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Toothless tiger with claws? Financial stability communication, expectations, and risk-taking

Johannes Beutel
Norbert Metiu
Valentin Stockerl

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

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Non-technical summary

Research Question

We study the effects of central bank communication about financial stability on individuals' expectations and risk-taking. We ask whether communication about financial stability can be an effective policy instrument by influencing the public's perception of the balance of risks and returns in financial markets and thereby its risk-taking behavior.

Contribution

Thus far, evidence on the effects of financial stability communication is relatively scarce. Only a few studies have investigated the effects of financial stability communication on financial markets and there is virtually no evidence on how it affects the expectations and behavior of households. To overcome challenges in identifying causal effects of financial stability communication, we use an experiment in which subjects receive excerpts from the central bank's assessment of risks to financial stability. The adjustment in individuals' beliefs induced by this information treatment allows us to identify how financial stability communication causally affects individuals' expectations and risk-taking behavior.

Results

We show that communication causally affects individuals' beliefs and risk-taking behavior. Individuals receiving a warning from the central bank expect a higher probability of a financial crisis. We exploit the resulting exogenous variation in individuals' crisis beliefs and show that higher perceived risks cause individuals to reduce their demand for risky assets. This reduction is driven by downward revisions in individuals' expected reward per unit of risk due to lower expected returns and higher perceived downside risks. In addition, these individuals deposit a smaller fraction of their savings at riskier banks. Our findings imply that central bank communication about financial stability can be an effective policy instrument.

Nichttechnische Zusammenfassung

Forschungsfrage

Wir untersuchen die Effekte von Finanzstabilitätskommunikation auf die Erwartungen und das Risikoverhalten von Individuen. Insbesondere beschäftigen wir uns mit der Frage, ob Finanzstabilitätskommunikation ein effektives Politikinstrument darstellt, das die Einschätzung von Haushalten zu Risiken auf Finanzmärkten beeinflusst und dadurch eine Anpassung ihres Risikoverhalten hervorruft.

Beitrag

Bislang existiert nur relativ wenig Evidenz zu den Effekten von Finanzstabilitätskommunikation durch Zentralbanken. Nur einige wenige Studien beschäftigten sich bisher mit den Auswirkungen von Finanzstabilitätskommunikation auf Finanzmärkte und es gibt bislang keine Evidenz zu den Auswirkungen von Finanzstabilitätskommunikation auf die Erwartungen und das Verhalten von privaten Haushalten. Um diese Forschungslücke zu schließen, werten wir eine Studie aus, in der Teilnehmer ausgewählte Textausschnitte zur Risikoeinschätzung von Zentralbanken zur Stabilität des Finanzsystems erhalten. Die dadurch (*Treatment*) ausgelöste Verhaltensanpassung verwenden wir anschließend, um kausale Effekte der Finanzstabilitätskommunikation auf Erwartungen und Risikoverhalten von Individuen aufzuzeigen.

Ergebnisse

Wir zeigen, dass Finanzstabilitätskommunikation die Erwartungen und das Risikoverhalten von Individuen beeinflussen kann. Teilnehmer, die eine Warnung der Zentralbank als Treatment erhalten, sehen eine zukünftige Finanzkrise als wahrscheinlicher an. Ein Anstieg der Krisenwahrscheinlichkeit führt dann zu einem Rückgang in der Nachfrage nach risikoreichen Anlageprodukten. Der Rückgang der Nachfrage ist von einer gesunkenen erwarteten Kompensation für die Übernahme von finanziellen Risiken getrieben, was sich in niedrigeren Renditeerwartungen am Kapitalmarkt und gleichzeitig stärker wahrgenommenen Abwärtsrisiken widerspiegelt. Zusätzlich führt ein Anstieg der wahrgenommenen Krisenwahrscheinlichkeit zu einem Abzug von Sparguthaben bei risikoreicheren Banken. Unsere Ergebnisse implizieren, dass die Finanzstabilitätskommunikation von Zentralbanken ein effektives Politikinstrument sein kann.

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Johannes Beutel
Deutsche Bundesbank

Norbert Metiu
Deutsche Bundesbank

Valentin Stockerl
Deutsche Bundesbank

February 16, 2021

Abstract

We study the effects of central bank communication about financial stability on individuals' expectations and risk-taking. Using a randomized information experiment, we show that communication causally affects individuals' beliefs and investment behavior, consistent with an expectations channel of financial stability communication. Individuals receiving a warning from the central bank expect a higher probability of a financial crisis and reduce their demand for risky assets. This reduction is driven by downward revisions in individuals' expected Sharpe ratios due to lower expected returns and higher perceived downside risks. In addition, these individuals deposit a smaller fraction of their savings at riskier banks.

JEL classification: C11, D12, D83, D91, E58, G11

Keywords: central bank communication; financial stability; stock market expectations; randomized information experiment.

*Johannes Beutel: Deutsche Bundesbank, Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main, Germany. E-mail: johannes.beutel@bundesbank.de. Norbert Metiu: Deutsche Bundesbank, Frankfurt am Main, Germany. E-mail: norbert.metiu@bundesbank.de. Valentin Stockerl: Deutsche Bundesbank, Frankfurt am Main, Germany. E-mail: valentin.stockerl@bundesbank.de. The authors thank Sophia List, Maik Schmeling, Michael Weber, and seminar participants at Deutsche Bundesbank for their helpful comments and discussions. This paper is based on the master's thesis of the third author, which was written during a research visit at the Deutsche Bundesbank.

Toothless Tiger

"A toothless tiger is an empty threat or an aggressive but harmless person. The expression dates in this sense from the mid-20th century and means the same thing as a paper tiger. Whoever coined this expression obviously forgot that toothless tigers still have claws."

— Idiom Origins, September 15, 2020.

1 Introduction

Communication as a policy instrument for central banks is both heavily used and hotly disputed. For instance, Coibion et al. (2019b) suggest that monetary policy communication has "systematically failed" in achieving its goal of anchoring the inflation expectations of households and firms. Against this backdrop, the prospects of using communication about the relatively opaque concept of financial stability appear bleak. While research on monetary policy communication has recently grown tremendously, much less is known about the impact of central bank communication about financial stability. Only a few studies have investigated the effects of financial stability communication on financial markets (see, e.g., Born et al., 2014), and there is virtually no evidence on how it affects the expectations and behavior of households.

The lack of evidence on the effects of central bank communication about financial stability on individuals' expectations and behavior is surprising, given that central banks routinely communicate their financial stability assessments to the general public via financial stability reviews, speeches, and interviews (see, e.g., Correa et al., 2020). The objectives of financial stability communication generally mirror those of monetary policy communication (see, e.g., Blinder et al., 2008; Born et al., 2014). Specifically, communication seeks to contribute to the central bank's goals by influencing the expectations and behavior of individuals and firms. Communication also aims to ensure the transparency and accountability of the central bank. To achieve these objectives, the target audience of financial stability communication includes the general public, reflecting lessons learned from monetary policy communication (see, e.g., Binder, 2017). Prominent examples citing the general public explicitly as a key part of the target audience for their financial stability communication include the Federal Reserve Board (FRB), the European Central Bank (ECB), and the Committee on the Global Financial System (CGFS), which represents 31 of

the world's major central banks.[1]

A key channel through which influencing individuals' expectations and behavior may contribute to safeguarding financial stability is by counteracting pro-cyclical surges in risk-taking (see, e.g., Svensson, 2003; Born et al., 2014). These can be fueled by excessive optimism and may generate simultaneous booms in credit, housing, and financial markets (see, e.g., Gennaioli and Shleifer, 2018; Mian and Sufi, 2011). Subsequent downward revisions in expectations can lead to panic in these markets, financial fragility, and bank runs (see, e.g., Kindleberger and Aliber, 2011). Studying the effects of financial stability communication may also be warranted from a broader perspective. Many central banks are legally required to publish financial stability reports (see, e.g., Born et al., 2012), and understanding their impact may thus help to avoid unintended side-effects on other policy goals, for instance, related to monetary policy. Moreover, central banks are not always granted full independence when it comes to enacting policies in order to mitigate financial stability risks. Instead, such policies often require the consent of or collaboration with other government agencies or legislators (see, e.g., Bernanke et al., 2019). Hence, aligning the public's perception of financial stability risks with those of the central bank can be a prerequisite for being able to employ other policy tools to address financial stability risks, both ex ante using macroprudential tools, and ex post using measures to counteract acute financial stress. The central bank's success in containing financial stability risks can, in turn, impact other policy areas, such as monetary or fiscal policy.

In this paper, we address the question of whether communication about financial stability can indeed "affect behavior by influencing the public's perception of the balance of risks [...]" (see CGFS, 2016). To address this question, we must identify the causal impact of financial stability communication. However, this presents a key challenge. Identification based on time series data is challenging because there is no obvious way of disentangling the exogenous surprise element of communication from its endogenous response to macroeconomic and financial developments. Identification based on the expectations and behavior observed for a cross-section of individuals is likewise challenging. Even if we had information on which individuals had been exposed to financial stability communication and which had not,

[1] The FRB states: "This report summarizes the Federal Reserve Board's framework for assessing the resilience of the U.S. financial system and presents the Board's current assessment. By publishing this report, the Board intends to promote public understanding and increase transparency and accountability for the Federal Reserve's views on this topic." (Link) The ECB states: "The Financial Stability Review provides an overview of potential risks to financial stability in the euro area. It aims to promote awareness in the financial industry and among the public of euro area financial stability issues." (Link) The CGFS (2016) states: "Communication is an important component of macroprudential policy because it can affect behavior by influencing the public's perception of the balance of risks and/or by helping stakeholders understand future policy actions".

the observed effects on individuals' expectations and behavior need not be causal, as the same unobserved characteristics may affect differences both in exposure to central bank communication and in expectations and behavior. In addition, estimating to what extent any observed changes in behavior are driven by changes in expectations as opposed to other factors is complicated by endogeneity concerns arising from potential reverse causality from behavior to expectations, for instance, due to asset holders forming expectations differently than those who do not hold assets (see, e.g., Kindermann et al., 2020).

To overcome these identification challenges, we use a randomized information experiment in which subjects receive excerpts from a central bank's assessment of risks to financial stability as an information treatment. We exploit the exogenous variation induced by the treatment to identify how financial stability communication causally affects individuals' beliefs and risk-taking behavior. The effects induced by the treatment are causal, since given the construction of the experiment, any systematic difference between the randomly assigned treatment groups and the control group must stem from the treatment. The information experiment is embedded in an unique online survey conducted among students enrolled at German universities. We consider two prototypical risk-taking decisions to which a broad range of ordinary individuals may be able to relate. On the one hand, we confront individuals' with a canonical portfolio choice decision in which they can choose to allocate a given amount of wealth between a risky asset that is tied to the stock market and a safe asset with a fixed return. On the other hand, we consider the allocation of individuals' savings between two banks with different risk-return profiles for individuals' deposits, which are contingent on the likelihood of a financial crisis.[2]

The experiment consists of three stages. In the first stage, respondents receive a financial crisis definition and are asked to report their belief about the probability of a crisis occurring in Germany within the next two years. They further indicate their confidence in this belief and their perception of how the crisis probability has evolved over the past five years. Respondents also report their expectations on the performance of the German stock market index, DAX, over the next two years. They are then asked to divide a hypothetical endowment between a risky asset that pays a return linked to the DAX and an asset with a fixed risk-free return. Respondents are also asked to allocate a given amount of savings between two bank branches with different risk profiles. The first branch offers a higher interest rate but is subject to

[2]We do not include real estate investment and mortgage decisions, as these may depend heavily on individuals' prior wealth and personal circumstances, and only a fraction of our student sample may currently be in a position to invest in real estate or take out a mortgage. Future research could, for instance, over-sample parts of the population representing the universe of marginal investors in the real estate market.

deposit risk, contingent on the occurrence of a financial crisis. The second branch offers an interest rate that is only slightly above zero, but is guaranteed to return deposits in full in any contingency. In the second stage, respondents are randomly allocated to one of three groups. Members of the first two groups receive two different excerpts from the Bundesbank's 2019 Financial Stability Review, each featuring a differently framed warning related to the risks in the financial system. The third group serves as a control group that receives no warning. In the final stage of the experiment, we re-elicit the items from the first stage in order to obtain respondents' *post*-treatment beliefs and risk-taking behavior. In addition, we elicit beliefs about the likelihood of an upper-tail and a lower-tail event in the stock market.

