes no sense to buy stocks."

"When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased."

1 (strongly disagree) - 2 - 3 - 4 - 5 - 6 - 7 (strongly agree)

Posterior expected future stock market return

Let us again think about the *next 12 months*. What do you think, what will the return (in percent) of the DAX be over the *next 12 months*?

__ percent

According to your estimate, an investor who today invests 100 euro in the DAX would own X euro 12 months from now.

Please explain your response in 1-2 sentences.

__

Posterior expected future stock market return: Subjective distribution

In the following we show you *6 possible scenarios* on how the DAX might develop over the *coming 12 months*.

Please indicate how likely you consider each scenario to be.

To do this, assign a probability to each scenario. The probabilities across the six scenarios have to sum to 100 percent.

Scenario 1: A return greater than 20%: __ percent

Scenario 2: A return between 10% and 20%: __ percent

Scenario 3: A return between 0% and 10%: __ percent

Scenario 4: A return between -10% and 0%: __ percent

Scenario 5: A return between -20% and -10%: __ percent

Scenario 6: A return less than -20 %: __ percent

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Advanced financial literacy test

At the end we would like to ask you a few general questions.

What happens with the price of a bond if interest rates increase.

Rises - Falls - Remains unchanged - I do not know.

Which of the following statements is correct? If someone buys a stock of company B, then ...

...he owns a share in this company. - ...he lends money to company B. - ...he is liable for the liabilities of company B. - No response is correct. - I do not know.

Is the following statement true or false? The value of a call option for a stock is - everything else unchanged - higher, the more volatile the stock is.

True - False - I do not know.

How many of these questions have you answered correctly?

__

Background questions I

To what extent to you agree with the following statement? *"I closely follow the development of the DAX."*

1 (strongly disagree) - 2 - 3 - 4 - 5 - 6 - 7 (strongly agree)

What information sources do you typically use before securities purchases / sales?

General news (e.g. newspapers, TV) - Specialized press (e.g. investment magazines) - Own online research - Chart analysis - Securities rankings (e.g. daily top ten) - I mostly trade with securities I already have / had in my portfolio - Recommendation from family / friends / acquaintances - Recommendation from a financial advisor - Recent stock price development - Other: __

How difficult have you found the questions in this survey?

1 (not difficult at all) - 2 - 3 - 4 - 5 - 6 - 7 (very difficult)

Have you looked up additional information to answer the survey (e.g. google)?

No - Yes, namely: __

Background questions II

For how many years have you been investing in stocks or stock mutual funds?

Enter 0 if you have no experience with investment in stocks or stock mutual funds.

For __ years.

When you personally make saving or investment decisions, how would you generally describe your *attitude toward risk*?

1 (not at all willing to take risks) - 2 - 3 - 4 - 5 - 6 - 7 (very willing to take risks)

How often do you trade with stocks on average?

Daily - Weekly - Once or twice per month - Once or twice per quarter - Once or twice per year - Less than once a year

What is your typical *investment horizon* for securities investments?

Less than 3 months - 3-12 months - 1-3 years - 3-5 years - 5-10 years - Longer than 10 years

Background questions III

What is your current *employment status*?

Full-time employed (including apprenticeships) - Part-time employed - Temporary leave (e.g. parental leave) - In school, university or unpaid internship - Unemployed - Permanent leave - Retired - Housekeeper - Other: __

Which of the following categories best describes your household's monthly *available net income*?

In your response, please account for all income of your household (e.g. also income from letting or leasing and child allowance). By household we mean all family members living with you at your main residence, excluding renters and flat mates.

[Categories]

Into which of the following categories falls your household's *net wealth*?

The net wealth is the value of everything the household members own (e.g. real estate, vehicles, financial assets, insurances) minus all liabilities (e.g. credit, loans, mortgages).

[Categories]

Background questions IV

Please indicate your gender.

Female - Male

In which year were you born?

[Dropdown menu]

What is your highest *educational attainment*?

Secondary school qualification - Secondary school certificate - Higher education entrance qualification - Higher education degree - No school-leaving qualification - Other: __

Technical questions

On which device have you filled out the questionnaire?

PC, laptop or tablet - Smartphone - Other: __

Did you experience a *technical issue* during the survey?

Yes - No.

Feedback questions

Did you have difficulties understanding one or more questions in this survey?

Yes - No

Do you have any suggestions or criticism related to our survey? Please let us know here (optional):

—

Payment and invitation to follow-up survey

Many thanks!

As a thank you for your responses you receive and *Amazon voucher of 10 EUR*.

If you would like to receive the voucher, you simply have to confirm this below and in a next step provide a valid email address. The voucher codes will be sent by email within the next 2 weeks.

Yes, I would like to receive a voucher code by email. - No, I would not like to receive a voucher code by email.

Are you interested in participating in a *follow-up survey*?

We would be happy to invite you to it by email.

Of course, we also reward participation in follow-up surveys with a bonus.

Yes, please invite me to a follow-up survey. - No, please do not invite me to a follow-up survey.

Please enter a *valid email address*:

Of course we will not give your email address to the bank or to third parties. Contacting you by email will be exclusively done to send you the voucher and / or invite you to a follow-up survey. After completion of this study your email address will be immediately deleted.

—

Goodbye screen

Many thanks for your participation!

You receive your *Amazon voucher of 10 EUR* in return for your participation *within the coming 2 weeks* by email.

B.2 Follow-up survey

Welcome screen

Welcome to the survey from Goethe University!

Many thanks for again taking the time to respond to our questions.

Completion of the survey takes *about 10 minutes*. Your participation is of course anonymous. Your responses will only be used for scientific research.

In return for completing the survey you will receive an *Amazon voucher of 5 euros*. We will send you your voucher code within the next days by email. Your email address will be saved separately from your responses in the survey, and will be deleted after we have sent out the voucher. You can learn more under our information on data protection.

Hint: The survey contains graphics that cannot be optimally displayed on smartphones. We therefore ask you to complete the survey *using a computer or a tablet* if possible.

Do you have questions? Please contact us under umfrage@finance.uni-frankfurt.de

Posterior expected future stock market return I

Let us now think about the future. What do you think, what will the return (in percent) of the DAX be over the *next 12 months*?

The return is the percent change in value of an investment in the DAX over the next 12 months. A positive number indicates that the value of the DAX increases, a negative number indicates that the value decreases.

__ percent

According to your estimate, an investor who today invests 100 euro in the DAX would own X euro 12 months from now.

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Posterior expected future stock market return: Subjective distribution

In the following we show you *6 possible scenarios* on how the DAX might develop over the *coming 12 months*.

Please indicate how likely you consider each scenario to be.

To do this, assign a probability to each scenario. The probabilities across the six scenarios have to sum to 100 percent.

Scenario 1: A return greater than 20%: __ percent

Scenario 2: A return between 10% and 20%: __ percent

Scenario 3: A return between 0% and 10%: __ percent

Scenario 4: A return between -10% and 0%: __ percent

Scenario 5: A return between -20% and -10%: __ percent

Scenario 6: A return less than -20 %: __ percent

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Posterior beliefs about autocorrelation of stock returns (qualitative) I

To what extent do you agree with the following statements?

"With an investment in stocks one can expect a positive return, independently of how the stock market has developed in the recent past."

"When the stock market has recently increased it makes no sense to buy stocks."

"When the stock market has recently increased it is more likely that stock returns will be positive over the following time than when the stock market has recently decreased."

1 (strongly disagree) - 2 - 3 - 4 - 5 - 6 - 7 (strongly agree)

Transition to main belief elicitation

On the following pages we would like to ask you about your estimates of the return of the DAX under *six different scenarios*.

Please take a moment to read the questions carefully. High attention in responding to the questions is essential for the quality of the results of this study.

Hint: Each question will be shown to you only once, and you will not be able to go back to previous questions later on.

Posterior belief about historical autocorrelation of stock returns (quantitative): Return below -20 percent

First think about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *less than -20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

The blue bar in the figure below illustrates your response.

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Return between -20 and -10 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between -20 and -10 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Return between -10 and 0 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between -10 and 0 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Return between 0 and 10 percent

Please think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between 0 and 10 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Return between 10 and 20 percent

Think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *between 10 and 20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Return above 20 percent

Think now about *all points in time* in the last 50 years at which the return of the DAX over the *preceding 12 months* was *above 20 percent*.

What do you think, what was the return of the DAX in these cases on average over the *immediately following 12 months*?

__ percent

Posterior belief about historical autocorrelation of stock returns (quantitative): Confidence

How confident are you about your responses in the six scenarios?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Perceived recent stock market return

Let us think about the *last 12 months*.

What do you think, what was the return (in percent) of the DAX over the *last 12 months*?

The return is the percent change in value of an investment in the DAX over the last 12 months. A positive number indicates that the value of the DAX has increased, a negative number indicates that the value has decreased.

__ percent

According to your estimate, an investor who 12 months ago invested 100 euro in the DAX would own X euro today.

How certain are you about your response?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Transition to repeated information treatment [Treatment group only]

On the next screen we will provide you with information on the *actual average returns* of the DAX in the different cases.