We find that survey respondents who receive the central bank's warning about financial stability risks revise their beliefs about the likelihood of a financial crisis significantly upward relative to the control group. Respondents update their crisis beliefs in a heterogeneous manner that is consistent with Bayesian updating. Upon receiving the treatment, they revise their crisis beliefs less strongly if their perceptions about how the crisis probability evolved in the years prior to the experiment are more in line with the information presented in the treatment, i.e., if they have a smaller "perception gap". In addition, for a given perception gap, respondents with higher confidence in their prior belief about the likelihood of a financial crisis also make smaller belief revisions.

Having established that individuals revise their beliefs about the likelihood of a financial crisis after receiving the treatment, we next investigate the impact of this belief revision on portfolio choice. We find that respondents treated with central bank information on risks to financial stability significantly reduce their portfolio share allocated to the risky asset relative to the control group. This change in risk-taking behavior can be rationalized with respondents' revision of their subjective stock market expectations. We find that an increase in perceived crisis probabilities leads to a decrease in subjective stock return expectations, and to higher perceived downside risk in the stock market. Lower return expectations combined with higher perceived downside risk imply a lower Sharpe ratio, i.e., the expected return per unit of risk decreases, which rationalizes the lower portfolio share allocated to the risky asset. In addition, we find that treated individuals reduce their share of savings deposited at the risky bank branch, as the increase in their perceived likelihood of a financial crisis lowers their expected return on deposits at the risky branch.

Experiments involving student subjects are common in behavioral economics and finance (see, e.g., Kahneman et al., 1986; Cadsby et al., 1990; Beshears et al., 2013; Forsythe et al., 2015). However, student samples might not be representative of the general population (see R. A. Peterson, 2001). In fact, our sample is skewed

towards survey participants with an economics or business background, who are financially more literate, and who participate more actively in the stock market than the average German citizen. We investigate the potential bias arising from these characteristics being over-represented in our sample. We find that economics and business students respond less to our treatments. Hence, the resulting bias works against us. Thus, on the one hand, our estimates may be seen as a lower bound on the true effects of communication, conditional on being treated. On the other hand, the estimates may represent an upper bound on the effect obtained in a field setting in which only a fraction of the population receives information by the central bank.[3]

Randomized information experiments have recently gained popularity in macroeconomics as a tool for studying causal effects on expectations and behavior (see, e.g., Armantier et al., 2016; Coibion et al., 2018; Armona et al., 2019; Coibion et al., 2019b; Roth and Wohlfart, 2019). They also have some well-known limitations that include potential biases arising from "anchoring" (see Tversky and Kahneman, 1974) and "experimenter demand" effects (see Crowne and Marlowe, 1964).[4] In our experimental design, we take several measures to address these potential issues. A distinguishing feature of our experiment relative to the existing literature is the use of qualitative instead of quantitative treatments. The use of qualitative information mitigates the aforementioned limitations because it does not provide a numerical anchor to respondents as an obvious target for their belief revisions. As an additional precaution, we choose the ordering of our questions to guard against potential experimenter demand effects.[5] Moreover, in our empirical analysis, we document complex patterns of heterogeneity in individuals' belief revisions, which vary systematically with individuals' perception gaps, confidence, and socio-demographic characteristics. The observed heterogeneity arguably goes beyond the reasoning that subjects might take into account when filling out the questionnaire and thus provides empirical support against the concern that anchoring or experimenter de-

[3] Evidence from a representative household survey conducted by Deutsche Bundesbank in October 2020 (Link) shows that around 85% of German households inform themselves regularly about financial stability issues. 90% of these households receive information about financial stability via traditional media, such as newspapers, TV or radio. Roughly 30% use reports by official institutions such as Financial Stability Reviews of Deutsche Bundesbank and the European Central Bank as one of their information sources.

[4] Anchoring refers to "the disproportionate influence on decision makers to make judgements that are biased toward an *initially presented value*" (see Furnham and Boo, 2011). The experimenter demand effect refers to the concern that "participants may try to infer the experimenter's objective from their treatment, and then act accordingly" (see De Quidt et al., 2018).

[5] In the baseline stage of the experiment, we elicit stock market expectations before crisis beliefs, such that the sequence of questions goes against our hypothesized direction of causality. Moreover, we place other questions before and after the treatment, so as not to elicit crisis beliefs (our central variable) right before or after the treatment. In the final stage of the experiment, we again reverse the order of causality by asking for respondents' portfolio allocation before eliciting their subjectively expected stock return.

mand effects might drive our results. This argument is supported by recent evidence showing that experimenter demand effects do not influence the qualitative conclusions from a study (see De Quidt et al., 2019), and that their quantitative effects are small (in the order of 0.13 standard deviations; see De Quidt et al., 2018) or absent (see Mummolo and E. Peterson, 2019).

Our results imply that communication of financial stability risks can be an effective macroprudential policy instrument. By affecting beliefs about the stability of the financial system, financial stability communication is able to influence individuals' risk-taking behavior, in line with an *expectations channel* of central bank communication (see, e.g., Blinder et al., 2008). Hence, the central bank can employ communication, for instance, to counteract a pro-cyclical build-up in risk-taking or to prepare for the deployment of other "hard" macroprudential policy tools. Our findings also offer guidance on the design of effective central bank communication. We find that the precise content of communication matters. A simple and targeted piece of information leads to a stronger response than the more subtle wording typically used in central bank communication about financial stability issues. We also find considerable heterogeneity in the effects of financial stability communication on individuals with different characteristics. For instance, male respondents are much less responsive to information treatments than female respondents, complementing existing evidence on inflation expectations where similar differences in responsiveness by gender have been found (see, e.g., Armantier et al., 2016; Coibion et al., 2019b). Central banks should take into account the heterogeneous effects of their communication and could potentially tailor different forms of communication to different subgroups of the population.

The remainder of the paper is organized as follows. Section 2 summarizes additional related literature. Section 3 discusses the survey, the experimental design, and sample characteristics. Section 4 illustrates the effects of the treatments on individuals' beliefs and risk-taking decisions in a simple, non-parametric way. Section 5 presents the main results on the effects of financial stability communication on respondents' crisis beliefs. Section 6 documents the effects on risk-taking decisions. Section 7 presents the effects on savings decisions. Section 8 concludes.

2 Related Literature

We contribute to a broad literature on central bank communication. One strand of the literature focuses on monetary policy communication and its impact on financial markets (see, e.g., Gürkaynak et al., 2005; Nakamura and Steinsson, 2018;

Ehrmann and Talmi, 2019; Schmeling and Wagner, 2019; Cieslak and Schrimpf, 2019). While communication with market participants appears to be quite successful, there appears to be room for improvement in communication with the general public. For example, Carvalho and Nechio (2014) document that only a fraction of U.S. households form their expectations on inflation and unemployment consistent with a Taylor rule. Moreover, Coibion et al. (2019b) show that most U.S. households are poorly informed about the objectives and names of monetary policymakers, while Coibion et al. (2020a) show that central bank communication about current monetary policy rates and forward guidance moves U.S. household expectations, although not beyond the one-year horizon. To improve communication with the public, Bholat et al. (2019) suggest using a more simple language and content that relates more to people's daily life. More recently, researchers have studied which message to communicate. Angeletos and Sastry (2020) argue theoretically that providing information about targets rather than instruments is more effective in managing expectations, which has been empirically confirmed by D'Acunto et al. (2020).

Central bank communication about financial stability has, in contrast to monetary policy, only received limited attention in the literature. The existing empirical literature focuses entirely on financial market participants and consists predominantly of event studies, with mixed results. In an event study covering over 1,000 communication events by 37 central banks, Born et al. (2014) provide evidence for a positive and significant relationship between the tone of central communication and abnormal stock market returns. Moreover, a number of papers have shown that the announcement of results of bank stress tests tend to be associated with significant abnormal returns, especially in times of financial distress (see, e.g., Morgan et al., 2014; Flannery et al., 2017; Fernandes et al., 2020). By contrast, Harris et al. (2019) find that sentiment and policy announcements in the Bank of England's financial stability reviews are highly predictable and do not lead to abnormal returns. The theoretical literature on optimal central bank communication has studied its role in stabilizing inflation expectations (see, e.g., Eusepi and Preston, 2010; Woodford, 2005), and, more recently, the optimal degree of transparency on financial stability issues (see, e.g., Horváth and Vaško, 2016). The approach taken in our paper is non-normative and provides an empirical basis for considering the optimality of central bank communication. To the best of our knowledge, we are the first to provide direct evidence on the effects of financial stability communication on individuals' expectations and risk-taking decisions. Our experimental setup allows us to overcome potential identification issues and thereby obtain causal effects.

Our empirical design fits into a recent literature that employs randomized infor-

mation experiments to investigate how economic agents learn from and adapt to new information in macroeconomic settings. The bulk of the literature investigates the formation of *inflation* expectations both by firms (e.g., Coibion et al., 2018; Coibion et al., 2019a), and households (e.g., Armantier et al., 2016; Coibion et al., 2019b). See also Coibion et al. (2020b) for an overview. The existing evidence suggests that economic agents are initially poorly informed but have a basic understanding of the economy, and they tend to update their expectations in response to new information in a manner consistent with Bayesian updating. Agents seem to face information constraints, for instance, arising from rational inattention (see, e.g. Sims, 2003; Mankiw and Reis, 2006; Mackowiak and Wiederholt, 2015), or from cognitive characteristics. For instance, Cavallo et al. (2017) show that both rational inattention and cognitive limitations are important sources of information frictions in the formation of households' inflation expectations.

Our econometric strategy is related to Roth and Wohlfart (2019), who show in a randomized information experiment that households adjust their economic outlook and behavior in response to new information about the chances of a recession occurring in the near future. Our empirical approach is also related to Armona et al. (2019), who study households' house price expectations using a randomized information experiment. Moreover, our approach is related to papers that study expectation formation and financial decisions via experiments performed in a controlled lab setting (see, e.g., Cadsby et al., 1990; Beshears et al., 2013; Forsythe et al., 2015; Kryvtsov and Petersen, 2020).

Finally, our paper adds to a literature on portfolio choice and the role of stock market expectations therein. In a seminal paper, Haliassos and Bertaut (1995) show that despite the existence of a sizeable equity premium, only a small proportion of U.S. households invest in stocks. Subsequent studies have found that households with higher return expectations are more likely to hold stocks (see, e.g., Dominitz and Manski, 2007; Hurd et al., 2011; Amromin and Sharpe, 2014). Giglio et al. (2019) show that retail investors with higher subjective return expectations allocate larger shares of their wealth to a risky equity investment and that the expected volatility or crash risk of risky assets has a weak impact on investors' portfolio choice. Adam et al. (2017) show that fluctuations in subjective return expectations can rationalize the postwar dynamics of the U.S. stock market. We contribute to this literature by showing that central bank communication can act as a shock to individuals' beliefs about the distribution of future stock market outcomes, causally affecting their risk-taking behavior.

3 Randomized Information Experiment

3.1 Survey

We analyze data from a randomized information experiment embedded in an internet-based survey of students enrolled at German universities. The survey was fielded from December 9, 2019 to February 9, 2020. A total of 831 survey participants began filling out the questionnaire and 484 completed it, implying a completion rate of 58%. An analysis of the characteristics of respondents who completed the survey and those who dropped out before finishing reveals only minor differences.[6] After removing outliers, we obtain a sample of N=414 respondents.[7] Respondents were distributed across approximately 70 different universities, spread geographically across the whole of Germany.[8] The full English version of the questionnaire is available in Appendix C.[9]

3.2 Experimental Design

The experimental setup of the survey consists of three stages: (i.) a baseline stage, eliciting respondents' prior beliefs and decisions, (ii.) a treatment stage, and (iii.) a final stage, eliciting respondents' posterior beliefs and decisions, as illustrated in Figure 1.

[6] We elicit respondents' gender and risk tolerance prior to the experiment. The average risk tolerance is measured on a scale from 0 to 10, where 0 is defined as "risk averse" and 10 "fully prepared to take on risks". The average risk tolerance is almost identical for those who started (4.92) and those who finished the survey (4.94). In addition, 49% of respondents who started the survey are female, while the share of females who completed the survey is 44%. As women respond on average more strongly to the treatments, the latter selection effect works against our results.

[7] We exclude 34 respondents who report not to be enrolled at a German university. We also discard respondents with a high share of item non-response (above 15%), who violate built-in logical checks of the survey, and who estimate the two-year return of the DAX to be below -85%, as well as respondents with implausibly extreme adjustments in their likelihood of a financial crisis of a magnitude of above 50 percentage points. We exclude missing values on an item-by-item basis. Item non-response typically falls in the interval of 1-3% of the sample size and is presented in Table A.1.

[8] The respondents attended universities in the following cities: Aachen, Amberg, Augsburg, Bad Honnef, Bamberg, Bayreuth, Berlin, Bielefeld, Bochum, Bonn, Braunschweig, Chemnitz, Cologne, Darmstadt, Dortmund, Dresden, Duisburg, Düsseldorf, Eichstätt, Elmshorn, Erlangen, Flensburg, Frankfurt, Göttingen, Hachenburg, Hagen, Halle-Wittenburg, Hamburg, Hanover, Heidelberg, Heidenheim, Idstein, Jena, Kassel, Kiel, Koblenz, Konstanz, Leipzig, Magdeburg, Mainz, Mannheim, Marburg, Munich, Münster, Nuremberg, Osnabrück, Passau, Riedlingen, Saarbrücken, Siegen, Stuttgart, Tübingen, Vallendar, Weimar, Wiesbaden, Wolfenbüttel, and Würzburg.

[9] The survey was administered using the web-based platform SoSci Survey. Respondents could choose between an English and a German version of the questionnaire. 92% of valid respondents used the German version of the questionnaire.

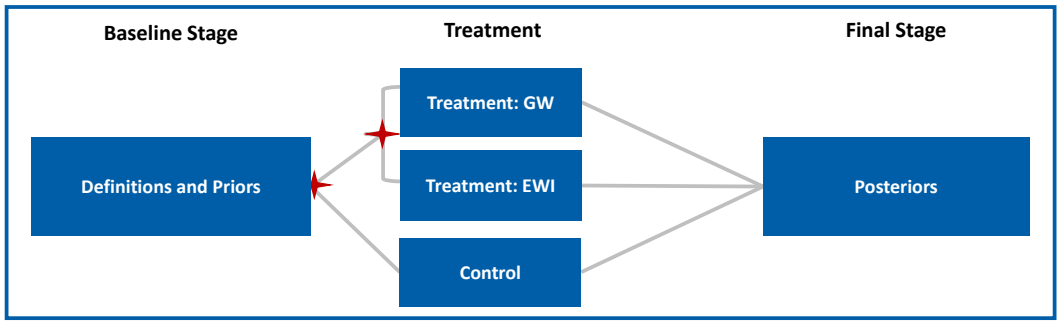

Figure 1: Setup of the experiment

Note: Schematic representation of the experimental design. The stars indicate points of randomization. Respondents are randomly allocated to one of three groups. Half of respondents is allocated to the control group (*Control*), in which they receive no additional information. One quarter of respondents receive a general warning (*Treatment: GW*) and one quarter receive a specific warning providing information on the Bundesbank's early warning indicator for financial crises (*Treatment: EWI*).

3.2.1 Baseline Stage

The experiment starts by giving survey participants a brief introduction on how to express expectations about future outcomes in probabilistic terms, following Armantier et al. (2016) and Roth and Wohlfart (2019). Information is then provided on the level of the leading German stock market index, DAX, at the time the survey was launched, and respondents are tasked with giving their expectation about the future level of the DAX, which is a total return index, two years after being surveyed. They are informed about the annualized rate of return their answer implies and have the option of revising their expectation before proceeding, so as to alleviate possible concerns regarding the framing of stock market expectations questions (see, e.g., Glaser et al., 2019).

Respondents receive a hypothetical endowment of €5,000 and are prompted to invest it for two years. They can divide the total amount between two assets: a portfolio of stocks that pays an annual return equal to the development of the DAX (henceforth "risky asset") and an asset that pays a fixed 1% annual return (henceforth "risk-free asset"). The phrasing follows a question on hypothetical investment behavior in Armona et al. (2019).

Next, respondents are confronted with a decision to deposit their savings at bank branches with different risk profiles. We frame the question in terms of different branches of the same bank to exclude potential confounding effects from unobserved bank characteristics perceived by our respondents. Branch A pays a fixed interest rate of 3% per annum, but in the event that a financial crisis materializes, individuals recover only three quarters of their deposits. Branch B pays a fixed 0.25% interest rate per annum and deposits in this branch are returned in full with certainty.

Based on the historical average probability of a financial crisis of around 10% for a horizon of one to three years ahead (see, e.g., Beutel et al., 2019), these choices are calibrated to yield an annual expected return of 1.7% for the risky asset, such that allocating a non-zero fraction of savings to the risky branch is rational from the perspective of optimal portfolio allocation. Our framing deliberately abstracts from the existing deposit insurance scheme in Germany, and our results suggest that respondents do indeed buy into the idea that their deposits might not be returned in full by the risky branch. Even respondents who are aware of the existence of a deposit insurance scheme may not be fully informed about its recovery rate, and they may face an illiquidity cost, pertaining to the perceived time it takes for deposits to be refunded through the scheme.

Subsequently, respondents obtain a definition of a financial crisis which is consistent with key features of past financial crises (see, e.g., Allen and Gale, 2009; Laeven and Valencia, 2013). Respondents are asked to express their beliefs regarding the likelihood of a financial crisis occurring in Germany within the next two years, expressed in probabilistic terms between 0 and 100 percent. They are also asked to quantify their confidence in their reported crisis beliefs. Respondents' confidence is elicited on a scale from 0 to 100 percent, where 0 is absolutely uncertain and 100 absolutely certain. In addition, we ask respondents to provide their perception about whether the probability of a financial crisis occurring within two years has changed over the past five years.

3.2.2 Treatment Stage

After the baseline stage, survey participants are randomly allocated into one of three groups. Respondents in the control group receive no further information. Respondents in one of the two treatment groups receive a piece of truthful information concerning risks to the financial system that stems from the Bundesbank's 2019 Financial Stability Review, published on November 21, 2019. Respondents in the first treatment group are presented with the following general warning (*GW*):

> *"**The vulnerability of the German financial system has increased considerably in the past few years.** Future credit risks may potentially be underestimated and the value of collateral like real estate overestimated."*

Respondents in the second treatment group obtain the following information on the development of the Bundesbank's early warning indicator (*EWI*) for financial crises:

> *"The early warning indicator of Deutsche Bundesbank provides information on how the current situation compares to the developments that typically preceded previous financial crises. An increase in the indicator suggests that the estimated likelihood of a financial crisis in Germany within the next 1-3 years has risen.* ***The early warning indicator for financial crises has been rising sharply for several years.****"*

The information provided in the treatments is a qualitative description of changes in risks to financial stability relative to the past few years. The use of qualitative information differs from related experimental studies which provide quantitative, absolute measures as an intervention, for example, an inflation target of 2%. In reality, central banks' communication about financial stability usually does not feature a simple, numerical metric. In contrast to the inflation rate as a key measure of price stability, a unique summary measure of financial stability does not exist. Hence, our identification strategy does not rely on absolute levels but rather on relative changes in the elicited crisis beliefs. An important advantage of the use of qualitative information is that it does not provide a numerical anchor, which has been found to significantly influence survey responses (see Furnham and Boo, 2011).

3.2.3 Final Stage

After the treatment, respondents in all three groups are again confronted with the questions from the baseline stage. Additionally, we elicit respondents' beliefs about the likelihood of an upside and downside scenario in the stock market. Given a level of the DAX of approximately 13,000 index points at the time of the survey, we ask them to quantify the likelihood of the DAX closing above 16,000 points and below 10,000 points two years into the future, which represents a change of roughly 25% relative to its level at the time of the survey. This question is designed to specifically assess how the tails of respondents' subjective return distributions are affected. The two-year horizon is chosen so as to correspond to the prediction horizon of the Bundesbank's early warning indicator, which predicts the probability of a financial crisis for a 1-3 year window.

3.3 Sample Characteristics

Table 1 presents the sample characteristics resulting from our survey. The first column reports the characteristics of the full sample. For instance, 56% of the respondents are male. Respondents with substantial economic and financial knowledge

are over-represented in the sample, as captured by three dimensions of the questionnaire. First, a large share of respondents in the sample (71%) are enrolled in an economics or business program. Second, the sample contains a high fraction of equity holders: 53% of respondents report holding some equity investment in individual stocks, funds, or equity options. In comparison, a representative survey found that only 15.7% of the German population (older than 14 years) held an investment in stocks or equity funds in 2019 (see Deutsches Aktieninstitut, 2020). Third, we borrow three questions from Lusardi and Mitchell (2011) that measure respondents' financial literacy by analyzing their understanding of three central economic concepts: diversification, inflation, and compounding interest. Based on these measures, respondents are highly financially literate, with 95% answering these "big three" questions correctly.[10]

Columns 2-4 of Table 1 break down the sample characteristics for the control group and the two treatment groups. Respondents have been randomly allocated to treatment and control groups, so as to ensure that there are no systematic differences between these groups, other than the received treatment. We test for equality between the three subgroups for all observable sample characteristics using a one-way analysis of variance (ANOVA) test. Column 5 reports the p-values of the test statistic. We cannot reject the null hypothesis of equality in most cases, with the only exception of the share of stockowners, which differs across groups at the 5% significance level. Overall, the randomization exercise successfully maintains the sample properties along nearly all observed characteristics. Remaining differences between the treatment groups are controlled for by using a vector of subject characteristics in the regressions.

4 Communication, Beliefs and Risk-taking: A Non-parametric Illustration

To build intuition, we begin our empirical analysis with a simple, non-parametric exercise that illustrates the effect of the treatments on individuals' beliefs and risk-taking decisions. In this exercise, we compare the differences in beliefs and risk-taking decisions between and within groups, and the differences-in-differences (DiD) that are at the heart of our identification strategy. Table 2 summarizes the total effect

[10]The answer categories to the question designed to capture respondents' understanding of compounding interest over a multi-year horizon was erroneously framed in terms of the one year return instead of the five-year return without compounding. As a consequence, the answer classified as financial literate is still correct. Yet, it captures only a basic understanding of interest rates and not an understanding of the concept of compounding interest.

Table 1: Sample characteristics

	Full Sample (in %)	Control (in %)	Treat: GW (in %)	Treat: EWI (in %)	p-value
Demographics					
Male	56	55	50	63	0.124
Age group					
18-20	20	19	16	26	0.151
21-23	35	31	42	35	0.198
24-26	27	29	30	21	0.278
27-29	11	13	7	10	0.219
30 and above	7	8	6	7	0.832
Not married	94	94	94	93	0.874
Academic level					
Bachelor	60	58	59	64	0.576
Master	35	37	37	29	0.348
Ph.D.	5	5	4	6	0.669
Above-median risk aversion	58	56	62	57	0.632
Above-median grading	50	47	49	55	0.362
Economic knowledge					
Economics/Business studies	71	75	67	68	0.199
Stockholder	53	59	46	48	0.037**
High financial literacy	95	95	93	98	0.227
Observations	414	199	105	110	

Note: The table reports sample characteristics as percentage shares of the full sample. The last column shows the p-values of a one-way ANOVA test of equality of each row variable across the three groups (Control, Treat: GW, and Treat: EWI). *Male* is a dummy variable that equals one if the respondent is male. *Age group* is a categorical variable for different age groups of the sample. *Not married* is a dummy variable which equals one if a respondent is not married. *Academic level* is a categorical variable that indicates the current type of program students are enrolled in. *Above-median risk aversion* is a dummy variable equal to one if the respondent reports at or above-median risk aversion. *Above-median grading* is a dummy variable equal to one if the respondent has above-median grades according to the German grading system. *Economics/Business studies* is a dummy variable equal to one if a respondent's field of studies falls in this category. *Stockholder* is a dummy variable equal to one if the respondent reports holding some form of equity investment. *High financial literacy* is a dummy variable that equals one if a respondent answers all three questions on financial literacy correctly. Asterisks ** denote significance at the 5% level.

of the treatments on respondents' perceived crisis probabilities between 0 and 100 percent (Panel A), their return expectations as measured by the implied annualized rate of return (Panel B), their investment behavior as measured by the fraction of the total endowment allocated to the risky asset (Panel C), and the share of savings allocated to the risky bank branch (Panel D). A description of all variables used in our analysis is provided in Table A.6.

The first and second row of each panel presents the pre-treatment and post-treatment responses, respectively. For all panels, the prior responses vary only slightly between groups.[11] Post-treatment, the between-group differences are much more pronounced. Relative to the control group, the perceived likelihood of a financial crisis

[11] An ANOVA test for equality shows that the three subgroups do not vary significantly across these three dimensions *prior* to the treatment. The results are presented in Table A.2.