Please take a moment to read the information carefully.

Hint: The information will be shown to you only once and you will not be able to go back to the information.

Repeated information treatment screen 1 [Treatment group only]

The figure below shows you the *actual average returns* of the DAX over the *following 12 months*, depending on what the return was over the *preceding 12 months*.

The figure is based on the returns of the DAX over the last 50 years.

Through repeated clicking on the button below you will be shown the actual average returns in the different scenarios. *Only when you have seen the actual average returns in all six scenarios will you be allowed to proceed with the survey.*

Repeated information treatment screens 1a-1f [Treatment group only]

The figure below shows you the *actual average returns* of the DAX over the *following 12 months*, depending on what the return was over the *preceding 12 months*.

The figure is based on the returns of the DAX over the last 50 years.

Through repeated clicking on the button below you will be shown the actual average returns in the different scenarios. *Only when you have seen the actual average returns in all six scenarios will you be allowed to proceed with the survey.*

When the return over the preceding 12 months was below -20%, the return over the following 12 months was *9.5%* on average (your estimate: *A%*).

When the return over the preceding 12 months was between -20% and -10%, the return over the following 12 months was *7.4%* on average (your estimate: *B%*).

When the return over the preceding 12 months was between -10% and 0%, the return over the following 12 months was *9.5%* on average (your estimate: *C%*).

When the return over the preceding 12 months was between 0% and 10%, the return over the following 12 months was *8.8%* on average (your estimate: *D%*).

When the return over the preceding 12 months was between 10% and 20%, the return over the following 12 months was *8.7%* on average (your estimate: *E%*).

When the return over the preceding 12 months was above 20%, the return over the following 12 months was *8.1%* on average (your estimate: *F%*).

Repeated information treatment screen 2 [Treatment group only]

Independently of the interval in which the return over the preceding 12 months was, the return of the DAX over the following 12 months was on average always between 7.4% and 9.5%.

This means that *regardless of the return of the DAX* over a particular year the *best forecast* of the return over the following year is close to the long-run historical mean return of *8.5%*.

High or low stock market returns over a particular year hence do not allow to make a prediction about stock market returns over the following year.

Imagine one could predict at which point stock prices would increase by more than on average. Large institutional investors would then buy securities in large amounts. This would put stock prices under upward pressure. The possibility to predict higher-than-average returns would vanish immediately.

Control group repeated information screen [Control group only]

Think now about the development of the DAX in the last 50 years. The average annual return of the DAX over this time period was

8.5 percent per year.

Posterior beliefs about autocorrelation of stock returns (qualitative) II

To what extent do you agree with the following statements?

"When the stock market has fallen in the previous year one can expect above-average returns for the next year."

"When the stock market has fallen over the previous 12 months there is a high probability that this trend will continue in the following 12 months."

1 (strongly disagree) - 2 - 3 - 4 - 5 - 6 - 7 (strongly agree)

Posterior expected future stock market return II

Let us now think again about the *next 12 months*. What do you think, what will the return (in percent) of the DAX be over the *next 12 months*?

The return is the percent change in value of an investment in the DAX over the next 12 months. A positive number indicates that the value of the DAX increases, a negative number indicates that the value decreases.

__ percent

According to your estimate, an investor who today invests 100 euro in the DAX would own X euro 12 months from now.

Beliefs about historical frequencies of return scenarios

Think of all *12-month periods* in the *last 50 years*. Please give an estimate. In how many percent of cases did the DAX achieve a return in a given interval.

To do this, assign a response in percent to each scenario. The responses across the six scenarios have to sum to 100 percent.

Scenario 1: A return greater than 20%: __ percent

Scenario 2: A return between 10% and 20%: __ percent

Scenario 3: A return between 0% and 10%: __ percent

Scenario 4: A return between -10% and 0%: __ percent

Scenario 5: A return between -20% and -10%: __ percent

Scenario 6: A return less than -20 %: __ percent

How certain are you about your responses?

1 (not at all certain) - 2 - 3 - 4 - 5 - 6 - 7 (very certain)

Background questions I

Have you learned about topics related to *economics or business* in *school*?

Yes - No

Have you completed a *university degree* with focus on *economics or business*?

Please indicate your highest university degree with corresponding focus.

No, I have *not* completed a *university degree* with focus on economics or business. - Yes, I have completed a *Bachelor degree* with focus on economics or business. - Yes, I have completed a *Master degree* with focus on economics or business. - Yes, I have completed a *doctorate* with focus on economics or business.

Are you or have you been working in the financial sector?

Yes - No.