Table 2: Non-parametric comparisons of crisis beliefs, investment behavior, and return expectations

	Levels			Between-group differences	
	Control	T^{GW}	T^{EWI}	T^{GW} - Control	T^{EWI} - Control
Panel A: Crisis beliefs					
$Pr(crisis)^{pre}$	36.13	38.39	35.50	2.26	–0.63
$Pr(crisis)^{post}$	35.36	40.70	42.58	5.34	7.23
$\Delta Pr(crisis)$	–0.77	2.30	7.08	**3.08**	**7.86**
Panel B: Return expectations					
$E(R)^{pre}$	1.63	1.27	1.08	–0.37	–0.56
$E(R)^{post}$	1.63	0.76	0.28	–0.86	–1.34
$\Delta E(R)$	–0.01	–0.51	–0.79	**−0.50**	**−0.79**
Panel C: Investment share					
Inv. share^{pre}	53.73	51.09	54.55	–2.65	0.81
Inv. share^{post}	52.96	45.81	50.29	–7.16	–2.67
Δ*Inv. share*	–0.77	–5.28	–4.25	**−4.51**	**−3.48**
Panel D: Savings share					
Savings share^{pre}	58.30	58.16	59.24	–0.13	0.94
Savings share^{post}	58.37	53.80	49.17	–4.57	–9.19
Δ*Savings share*	0.07	–4.36	–10.06	**−4.43**	**−10.13**

Note: The table shows averages of survey respondents' beliefs about the probability of a future financial crisis reported prior to the treatment stage, $Pr(crisis)^{pre}$, and in the final stage of the information experiment, $Pr(crisis)^{post}$ (Panel A); their stock market return expectations before treatment, $E(R)^{post}$, and after treatment, $E(R)^{post}$ (Panel B); the share of the risky asset in their portfolio before treatment, *Inv. share*^{pre}, and after treatment, *Inv. share*^{post} (Panel C); and their savings share allocated to the risky bank before treatment *Savings share*^{pre}, and after treatment *Savings share*^{post} (Panel D). The within-group differences are computed as the differences between posterior and prior values (third row of each panel). Differences between each of the treatment groups and the control group are presented in columns 4 and 5 for prior and posterior values. The boldfaced numbers represent the average difference-in-difference value of the pre-treatment and post-treatment responses between treatment groups and the control group.

for respondents receiving the GW (EWI) treatment is, on average, 5.34 (7.23) percentage points (p.p.) higher, the expected return on the stock market is, on average, 0.86 (1.34) p.p. lower, the share of the risky asset is, on average, 7.16 (2.67) p.p. lower, and the savings share deposited at the risky bank is, on average, 4.57 (9.19) p.p. lower.

The third row of each panel reports the within-group variation, capturing the average adjustment in respondents' beliefs for the two treatment groups and the control group. After treatment, the perceived likelihood of a financial crisis is, on average, 2.30 (7.08) p.p. higher, return expectations are, on average, 0.50 (0.79) p.p. lower, the share of the risky asset is, on average, 5.28 (4.25) p.p. lower, and the savings share deposited at the risky bank is, on average, 4.36 (10.06) p.p. lower for respondents in the *GW* (*EWI*) treatment group than before receiving the treatment.

While comparing the differences between and within groups is already suggestive,

the focus of our identification strategy is on the comparison of the pre-treatment and post-treatment responses between treatment groups and the control group, obtained by taking the DiD value from Table 2 (figures in bold). To appreciate this insight, notice that respondents in the control group revise their beliefs about the probability of a crisis and the share of the risky asset downwards, on average, by 0.77 p.p. in the final stage of the experiment relative to the values reported at the baseline stage. Several factors could influence respondents to update their responses even without receiving any additional information. For instance, the survey might induce respondents to give more thought to their responses .[12] Such confounding effects cancel out when considering the DiD values.

The DiD, that is, the change between pre-treatment and post-treatment responses relative to the control group for respondents who receive the GW (EWI) treatment, is on average 3.08 (7.86) p.p. higher for the perceived likelihood of a financial crisis, 0.50 (0.79) p.p. lower for the expected return on the stock market, 4.51 (3.48) p.p. lower for the portfolio share of the risky asset, and 4.43 (10.13) p.p. lower for the share of deposits allocated to the risky bank.

This non-parametric DiD exercise suggests a relationship between information treatments and individuals' beliefs about financial stability, stock market expectations, and risk-taking decisions. In the remainder of the paper, we further explore this relationship.

Our analysis proceeds in the following steps. First, we investigate whether individuals update their beliefs about the probability of a future financial crisis in response to information treatments and whether they do so in a manner consistent with Bayesian updating. Second, we exploit the exogenous variation in individuals' crisis beliefs induced by the treatments to estimate their effects on portfolio investment decisions. Third, we rationalize changes in investment decisions with the way in which individuals update their subjective stock market expectations. Finally, we investigate whether changes in the perceived likelihood of a financial crisis also affect respondents' behavior with respect to the share of savings allocated to banks with different risk-return profiles.

[12] For a discussion of the impact of surveys on respondents' subsequent behavior, see Zwane et al. (2011).

5 Communication and Crisis Beliefs

5.1 Effect of Communication on the Perceived Likelihood of a Financial Crisis

To assess how different communication treatments affect individuals' beliefs regarding the probability of a future financial crisis, we estimate the following regression:

$$\Delta Pr(crisis)_i = \alpha_0 + \alpha_1 T_i^{GW} + \alpha_2 T_i^{EWI} + \alpha_3 Pr(crisis)_i^{pre} + \theta \mathbf{X_i} + \varepsilon_i, \qquad (1)$$

where $\Delta Pr(crisis)_i \equiv Pr(crisis)_i^{post} - Pr(crisis)_i^{pre}$ is the difference between individual i's posterior belief about the probability of a financial crisis reported in the final stage of the experiment and her prior belief reported in the baseline stage. T_i^{GW} and T_i^{EWI} are binary variables that are equal to one if individual i belongs to the *GW* or the *EWI* treatment group, respectively, and zero otherwise. We include prior beliefs, $Pr(crisis)_i^{pre}$, as a control variable in order to remove potential mechanical correlations between the dependent variable and prior crisis beliefs. Such correlations can arise because the probability of a financial crisis is bounded on the interval [0,100].[13] The vector $\mathbf{X_i}$ contains control variables on demographic characteristics (gender, age group, marital status, self-reported risk aversion, and grades), and a group of variables related to individuals' "economic knowledge" (economics or business studies, stock ownership, and financial literacy). Finally, ε_i is a random error term capturing measurement error and any remaining unobserved differences between individuals.

The main coefficients of interest are α_1 and α_2, which identify the average treatment effects (ATEs), that is, the average change in respondents' beliefs about the probability of a financial crisis relative to the control group caused by the information treatments. Under the null hypothesis, central bank communication about financial stability does not significantly affect respondents' beliefs about the likelihood of a financial crisis (H_0: $\alpha_1 = \alpha_2 = 0$). This null hypothesis is consistent with Harris et al. (2019), who show that the Bank of England's financial stability communication does not contain any news that has not already been taken into account by financial

[13] For example, consider an extreme case in which a respondent believes that a financial crisis will occur in the next two years with almost absolute certainty (99%). Assume that upon receiving an information treatment, the respondent's perceived probability of a crisis increases. In that case, the respondent can report an at most 1 p.p. higher perceived likelihood of a financial crisis. If the same person had instead reported a lower prior belief, she could have adjusted by more than 1 p.p. Consequently, prior beliefs and their revision are mechanically correlated. Not controlling for this correlation would lead to a (small) downward bias in the α_1 and α_2 estimates.

Table 3: Effects of central bank communication on beliefs about financial stability

Dependent variable: $\Delta Pr(crisis)_i$ *(p.p.)*

	(1)	(2)	(3)	(4)	(5)
Treatment					
T_i^{GW}	3.15***		3.24***		
	(1.10)		(1.01)		
T_i^{EWI}	7.25***		7.81***		
	(1.25)		(1.19)		
T_i^{pooled}		5.19***		5.58***	5.13***
		(0.95)		(0.87)	(0.96)
$Pr(crisis)_i^{pre}$	-0.06***	-0.06***	-0.07***	-0.07***	
	(0.02)	(0.02)	(0.02)	(0.02)	
Constant	2.47	2.43	1.79***	1.90***	-0.30
	(3.66)	(3.59)	(0.67)	(0.68)	(3.81)
Demographics	Yes	Yes	No	No	Yes
Economic knowledge	Yes	Yes	No	No	Yes
R^2	0.21	0.18	0.15	0.12	0.16
N	331	331	414	414	331

Note: The table presents OLS estimates of changes in individuals' beliefs about the likelihood of a financial crisis caused by the information treatment (see Equation 1). Column 1 reports the average treatment effect of each treatment relative to the control group. Columns 2 reports the pooled average treatment effect, describing the average change in crisis beliefs conditional on receiving any of the two treatments, relative to the control group. Columns 3-5 report robustness checks. Asterisks *** denote significance at the 1% level. Robust standard errors are in parentheses.

markets.

Table 3 reports the ordinary least squares (OLS) estimates of Equation 1. Inference is based on heteroskedasticity-consistent standard errors introduced by White (1980). The first two rows of column 1 present the ATEs of the two different pieces of central bank communication on individual beliefs about the probability of a financial crisis. The ATEs are positive and statistically significant at the 1% level, showing that respondents who learn about risks to financial stability revise their crisis beliefs upwards relative to those who do not receive an information treatment. Controlling for demographics and economic background knowledge, the *GW* treatment causes an upward revision in respondents' crisis beliefs, by 3.15 p.p., while the *EWI* treatment leads to an upward revision in crisis beliefs, by 7.25 p.p. relative to the control group.

Note that, while the ATE of the *EWI* treatment is more than twice as large as that of the *GW* treatment, survey respondents also respond significantly to the more subtle information provided in the *GW* treatment. This finding offers valuable insights to policymakers. On the one hand, it shows that central bankers can resort to more complex and nuanced forms of communication because these are by no means in-

effective. On the other hand, it suggests that simple and direct communication is a more effective instrument to influence individuals' beliefs about financial stability.

Since both information treatments cause significant variation in respondents' beliefs about the likelihood of a financial crisis, we can also pool respondents from the two treatment groups. Column 2 of Table 3 presents the unweighted ATE of receiving any type of information treatment. The ATE from the pooled estimation lies between the individual effects of each treatment and are statistically significant at the 1% level. Columns 3-5 report robustness checks, which yield only minor differences in ATEs estimated using different sets of control variables. To ease exposition, we will in the remainder of the paper focus on the pooled treatment as an instrument for exogenous changes in respondents' beliefs. Results for individual treatments for all subsequent specifications will be shown in the Appendix.

5.2 Bayesian Updating

Bayesian updating implies that respondents who are more surprised by the content of the treatment should, ceteris paribus, revise their beliefs more strongly. In addition, respondents who are more confident in their prior beliefs should, ceteris paribus, update their beliefs less strongly (see Armona et al., 2019). Therefore, to investigate whether respondents update their crisis beliefs consistent with Bayesian updating, we estimate the following regression:

$$\begin{aligned} \Delta Pr(crisis)_i &= \alpha_0 + \alpha_1 * T_i^{pooled} + \alpha_2 * Gap_i + \alpha_3 * Confidence_i + \\ &+ \alpha_4 * T_i^{pooled} * Gap_i + \alpha_5 * T_i^{pooled} * Confidence_i + \\ &+ \alpha_6 * Gap_i * Confidence_i + \\ &+ \alpha_7 * T_i^{pooled} * Gap_i * Confidence_i + \theta \mathbf{X_i} + \varepsilon_i, \end{aligned} \tag{2}$$

where Gap_i denotes respondent i's perception gap, i.e., the discrepancy between her perception of how the probability of a crisis evolved over the past five years and the information provided in the treatment, and $Confidence_i$ describes respondent i's level of confidence in her initial crisis beliefs on a scale between 0 and 100 percent.[14] T_i^{pooled} is the pooled treatment dummy. We specify the regression with interaction terms between all three of these variables.

[14] Recall that respondents' perception of how the crisis probability has evolved over the past five years is elicited on a qualitative 1-5 scale, where 1 implies that the likelihood of a financial crisis "strongly increased", while 5 means that it "strongly decreased" over the past five years. Starting from the premise that the information treatments are most consistent with a 1 on the ordinal scale, we derive Gap_i as a qualitative measure between 0 (no gap) and 4 (large gap). As an alternative measure of the perception gap, we use a binary variable, which is equal to one if the perception gap is larger than 1.

Table 4: Bayesian updating of crisis beliefs

Dependent variable: $\Delta Pr(crisis)_i$ *(p.p.)*

	Categorical Gap-measure		Binary Gap-measure	
	(1)	(2)	(3)	(4)
Treatment (T_i)	-5.687	-5.475	1.421	2.205
	(5.303)	(4.43)	(3.510)	(2.829)
Gap (G_i)	-3.004	-2.195	-6.569*	-3.480
	(2.048)	(1.542)	(3.631)	(2.573)
Confidence (C_i)	-0.054	-0.046	-0.028	-0.025
	(0.047)	(0.036)	(0.028)	(0.023)
$T_i \times G_i$	8.379**	8.070***	13.872**	9.848*
	(3.464)	(2.945)	(7.038)	(5.418)
$T_i \times C_i$	0.130*	0.122**	0.048	0.038
	(0.075)	(0.062)	(0.051)	(0.042)
$G_i \times C_i$	0.039	0.027	0.090*	0.046
	(0.029)	(0.021)	(0.050)	(0.036)
$T_i \times G_i \times C_i$	-0.101**	-0.086**	-0.181*	-0.098
	(0.048)	(0.041)	(0.098)	(0.078)
Constant	0.977	2.733	-0.440	0.891
	(4.637)	(2.541)	(3.972)	(1.467)
Demographics	Yes	No	Yes	No
Economic knowledge	Yes	No	Yes	No
R^2	0.18	0.12	0.17	0.10
N	331	414	331	414

Note: The table shows OLS estimates of Equation 3. Columns 1-2 use a categorical *Gap* measure which is scaled between 0 (no gap) and 4 (large gap). Columns 3-4 use a binary *Gap* measure, which equals one for all individuals with a perception gap of 2 or higher, and zero otherwise. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

The coefficients of interest in Equation 3 are α_4 and α_7. If respondents update in a Bayesian manner, those who are more surprised by the information should increase their beliefs to a larger extent. Thus, we expect that $\alpha_4 > 0$. Moreover, for a given perception gap, individuals who are more confident in their prior belief should revise less. Therefore, we expect that $\alpha_7 < 0$.

Table 4 presents the results. Column 1 shows that the treatment effect depends on the extent to which respondents are surprised by the treatment. The bigger the surprise, the larger the magnitude of the revision ($\hat{\alpha_4} > 0$). For example, consider two respondents of same characteristics, who both received an information treatment but who differ in their perception how the probability of a crisis occurring has changed in the past five years. Suppose that Person A has the prior perception that the probability "slightly increased" (Gap_A=1), and Person B has the prior

perception that it "strongly increased" (Gap_B=0), while both persons' confidence in their prior belief about the likelihood of a financial crisis is at the sample mean of 59%. Our estimates indicate that, on average, Person A updates their belief by 1.717 p.p. ($\approx$ -3.004+8.379+59*0.039+59*(-0.101)) more than Person B. In addition, for a given perception gap, treated respondents with higher confidence in their prior belief about the likelihood of a financial crisis also make smaller belief revisions. We obtain a negative relationship of -0.101 p.p. which is significant at the 5% level ($\hat{\alpha}_7 < 0$). To put this into perspective, a treated respondent with 10 p.p. higher confidence in her prior crisis belief and a perception gap of 2 revises her belief by -0.48 p.p. more than an otherwise identical individual ($\approx$ 10*(-0.054+0.13+2*0.039-2*0.101)). The results remain robust when not including any control variables (column 2). Specifying Gap_i as a binary variable, the results remain qualitatively similar and significant (column 3) but loose some statistical power when not including the set of control variables (column 4).[15]

In sum, we find that respondents update their beliefs in a manner that is consistent with Bayesian updating. The next section explores the heterogeneity in updating behavior across respondents with different socio-demographic characteristics, prior knowledge, and confidence.

5.3 Heterogeneity in Treatment Effects

Does the extent to which individuals update their crisis beliefs vary systematically with individuals' characteristics? If it does, what are the implications of this heterogeneity? To address these questions, Table 5 reports the ATEs for the full sample and for samples split by stock ownership, field of studies, grades, and gender. We pool the two treatment groups, and each regression controls for respondents' prior beliefs.[16] Panel A displays the total ATE for each subsample. In addition, we decompose the total ATE into its extensive margin (Panel B) and intensive margin (Panel C). The extensive margin is defined as the probability that a respondent up-

[15] Table A.3 replicates this analysis separately for each treatment group. The results are qualitatively similar to those of table 4, but the magnitude and statistical significance of coefficients varies across the two treatment groups. In particular, while we find strong evidence of belief updating consistent with Bayesian updating ($\hat{\alpha}_4 >0$ and $\hat{\alpha}_7 <0$) for respondents who receive the *Early Warning Indicator Treatment* (Columns 5-8), the effects are smaller and less significant for the *General Warning Treatment* (Columns 1-4).

[16] Table A.4 reports these estimates separately for the two treatments instead of the pooled treatment. *Confidence* and *Gap* estimates do not differ by treatment group and are identical with those in Table 5. Overall, the results are broadly consistent with those in Table 5.

dates her belief about the likelihood of a financial crisis after the treatment stage.[17] The intensive margin reflects the average revision, conditional on an update taking place. Panel D reports the average confidence in prior beliefs and the average perception gap for each subsample. By comparing these across subsamples, we explore whether Bayesian updating can explain not only average treatment effects for the entire sample (see previous section) but also the heterogeneity in updating behavior across subsets of individuals.

We use the variation between stockholders and non-stockholders to shed light on the nature of information incompleteness faced by our respondents. More than 50% of our respondents' report holding stocks, funds, or equity options. Non-stockholders may follow news with relevance for financial markets less closely. Therefore, they might be more surprised by the treatments and revise their beliefs more strongly. We find that the treatments do indeed have stronger average effects on those who do not own stocks (7.77 p.p.) than on those who do (3.32 p.p.). The ATEs are higher at both the extensive and the intensive margin for non-stockholders compared to stockholders. Panel D shows that the stronger updating behavior of non-stockholders is associated with a wider perception gap and lower confidence in their initial beliefs, consistent with non-stockholders consciously being less informed about financial market-related news.

Given that our sample is tilted towards stockholders and economics and business students, the heterogeneity along these dimensions can be exploited to provide inference on the results that might be obtained in a more representative sample. The ATE turns out to be more than twice as large for students in other programs (8.95 p.p.) than it is for economics and business students (3.97 p.p.), with both ATEs being significant at the 1% level. This difference is driven by the intensive margin: conditional on an update taking place, economics and business students update their crisis beliefs, on average, by 7.38 p.p., while students in other programs update their crisis beliefs, on average, by 12.08 p.p. Moreover, economics and business students are more confident in their prior beliefs and have a smaller perception gap. Taken together, we find substantial differences in updating behavior along the characteristics that are over-represented in our sample, namely stock ownership and field of studies, which suggests that our results may provide a conservative estimate of the treatment effects that might be obtained in a more representative sample.

Splitting the sample by grades, we find that respondents with weaker course per-

[17] To compute the extensive margin, we derive a dummy variable that is equal to one if a respondent's revision in crisis belief is different from zero. We then run a limited dependent variable regression to investigate whether respondents in the treatment group are more likely to adjust their beliefs relative to the respondents in the control group.

Table 5: Heterogeneity in treatment effects - Crisis beliefs

Dependent variable: $\Delta Pr(crisis)_i$ *(p.p.)*

	Aggregate	By stock ownership		By field of studies		By grades		By gender		By risk aversion	
		None	Some	Others	Economics	Good	Poor	Female	Male	Low	High
A: Total effect											
T_i^{Pooled}	5.58***	7.77***	3.32***	8.95***	3.97***	4.27***	7.14***	8.96***	2.95***	3.68***	6.86***
	(0.87)	(1.29)	(1.25)	(1.87)	(0.95)	(1.21)	(1.35)	(1.49)	(1.00)	(1.30)	(1.16)
N	414	191	213	117	289	187	184	181	229	174	240
B: Extensive margin											
T_i^{Pooled}	0.15***	0.20***	0.12*	0.13	0.14**	0.12*	0.18**	0.25***	0.09	0.05	0.21***
	(0.05)	(0.07)	(0.07)	(0.09)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.06)
N	414	191	213	117	289	187	184	181	229	174	240
C: Intensive margin											
T_i^{Pooled}	9.37***	13.33***	5.25**	12.08***	7.38***	7.28***	11.97***	12.32***	5.70***	7.10***	11.02***
	(1.48)	(2.31)	(2.18)	(2.64)	(1.81)	(2.12)	(2.26)	(2.12)	(1.99)	(2.57)	(1.75)
N	225	108	110	80	141	100	102	114	110	82	143
D: Bayesian updating											
$Confidence_i$	59.45	56.65	61.99	52.42	62.55	56.17	62.92	54.10	63.92	64.07	56.10
	[25.18]	[25.10]	[25.11]	[25.87]	[24.51]	[26.70]	[23.02]	[25.26]	[24.24]	[24.14]	[25.44]
$Gap_i^{categoric}$	1.21	1.28	1.14	1.27	1.19	1.28	1.13	1.39	1.08	1.09	1.30
	[0.85]	[0.84]	[0.86]	[0.89]	[0.85]	[0.89]	[0.82]	[0.88]	[0.81]	[0.77]	[0.90]
Gap_i^{binary}	0.84	0.87	0.81	0.85	0.83	0.87	0.81	0.90	0.79	0.82	0.85
	[0.37]	[0.34]	[0.40]	[0.35]	[0.38]	[0.34]	[0.39]	[0.31]	[0.41]	[0.39]	[0.35]
N	414	191	213	117	289	187	184	181	229	174	240

Note: Panel A presents the average effects of the pooled treatment for selected subsamples which are split along binary individual-specific characteristics of respondents (dummies on respondents' stock-ownership, field of studies, grades, gender and risk-aversion). The parameters are expressed relative to the average effects of the specific subgroup who is allocated into the control group. Panel B displays the extensive margin of the treatment effects. Panel C contains the intensive margin of treatment effects. Panel D reports the average confidence in prior beliefs and the average perception gap of the categorical and binary measure for each subsample with the standard deviation in square brackets. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

formance update their beliefs more strongly than respondents with stronger performance. Related to recent research about the effect of IQ on expectation formation (see, e.g., D'Acunto et al., 2019), our results suggest that cognitive abilities may play a role in shaping individuals' responses to information communicated by the central bank. The stronger updating gain of individuals with poorer grades is also interesting from the perspective of findings by Adam et al. (2015), who show that less experienced households update their stock return expectations too strongly and suffer welfare losses as a result.

Differences in gender matter, too. The ATE for female respondents (8.96 p.p.) is significantly higher than the ATE for male respondents (2.95 p.p.). We find that female respondents who receive a treatment are 25 p.p. more likely to update their crisis beliefs relative to female respondents that belong to the control group. Conversely, male respondents who receive a treatment are not significantly more likely to update relative to male respondents belonging to the control group. Furthermore, conditional on updating, the ATE at the intensive margin is higher for female respondents than for male respondents. Female respondents revise their estimates on average by 12.32 p.p. more in the treatment group relative to the control group, whereas the ATE at the intensive margin for male respondents is only 5.7 p.p. The result that female survey participants display stronger updating behavior than male participants is in line with, e.g., Armantier et al. (2016) and Coibion et al. (2019b), who investigate updating behavior in the context of inflation expectations. Panel D sheds light on potential reasons between the differential updating behavior of male and female respondents. Female respondents have a wider perception gap and are less confident in their prior beliefs than male respondents. While existing research in behavioral finance suggests that men are on average more prone to "overconfidence" than women (see, e.g., Barber and Odean, 2001), the smaller perception gap observed on average for male respondents suggests better informedness as an alternative explanation.

6 Communication and Investment Decisions

6.1 Effect of Communication on Risky Asset Portfolio Share

As stated in the introduction, central banks use communication about financial stability as a macroprudential instrument with the objective to "affect behavior by influencing the public's perception of the balance of risks [...]" (see CGFS, 2016, p. 22). Having shown that communication can indeed shift respondents' perception of

the balance of risks as measured by changes in beliefs about the likelihood of a financial crisis, we now ask the natural follow-up question: Do beliefs about financial stability affect behavior?

A naive way of formalizing the relationship between beliefs about the probability of a financial crisis and individual behavior would be to use the following regression equation:

$$Inv.\ share_i^{pre,post} = b_0 + b_1 Pr(crisis)_i^{pre,post} + \vartheta \mathbf{X_i} + \varphi_i, \tag{3}$$

where $Inv.\ Share_i^{pre,post}$ denotes the fraction of the total amount allocated to the risky asset before or after treatment. While this setup allows us to study the correlation between respondents' crisis beliefs and the portfolio share invested in the risky asset, it is not suitable for identifying causal effects. It is well documented that personal experiences influence individual expectations of macro-level aggregates (see, e.g., Malmendier and Nagel, 2011; Kuchler and Zafar, 2019), pointing to a potential endogeneity between beliefs and behavior. In addition, any unobserved characteristics that influence both the belief about the likelihood of a financial crisis and investment behavior could lead to spurious correlation without causality. Measurement errors in the elicited crisis beliefs constitute another challenge which could attenuate the b_1 coefficient towards zero.