Background questions II

Did you follow the German stock market during the last 4 weeks?

not at all - a little bit - closely - very closely

To what extent do you agree with the following statement: "I always follow the development of the DAX."

1 (strongly disagree) - 2 - 3 - 4 - 5 - 6 - 7 (strongly agree)

On which device have you filled out the questionnaire?

PC, laptop or tablet - Smartphone - Other: __

Do you have any suggestions or criticism related to our survey? Please let us know here (optional):

__

Payment and invitation to future surveys

Many thanks!

As a thank you for your responses you receive an *Amazon voucher of 5 EUR*.

If you would like to receive the voucher, you simply have to confirm this below and in a next step provide a valid email address. The voucher codes will be sent by email within the next 2 weeks.

Yes, I would like to receive a voucher code by email. - No, I would not like to receive a voucher code by email.

Are you interested in participating in a *follow-up survey*?

We would be happy to invite you to it by email.

Of course, we also reward participation in follow-up surveys with a bonus.

Yes, please invite me to a follow-up survey. - No, please do not invite me to a follow-up survey.

Please enter a *valid email address*:

Of course we will not give your email address to the bank or to third parties. Contacting you by email will be exclusively done to send you the voucher and / or invite you to a follow-up survey. After completion of this study your email address will be immediately deleted.

—

Goodbye screen

Many thanks for your participation!

You receive your *Amazon voucher of 5 EUR* in return for your participation *within the coming 2 weeks* by email.

References for the appendix

Ansolabehere, Stephen, Marc Meredith, and Erik Snowberg, "Asking about Numbers: Why and how," *Political Analysis*, 2013, *21* (1), 48–69.

Armona, Luis, Andreas Fuster, and Basit Zafar, "Home Price Expectations and Behavior: Evidence from a Randomized Information Experiment," *Review of Economic Studies*, 2019, *86* (4), 1371–1410.

Campbell, John Y and Robert J Shiller, "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors," *Review of Financial Studies*, 1988, *1* (3), 195–228.

Cavallo, Alberto, Guillermo Cruces, and Ricardo Perez-Truglia, "Inflation Expectations, Learning and Supermarket Prices: Evidence from Field Experiments," *American Economic Journal: Macroeconomics*, 2017, *9* (3), 1–35.

Cochrane, John H, "The Dog that Did not Bark: A Defense of Return Predictability," *Review of Financial Studies*, 2008, *21* (4), 1533–1575.

Coibion, Olivier, Yuriy Gorodnichenko, and Michael Weber, "Monetary Policy Communications and Their Effects on Household Inflation Expectations," *Journal of Political Economy*, 2021.

de Quidt, Jonathan, Johannes Haushofer, and Christopher Roth, "Measuring and Bounding Experimenter Demand," *American Economic Review*, 2018, *108*, 3266–3302.

Dominitz, Jeff and Charles F Manski, "Measuring and Interpreting Expectations of Equity Returns," *Journal of Applied Econometrics*, 2011, *26* (3), 352–370.

Giglio, Stefano, Matteo Maggiori, Johannes Stroebel, and Stephen Utkus, "Five Facts About Beliefs and Portfolios," *American Economic Review*, 2021, *111* (5), 1481–1522.

Golez, Benjamin and Peter Koudijs, "Four Centuries of Return Predictability," *Journal of Financial Economics*, 2018, *127* (2), 248–263.

Greenwood, Robin and Andrei Shleifer, "Expectations of Returns and Expected Returns," *Review of Financial Studies*, 2014, *27* (3), 714–746.

Haaland, Ingar, Christopher Roth, and Johannes Wohlfart, "Designing Information Provision Experiments," *Journal of Economic Literature*, 2021.

Heiss, Florian, Michael Hurd, Maarten van Rooij, Tobias Rossmann, and Joachim Winter, "Dynamics and Heterogeneity of Subjective Stock Market Expectations," *Journal of Econometrics*, 2022, *231* (1), 213–231.

Rangvid, Jesper, Maik Schmeling, and Andreas Schrimpf, "Dividend Predictability Around the World," *Journal of Financial and Quantitative Analysis*, 2014, *49* (5-6), 1255–1277.

Roth, Christopher and Johannes Wohlfart, "How Do Expectations About the Macroeconomy Affect Personal Expectations and Behavior?," *Review of Economics and Statistics*, 2020, *102* (4), 731–748.

Vissing-Jorgensen, Annette, "Perspectives on Behavioral Finance: Does "Irrationality" Disappear with Wealth? Evidence from Expectations and Actions," *NBER Macroeconomics Annual*, 2003, *18*, 139–194.