To confront these concerns, we take advantage of the specific design of our experiment. Focusing on intra-subject variation allows us to cancel out all fixed effects and potential measurement errors in the level of crisis beliefs, for instance, due to heterogeneous perceptions of probabilities. To resolve endogeneity concerns and pin down causal effects, we employ an instrumental variables (IV) approach which exploits the DiD shown in our non-parametric illustration. Specifically, we exploit the exogenous variation in respondents' beliefs about the probability of a future financial crisis introduced via information treatments as a first stage, in order to identify the causal effect of a change in crisis beliefs induced by central bank communication on investment behavior in a second stage. This econometric approach is in line with Roth and Wohlfart (2019). We opt for pooling the treatment groups rather than using two separate treatment dummies as an instrument because the pooled treatment provides a stronger first stage.

Formally, we estimate the following IV regression system, which isolates the effect of changes in crisis beliefs that are caused by the exogenous information treatment by instrumenting for the change in crisis beliefs with the random allocation to the

Table 6: The impact of beliefs about financial stability on risk-taking

Dependent variable: ΔInv. share$_i$ (p.p.)

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
$\Delta Pr(crisis)_i$	-0.44***	-0.73**	-0.73***	-0.70**	-0.72**
	(0.12)	(0.33)	(0.27)	(0.28)	(0.30)
$Pr(crisis)_i^{pre}$	-0.16***	-0.18***	-0.19***	-0.17***	
	(0.05)	(0.05)	(0.04)	(0.04)	
$Inv.\ share_i^{pre}$	-0.16***	-0.16***	-0.15***		
	(0.04)	(0.04)	(0.03)		
Constant	9.04	10.70	12.70***	4.96**	-1.33
	(7.51)	(7.39)	(2.94)	(2.00)	(1.09)
Initial corner solution	Yes	Yes	Yes	No	No
Demographics	Yes	Yes	No	No	No
Economic knowledge	Yes	Yes	No	No	No
R^2	0.19				
N	331	331	414	414	414
$First\ stage\ F-Stat$		30.30	41.35	41.15	39.11

Note: This table reports estimates of the effect of changes in crisis beliefs on changes in financial risk-taking behavior. Column 1 shows the OLS estimate of Equation 3, and IV estimates of Equation 4 are shown in columns 2-5. The R^2 of these regressions is omitted as they lack a meaningful statistical interpretation in the case of 2SLS estimation. *Initial corner solution* is a dummy variable that indicates whether respondents have an extreme (0 or 100%) asset allocation prior to the treatment. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

pooled treatment group (T_i^{pooled}):

$$\begin{aligned} \Delta Inv.share_i &= \beta_0 + \beta_1 \Delta \widehat{Pr(crisis)}_i + \qquad (4) \\ &+ \beta_2 Pr(crisis)_i^{pre} + \beta_3 Inv.share_i^{pre} + \sigma \mathbf{X_i} + \rho_i, \\ \Delta \widehat{Pr(crisis)}_i &= \hat{\alpha}_0 + \hat{\alpha}_1 T_i^{pooled} + \hat{\alpha}_2 Pr(crisis)_i^{pre} + \hat{\alpha}_3 Inv.share_i^{pre} + \hat{\theta} \mathbf{X_i}. \qquad (5) \end{aligned}$$

We control for respondents' prior crisis beliefs, $Pr(crisis)_i^{pre}$, and their prior investment allocation, $Inv.share_i^{pre}$, in both equations. These priors remove potential mechanical correlations that may distort the β_1 and α_1 coefficients. As before, we include control variables for demographics and economic knowledge. In addition, we control for corner solutions in the prior investment share using a dummy variable, which takes the value of one if $Inv.share_i^{pre}$ equals a 0% or 100% share of the risky asset and the value of zero otherwise. The null hypothesis that changes in beliefs about the likelihood of a financial crisis have no impact on respondents' decisions regarding the portfolio share allocated to the risky asset is $H_0 : \beta_1 = 0$.

Table 6 shows the results obtained for the second-stage regression in Equation 4 estimated by OLS and IV. The OLS estimates in column 1 indicate that there is a negative correlation between changes in the likelihood of a financial crisis and

changes in the risky asset share. The second-stage IV regression in column 2 is based on a strong instrument for respondents' revision in crisis beliefs (F-Stat = 30.30).[18] In the fully specified IV model, we find that a 1 p.p. increase in the perceived likelihood of a financial crisis causes a reduction in the risky asset share by 0.73 p.p. (column 2). This effect is statistically significant at the 5% level. The effect is also economically significant. Consider the average revision of the pooled treatment: Upon receiving information on the central bank's assessment about financial stability, respondents increase their perceived likelihood of a financial crisis by 5.19 p.p. This increase causes respondents to adjust the risky asset portfolio share, on average, by -3.79 p.p. ($\approx -0.73 * 5.19$). These results suggest that central bank communication has the power to influence risk-taking behavior by significantly changing individuals' perceptions about financial stability risks and about the balance of risk and return in financial markets.

6.2 Consistency with Models of Optimal Portfolio Choice

What explains individuals' revisions of their portfolio investment decision? In this section, we assess whether individuals' decision can be rationalized by a simple model of portfolio choice in which the optimal portfolio share allocated to the risky asset depends positively on its expected return and negatively on its perceived risk. This basic risk-return trade-off which characterizes financial markets can be derived under different specifications. For instance, Campbell and Viceira (2003) consider a standard model of portfolio choice in which individuals maximize the discounted value of the utility of consumption, C, under constant relative risk aversion preferences with parameter γ and a standard inter-temporal budget constraint:

$$\max E_t \sum_{i=0}^{\infty} \delta^i \frac{C_{t+i}^{1-\gamma} - 1}{1-\gamma} \tag{6}$$

$$W_{t+1} = (1 + R_{p,t+1})(W_t - C_t) \tag{7}$$

$$R_{p,t+1} = \alpha_t R_{t+1} + (1-\alpha_t) R_{f,t+1} \tag{8}$$

where wealth in period $t+1$, W_{t+1}, depends on the amount of savings from the previous period multiplied by the return on individuals' portfolio, $R_{p,t+1}$, which is a weighted average of the return on the risky asset, R_{t+1}, and the return on the risk-free asset, $R_{f,t+1}$, weighted by individuals' portfolio share allocated to the risky asset, α_t. Under the assumptions maintained in Campbell and Viceira (2003), this yields a familiar expression for the optimal portfolio share allocated to the risky

[18] The results are qualitatively similar to those in Table 6 when using the two separate treatment dummies as instruments; however, these sometimes lack statistical power (see Table A.5, columns 1-4).

asset:

$$\alpha_t = \frac{E_t r_{t+1} - r_{f,t+1} + \sigma_t^2/2}{\gamma \sigma_t^2} \tag{9}$$

where lowercase letters denote the natural logarithm of the respective gross returns, i.e. $r_{t+1} = \ln(1 + R_{t+1})$, and one half of the conditional variance of the log risky gross return denoted, σ_t^2, is added to convert from expected log returns to log expected returns.[19] This yields the optimal portfolio share as a linear function of the (log) expected equity premium scaled by its variance and individuals' risk aversion.

Based on individuals' revisions in beliefs about expected returns and risk, we investigate whether the observed shift in investment behavior triggered by information treatments is consistent with optimal portfolio choice. While we do not elicit a density forecast from respondents, we elicit their perceived likelihood of tail scenarios in the stock market as a proxy for perceived risk. This allows us to test qualitatively whether the revision in respondents' portfolio share is consistent with the risk-return trade-off predicted by optimal portfolio allocation. The observed reduction of individuals' risky asset share is consistent with the model's predictions if respondents i) reduce their expected excess stock market return and/or ii) increase their perceived risk of a downside stock market scenario. We investigate both of these aspects in turn.

6.2.1 Revisions in Subjective Expected Returns

To investigate how changes in respondents' perceived likelihood of a financial crisis caused by the treatments affect their subjective stock return expectations, we reformulate our IV regression system as follows:

$$\begin{aligned} \Delta E(R)_i &= \beta_0 + \beta_1 \Delta \widehat{Pr(crisis)}_i + \\ &+ \beta_2 Pr(crisis)_i^{pre} + \beta_3 E(R)_i^{pre} + \sigma \mathbf{X_i} + \rho_i, \end{aligned} \tag{10}$$

$$\Delta \widehat{Pr(crisis)}_i = \hat{\alpha_0} + \hat{\alpha_1} T_i^{pooled} + \hat{\beta}_2 Pr(crisis)_i^{pre} + \hat{\beta}_3 E(R)_i^{pre} + \hat{\theta} \mathbf{X_i}. \tag{11}$$

The OLS and IV regression estimates are shown in Table 7. Column 1 displays the OLS estimates. We find robust evidence that an increase in the perceived probability of a financial crisis is significantly negatively associated with respondents' subjective return expectations. The IV estimates in column 2 indicate that this relationship is causal: For the fully specified model, an exogenous 1 p.p. increase in the perceived likelihood of a financial crisis causes a significant reduction in return expectations by 0.14 p.p. The effect is robust to specifications with a different set of control variables and to using the two treatment dummies as separate instruments

[19] The assumption that the natural logarithm of the (risky) return is normally distributed, implies that $E_t r_{t+1} - r_{f,t+1} + \sigma_t^2/2 = \ln E_t(1 + R_{t+1})/(1 + R_{f,t+1})$ (see Campbell and Viceira, 2003).

Table 7: Beliefs about the likelihood of a crisis and their impact on return expectations

Dependent variable: $\Delta E(R)_i$ *(p.p.)*

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
$\Delta Pr(crisis)_i$	-0.05**	-0.14***	-0.12***	-0.11***	-0.12***
	(0.02)	(0.05)	(0.04)	(0.04)	(0.04)
$Pr(crisis)_i^{pre}$	-0.02**	-0.02**	-0.02**	-0.02**	
	(0.01)	(0.01)	(0.01)	(0.01)	
$E(R)_i^{pre}$	-0.06*	-0.07*	-0.05		
	(0.04)	(0.04)	(0.03)		
Constant	-0.47	0.13	0.67*	0.46*	-0.10
	(1.11)	(1.19)	(0.38)	(0.27)	(0.12)
Demographics	Yes	Yes	No	No	No
Economic knowledge	Yes	Yes	No	No	No
R^2	0.109				
N	331	331	414	414	414
First stage $F-Stat$		29.55	40.54	41.15	39.11

Note: The table presents estimates of the effect of changes in crisis beliefs on changes in subjective return expectations (see Equation 10). OLS estimates are reported in column 1, IV estimates are shown in columns 2-5. The R^2 in columns 2-5 is omitted as it lacks a meaningful statistical interpretation in the case of 2SLS estimation. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

(see Table A.5).

The estimated effect is also economically significant. Recall that the pooled ATE of the information treatment on the perceived likelihood of a financial crisis is equal to 5.19 p.p. The average increase in the perceived crisis probability causes respondents to adjust their subjective return expectations by -0.73 p.p. ($\approx -0.14 * 5.19$). The reduction in subjective return expectations is consistent with the reduction in the portfolio share of the risky asset.

6.2.2 Perceived Likelihood of Stock Market Tail Events

To investigate the second channel that could rationalize the observed revisions in individuals' investment behavior, we estimate the effect of changes in crisis beliefs on the tails of respondents' subjective return distributions. We use a survey item elicited in the post-treatment stage of the experiment, which asks respondents to provide their perceptions regarding the probability (measured between 0-100 percent) of two potential stock market scenarios materializing in two years. The first is an upside scenario in which the DAX closes at above 16,000 points, and the second is a downside scenario in which the DAX closes at below 10,000 points. Start-

ing from an initial level of 13,000 points in late 2019, these tail scenarios imply an annualized return of above 12% and below -11% over two consecutive years, respectively.

Since we elicited beliefs about these tail scenarios only after treatment, we cannot compute within-group revisions, and therefore focus on the between-group differences in the posterior tail perceptions for identification. To that end, we follow Roth and Wohlfart (2019) by assuming that, due to the randomization of the treatment groups, there are no material differences between the *prior* tail perceptions of the pooled treatment group and the control group (see also the ANOVA tests for equality of means shown in Table A.2). Under this assumption, posterior differences between control and treatment groups can be identified as causal effects. To analyze the causal impact of the perceived probability of a financial crisis on stock market tail perceptions, we estimate the following IV regression system:

$$Tail\ scenario_i^{post} = \beta_0 + \beta_1 \widehat{Pr(crisis)}_i^{post} + \rho \mathbf{X_i} + \varepsilon_i, \tag{12}$$

$$\widehat{Pr(crisis)}_i^{post} = \hat{\alpha}_0 + \hat{\alpha}_1 T_i^{pooled} + \hat{\alpha}_2 Pr(crisis)_i^{pre} + \hat{\theta} \mathbf{X_i}. \tag{13}$$

where, depending on the specification, $Tail\ scenario_i^{post}$ is either the perceived likelihood of an upper-tail or a lower-tail scenario in the stock market, and we instrument posterior crisis beliefs with the random allocation to the pooled treatment group.

OLS and IV estimates of the regression in Equation 12 are shown in Table 8 for the lower-tail and upper-tail scenario. Panel B displays the results of the IV approach. We find a positive and significant effect on the likelihood of the lower tail scenario. A 1 p.p. higher likelihood of a financial crisis increases the subjective likelihood of the lower-tail scenario by 1.19 p.p. IV estimates for the upper-tail scenario are not statistically significant, suggesting that individuals' do not just shift their return distribution, but change its shape by shifting more mass to its lower tail.[20]

Taken together, these findings suggest that respondents incorporate beliefs about financial stability into their subjective return distribution. An exogenous increase in the perceived likelihood of a financial crisis causes respondents to not only re-

[20] A caveat is the strength of the instrument. The first stage F-statistic is only 5.34 (7.27) with (without) the full set of control variables and thus below the commonly used threshold of 10. We test for under-identification using the Kleibergen and Paap (2006) test. We find that the correlation between the endogenous variable and the instrument is statistically different from zero with a p-value of 0.0196 (0.0074) with (without) the full set of control variables. We attribute the relatively weak first stage to the alternative identification strategy. In all the previous settings, we utilize the within-individual variation in respondents' beliefs as an instrumented variable. In this case, we rely on a between-group comparison, where the individual fixed effects cannot be canceled out. Consequently, we can only explain a much smaller fraction of the total variation in the endogenous variable with the randomized group allocation.

Table 8: Beliefs about financial stability and the impact on the perceived likelihood of tail events

Dependent variable: Tail scenario$_i^{post}$ (p.p.)

	Lower tail (p. p.)		Upper tail (p. p.)	
	(1)	(2)	(3)	(4)
Panel A: OLS				
$Pr(crisis)_i^{post}$	0.45***	0.45***	0.07*	0.10***
	(0.06)	(0.05)	(0.04)	(0.03)
Constant	19.43**	7.50***	29.73***	18.18***
	(8.57)	(1.80)	(7.11)	(1.56)
Demographics	Yes	No	Yes	No
Ecconomic knowledge	Yes	No	Yes	No
Panel B: IV				
$Pr(crisis)_i^{post}$	1.19**	0.88**	-0.01	-0.26
	(0.47)	(0.35)	(0.30)	(0.29)
Constant	-18.10	-8.91	33.84**	32.08***
	(26.43)	(13.58)	(16.75)	(11.43)
Demographics	Yes	No	Yes	No
Economic knowledge	Yes	No	Yes	No
N	331	414	331	414
$First\ stage\ F-Stat.$	5.34	7.27	5.34	7.27

Note: The table shows OLS estimates (Panel A) and IV estimates (Panel B) of the effect of crisis beliefs on the perceived likelihood of a lower-tail (columns 1-2) and upper-tail (columns 3-4) stock market scenario (see Equation 12). Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

duce their return expectations but also report a higher likelihood of the downside stock market scenario, implying a heavier lower tail of the distribution. The change in respondents' subjective return distribution leads to a reduction in the subjective Sharpe ratio, causing a reduction in respondents' demand for risky assets. This finding sheds light on the transmission mechanism of financial stability communication: Central bank communication about increased risks to financial stability lowers expected returns and exacerbates perceived downside risks, leading individuals' to decrease their risk-taking.

7 Communication and Deposit Decisions

The financial crisis of 2008 has shown that despite sophisticated deposit insurance schemes, the safety of individuals' bank deposits and the prospect of bank runs can be a serious issue in the unfolding of a financial crisis. While traditional bank runs (see, e.g., Diamond and Dybvig, 1983) were not the original cause of the problems in the financial sector, the threat of bank runs by the general public was real. In the months preceding the bankruptcy of Lehman Brothers, the Deposit Insurance Facil-

ity's (DIF) reserve ratio dropped below the statutory minimum of 1.15% of insured deposits. After Lehman's collapse, depletion of the DIF accelerated, reaching a low point of negative USD 20.9 billion by the end of 2009 (see Federal Deposit Insurance Corporation, 2018). These events led to several interventions by the FDIC in order to replenish the DIF and ensure the safety of deposits. In Europe and the Asia-Pacific region, many governments announced unprecedented blanket guarantees for individuals' deposits shortly after the Lehman bankruptcy (see Schich, 2009).

What are the channels through which communication about financial stability could impact the risks related to individuals' deposits and bank runs? First, related to the discussion on the optimal degree of transparency of central banks (see, e.g., Horváth and Vaško, 2016), raising awareness of financial stability risks could potentially have the unintended consequence of triggering a bank run, or of exacerbating problems at weaker institutions. Second, to the extent that individuals adjust their deposit behavior in response to heightened perceived financial stability risks, this could alleviate moral hazard concerns associated with deposit insurance schemes (see, e.g., Keeley, 1990; Demirgüç-Kunt and Huizinga, 2004). Even for fully insured deposits, such a disciplining element for banks could arise when depositors perceive liquidity or administrative costs associated with refunding through a deposit insurance scheme. Third, informing the public about a gradual build-up of risks in the financial system might mitigate systemic risk by reducing individuals' exposure to weaker banks at a time when these are still able to raise funding from other sources or to sell assets at non-distressed market prices. Our experiment provides an empirical basis for assessing these potential effects, and for designing optimal communication strategies that take such effects into account.

To trace out the change in the savings share allocated to the risky bank caused by the change in the perceived likelihood of a financial crisis induced by financial stability communication, we estimate the following IV regression system:

$$\begin{aligned} \Delta Savings\ share_i &= \beta_0 + \beta_1 \Delta \widehat{Pr(crisis)}_i + \\ &+ \beta_2 Pr(crisis)_i^{pre} + \beta_3 Savings\ share_i^{pre} + \sigma \mathbf{X_i} + \rho_i, \end{aligned} \tag{14}$$

$$\begin{aligned} \Delta \widehat{Pr(crisis)}_i &= \hat{\alpha}_0 + \hat{\alpha}_1 T_i^{pooled} + \hat{\alpha}_2 Pr(crisis)_i^{pre} + \\ &+ \hat{\alpha}_3 Savings\ share_i^{pre} + \hat{\theta} \mathbf{X_i}. \end{aligned} \tag{15}$$

The resulting estimates in Table 9 show that, in response to an upward revision of the perceived crisis probability induced by the financial stability communication treatment, respondents revise their savings share allocated to the risky bank branch downwards. Column 2 contains our main IV specification with the full set of controls. It shows that a 1 p.p. increase in the perceived crisis probability lowers

Table 9: The impact of beliefs about financial stability on saving decisions

Dependent variable: Δ Savings share$_i$ (p.p.)

	OLS	IV			
	(1)	(2)	(3)	(4)	(5)
$\Delta Pr(crisis)_i$	-0.56***	-1.34***	-1.31***	-1.32***	-1.33***
	(0.13)	(0.29)	(0.27)	(0.27)	(0.28)
$Pr(crisis)_i^{pre}$	-0.07*	-0.12***	-0.13***	-0.09**	
	(0.04)	(0.04)	(0.04)	(0.04)	
$Savings\ share_i^{pre}$	-0.10***	-0.10***	-0.11***		
	(0.02)	(0.03)	(0.02)		
Constant	7.21	12.43*	10.48***	2.14	-0.96
	(6.28)	(7.35)	(2.74)	(1.37)	(0.71)
Initial corner solution	Yes	Yes	Yes	No	No
Demographics	Yes	Yes	No	No	No
Economic knowledge	Yes	Yes	No	No	No
R^2	0.24	.	.	.	.
N	331	331	414	414	414
First stage F-Stat		29.90	40.98	41.15	39.11

Note: This table reports estimates of the effect of changes in crisis beliefs on changes in individuals' saving behavior (see Equation 14). OLS estimates are reported in column 1, IV estimates are shown in columns 2-5. The R^2 in columns 2-5 is omitted as it lacks a meaningful statistical interpretation in the case of 2SLS estimation. *Initial corner solution* is a dummy variable that indicates whether respondents have an extreme (0 or 100%) asset allocation prior to the treatment. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

the share of savings allocated to the risky bank branch by roughly 1.3 p.p. This magnitude is economically significant and explains the observations from the non-parametric exercise in Table 2: For an average change of crisis beliefs of roughly 8 p.p. (3 p.p.) in the EWI (GW) treatment group relative to the control group, the estimated effect explains the decrease in the savings share of roughly 10 p.p. (4.4 p.p.) in the EWI (GW) treatment group relative to the control group. The first column of Table 9 shows that an OLS regression would have substantially underestimated the effect of changes in crisis beliefs on the savings allocation. Columns 3 to 5 show that although our control variables are significant, they do not exert a major influence on the estimated effect of the change in crisis beliefs.

Table 10 analyses the heterogeneity in the revisions of the savings allocation induced by the communication treatments. With the exception of stock ownership, we find that the same characteristics that affect the change in crisis beliefs also determine the change in the savings share allocated to the risky bank branch. This suggests that the cross-sectional heterogeneity in the revision of the savings allocation can largely be explained by the impact of these characteristics on belief revisions. Our estimates show that a non-economic background, poor grades, and high risk

aversion are associated with larger downward revisions in the savings share allocated to the risky bank branch in response to the communication treatment. Female respondents also display larger revisions in the savings share which is consistent with their belief updating behavior.

Our findings suggest that central bank communication about financial stability can indeed affect individuals' savings allocation decision. More research may be needed on individuals' perception of the guarantees offered by deposit insurance, from which our experiment deliberately abstracted. With this caveat in mind, our findings suggest that, when communicating about financial stability, central banks may want to consider the above discussed (desired as well as unintended) consequences of their communication on individuals' savings allocation decisions.

Table 10: Heterogeneity in treatment effects - savings share

Dependent variable: ΔSavings share$_i$ (p.p.)

	Aggregate	By stock ownership		By field of studies		By grades		By gender		By risk aversion	
		None	Some	Others	Economics	Good	Poor	Female	Male	Low	High
A: Total effect											
T_i^{Pooled}	-7.28***	-7.27***	-7.16***	-9.17***	-6.31***	-6.59***	-8.33***	-10.92***	-4.50***	-5.43***	-8.56***
	(1.33)	(2.05)	(1.60)	(2.97)	(1.43)	(2.17)	(1.95)	(2.45)	(1.25)	(1.91)	(1.84)
N	414	191	213	117	289	187	184	181	229	174	240
B: EM											
T_i^{Pooled}	0.16***	0.21***	0.13**	0.17**	0.15***	0.19***	0.10	0.20***	0.13**	0.11*	0.19***
	(0.04)	(0.06)	(0.06)	(0.08)	(0.05)	(0.06)	(0.06)	(0.07)	(0.05)	(0.06)	(0.05)
N	414	191	213	117	289	187	184	181	229	174	240
C: IM											
T_i^{Pooled}	-19.78***	-18.29**	-19.04***	-20.57**	-18.19***	-16.05***	-24.19***	-21.54***	-13.31***	-13.59*	-22.91***
	(4.16)	(7.80)	(4.73)	(9.29)	(4.50)	(5.85)	(5.71)	(6.12)	(4.27)	(7.20)	(5.46)
N	106	49	54	36	70	53	46	56	50	42	64

Note: Panel A presents the average effects of the pooled treatment on revisions in individuals' savings share. Results are reported for the aggregate as well as for selected subsamples, which are split along binary individual-specific characteristics of respondents (dummies on respondents' stock ownership, field of studies, grades, gender, and risk-aversion). The parameters are expressed relative to the average effects of the specific subgroup that is allocated into the control group. Panel B displays the extensive margin of the treatment effects. Panel C contains the intensive margin of treatment effects. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

8 Conclusion

Central bank communication has become an increasingly important instrument, not only for monetary policy but also for macroprudential policy. While research on the effects of monetary policy communication has recently flourished, much less is known about the effects of financial stability communication. We present novel evidence on the impact of central bank communication about financial stability on individuals' expectations and risk-taking.

Using a randomized information experiment embedded in a survey, we show that survey participants react to financial stability communication by significantly revising their beliefs about the likelihood of a future financial crisis: If the central bank asserts that risks to financial stability have risen, respondents believe that a crisis is more likely to happen in the near future. We exploit the resulting exogenous variation in individuals' beliefs to establish causal effects on individuals' risk-taking behavior. We find that, when survey respondents are confronted with a portfolio choice between a risky and a risk-free asset, an exogenous increase in their perceived crisis probability induced by central bank communication significantly reduces their demand for the risky asset. This reduction is largely driven by a downward revision in individuals' subjective return expectations and an increase in the perceived downside tail risk for the asset's return. The observed revision in respondents' investment decisions is consistent with standard models of portfolio choice, which predict that downward revisions in respondents' expected Sharpe ratio should, ceteris paribus, cause them to lower their demand for risky assets. In a similar vein, respondents lower their share of deposits at riskier banks in response to receiving a warning about financial stability risks.

The extent to which individuals update their beliefs regarding the probability of a crisis varies along key dimensions predicted by Bayesian theory. Specifically, respondents who are more surprised by the information treatments and are less confident in their prior beliefs update their beliefs more strongly. In addition, individuals with lower incentives to acquire information about the state of the financial system due to not owning financial assets are more surprised by the treatments and, consequently, update their beliefs more strongly. Interestingly, female respondents also tend to display stronger updating behavior than male respondents, consistent with existing evidence on the formation of individuals' inflation expectations. We find that the smaller updating gain of male respondents may be explained by smaller perception gaps and higher confidence.

Our findings imply that central bank communication about financial stability can

be an effective policy instrument. This instrument operates through an expectations channel: By steering beliefs about the stability of the financial system and the perceived balance between risk and return in financial markets, the financial risk-taking behavior of individuals can be influenced. A central bank seeking to achieve maximum impact on individuals' expectations and behavior should communicate in simple and direct terms rather than using more complex information.

Several interesting questions for future research arise. While randomized information experiments have become a key method to estimate the effects of communication conditional on individuals receiving it, assessing how many people are exposed to central bank communication in practice, e.g., via newspapers and social media, and which of these communication channels are most effective is left for future research. More research is also needed to understand the impact of financial stability communication on different dimensions of risk-taking, for instance, in the housing market or regarding household indebtedness. In addition, future research should investigate whether financial and non-financial firms react differently to financial stability communication than individuals. Our findings may also provide renewed impetus for considerations on the timing, content, and aims of *optimal* financial stability communication.

9 References

Adam, Klaus, Johannes Beutel, Albert Marcet, and Sebastian Merkel (2015). Can a Financial Transaction Tax Prevent Stock Price Booms? *Journal of Monetary Economics*, vol. 76, pp. 90–109.

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

Allen, Franklin and Douglas Gale, eds. (2009). Understanding Financial Crises. Clarendon Lectures in Finance. Oxford University Press.

Amromin, Gene and Steven A. Sharpe (2014). From the Horse's Mouth: Economic Conditions and Investor Expectations of Risk and Return. *Management Science*, vol. 60 (4), pp. 845–866.

Angeletos, George-Marios and Karthik A. Sastry (2020). Managing Expectations: Instruments vs. Targets. NBER Working Paper, upyeard version (25404).

Armantier, Olivier, Scott Nelson, Giorgio Topa, Wilbert van der Klaauw, and Basit Zafar (2016). The Price Is Right: Updating Inflation Expectations in a Random-

ized Price Information Experiment. *Review of Economics and Statistics*, vol. 98 (3), pp. 503–523.

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

Barber, Brad M. and Terrance Odean (2001). Boys will be Boys: Gender, Overconfidence, and Common Stock Investment. *Quarterly Journal of Economics*, vol. 116 (1), pp. 261–292.

Bernanke, Ben S., Timothy F. Geithner, and Henry M. Paulson (2019). Firefighting: The financial crisis and its lessons. Penguin Books.

Beshears, John, James J. Choi, Andreas Fuster, David Laibson, and Brigitte C. Madrian (2013). What Goes Up Must Come Down? Experimental Evidence on Intuitive Forecasting. *American Economic Review*, vol. 103 (3), pp. 570–574.

Beutel, Johannes, Sophia List, and Gregor von Schweinitz (2019). Does machine learning help us predict banking crises? *Journal of Financial Stability*, vol. 45, in press.

Bholat, David, Nida Broughton, Janna Ter Meer, and Eryk Walczak (2019). Enhancing Central Bank Communications using Simple and Relatable Information. *Journal of Monetary Economics*, vol. 108, pp. 1–15.

Binder, Carola (2017). Fed speak on main street: Central bank communication and household expectations. *Journal of Macroeconomics*, vol. 52, pp. 238–251.

Blinder, Alan S., Michael Ehrmann, Marcel Fratzscher, Jakob de Haan, and David-Jan Jansen (2008). Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence. *Journal of Economic Literature*, vol. 46 (4), pp. 910–945.

Born, Benjamin, Michael Ehrmann, and Marcel Fratzscher (2012). Communicating About Macro-prudential Supervision: A New Challenge for Central Banks. *International Finance*, vol. 15 (2), pp. 179–203.

– (2014). Central Bank Communication on Financial Stability. *Economic Journal*, vol. 124 (577), pp. 701–734.

Cadsby, Charles B., Murray Frank, and Vojislav Maksimovic (1990). Pooling, Separating, and Semiseparating Equilibria in Financial Markets: Some Experimental Evidence. *Review of Financial Studies*, vol. 3 (3), pp. 315–342.

Campbell, John Y. and Luis M. Viceira (2003). Strategic asset allocation: Portfolio choice for long-term investors. Reprinted. Oxford Univ. Press.

Carvalho, Carlos and Fernanda Nechio (2014). Do People Understand Monetary Policy? *Journal of Monetary Economics*, vol. 66, pp. 108–123.

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

CGFS (2016). "Objective-setting and communication of macroprudential policies. Report submitted by a Study Group established by the Committee on the Global Financial System". CGFS Papers 57. Bank for International Settlements.

Cieslak, Anna and Andreas Schrimpf (2019). Non-monetary news in central bank communication. *Journal of International Economics*, vol. 118, pp. 293–315.

Coibion, Olivier, Dimitris Georgarakos, Yuriy Gorodnichenko, and Michael Weber (2020a). Forward guidance and household expectations. NBER Working Paper (26778).

Coibion, Olivier, Yuriy Gorodnichenko, and Saten Kumar (2018). How Do Firms Form Their Expectations? New Survey Evidence. *American Economic Review*, vol. 108 (9), pp. 2671–2713.

Coibion, Olivier, Yuriy Gorodnichenko, Saten Kumar, and Mathieu Pedemonte (2020b). Inflation Expectations as a Policy Tool? *Journal of International Economics*, forthcoming.

Coibion, Olivier, Yuriy Gorodnichenko, and Tiziano Ropele (2019a). Inflation Expectations and Firm Decisions: New Causal Evidence. *Quarterly Journal of Economics*, vol. 135 (1), pp. 165–219.

Coibion, Olivier, Yuriy Gorodnichenko, and Michael Weber (2019b). Monetary Policy Communications and their Effects on Household Inflation Expectations. NBER Working Paper (25482).

Correa, Ricardo, Keshav Garud, Juan M Londono, and Nathan Mislang (2020). Sentiment in Central Banks' Financial Stability Reports. *Review of Finance*, pp. 1572–3097.

Crowne, Douglas P. and David Marlowe (1964). The Approval Motive: Studies in Evaluative Dependence. New York: Wiley.

D'Acunto, Francesco, Daniel Hoang, Maritta Paloviita, and Michael Weber (2020). Effective Policy Communication: Targets versus Instruments. Chicago Booth Research Paper.

D'Acunto, Francesco, Daniel Hoang, Maritta Paloviita, and Michael Weber (2019). IQ, expectations, and choice. NBER Working Paper (25496).

De Quidt, Jonathan, Johannes Haushofer, and Christopher Roth (2018). Measuring and Bounding Experimenter Demand. *American Economic Review*, vol. 108 (11), pp. 3266–3302.

De Quidt, Jonathan, Lise Vesterlund, and Alistair J. Wilson (2019). "Experimenter demand effects". *Handbook of research methods and applications in experimental economics*. Edward Elgar Publishing.

Demirgüç-Kunt, Asli and Harry Huizinga (2004). Market discipline and deposit insurance. *Journal of Monetary Economics*, vol. 51 (2), pp. 375–399.

Deutsches Aktieninstitut (2020). Aktionärszahlen des Deutschen Aktieninstituts 2019.

Diamond, Douglas W. and Philip H. Dybvig (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, vol. 91 (3), pp. 401–419.

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

Ehrmann, Michael and Jonathan Talmi (2019). Starting from a Blank Page? Semantic Similarity in Central Bank Communication and Market Volatility. *Journal of Monetary Economics*, in press.

Eusepi, Stefano and Bruce Preston (2010). Central bank communication and expectations stabilization. *American Economic Journal: Macroeconomics*, vol. 2 (3), pp. 235–271.

Federal Deposit Insurance Corporation (2018). Crisis and Response: An FDIC History, 2008-2013. Federal Deposit Insurance Corporation.

Fernandes, Marcelo, Deniz Igan, and Marcelo Pinheiro (2020). March Madness in Wall Street: (What) Does the Market Learn from Stress Tests? *Journal of Banking and Finance*, vol. 112, in press.

Flannery, Mark, Beverly Hirtle, and Anna Kovner (2017). Evaluating the Information in the Federal Reserve Stress Tests. *Journal of Financial Intermediation*, vol. 29, pp. 1–18.

Forsythe, Robert, Russell Lundholm, and Thomas Rietz (2015). Cheap Talk, Fraud, and Adverse Selection in Financial Markets: Some Experimental Evidence. *Review of Financial Studies*, vol. 12 (3), pp. 481–518.

Furnham, Adrian and Hua Chu Boo (2011). A literature review on the anchoring effect. *The Journal of Socio-Economics*, vol. 40 (1), pp. 35–42.

Gennaioli, Nicola and Andrei Shleifer (2018). A Crisis of Beliefs: Investor Psychology and Financial Fragility. Princeton University Press.

Giglio, Stefano, Matteo Maggiori, Johannes Stroebel, and Stephen Utkus (2019). Five Facts about Beliefs and Portfolios. NBER Working Paper (25744).

Glaser, Markus, Zwetelina Iliewa, and Martin Weber (2019). Thinking about Prices versus Thinking about Returns in Financial Markets. *The Journal of Finance*, vol. 74 (6), pp. 2997–3039.

Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson (2005). Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, vol. 1 (1), pp. 55–93.

Haliassos, Michael and Carol C. Bertaut (1995). Why do so Few Hold Stocks? *Economic Journal*, vol. 105 (432), pp. 1110–1129.

Harris, Richard D. F., Veselin Karadotchev, Rhiannon Sowerbutts, and Evarist Stoja (2019). Have FSRs Got News for You? Evidence from the Impact of Financial Stability Reports on Market Activity. Bank of England Staff Working Papers (792).

Horváth, Roman and Dan Vaško (2016). Central bank transparency and financial stability. *Journal of Financial Stability*, vol. 22, pp. 45–56.

Hurd, Michael, Maarten van Rooij, and Joachim Winter (2011). Stock market expectations of Dutch households. *Journal of Applied Econometrics*, vol. 26 (3), pp. 416–436.

Kahneman, Daniel, Jack L. Knetsch, and Richard H. Thaler (1986). Fairness and the Assumptions of Economics. *Journal of Business*, vol. 59 (4), S285–S300.

Keeley, Michael C (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, pp. 1183–1200.

Kindermann, Fabian, Julia Le Blanc, Monika Piazzesi, and Martin Schneider (2020). Learning about Housing Cost: Survey Evidence from the German House Price Boom. Working Paper.

Kindleberger, Charles P and Robert Z Aliber (2011). Manias, panics and crashes: a history of financial crises. Palgrave Macmillan.

Kleibergen, Frank and Richard Paap (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of Econometrics*, vol. 133 (1), pp. 97–126.

Kryvtsov, Oleksiy and Luba Petersen (2020). Central bank communication that works: Lessons from lab experiments. *Journal of Monetary Economics*, in press.

Kuchler, Theresa and Basit Zafar (2019). Personal Experiences and Expectations about Aggregate Outcomes. *Journal of Finance*, vol. 74 (5), pp. 2491–2542.

Laeven, Luc and Fabián Valencia (2013). Systemic Banking Crises Database. *IMF Economic Review*, vol. 61, pp. 225–270.

Lusardi, Annamaria and Olivia S. Mitchell (2011). "Financial Literacy Around the World: An Overview. *Journal of Pension Economics and Finance*, vol. 10 (4), pp. 497–508.

Mackowiak, Bartosz and Mirko Wiederholt (2015). Business Cycle Dynamics under Rational Inattention. *Review of Economic Studies*, vol. 82 (4), pp. 1502–1532.

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

Mankiw, N. Gregory and Ricardo Reis (2006). Pervasive Stickiness. *American Economic Review*, vol. 96 (2), pp. 164–169.

Mian, Atif and Amir Sufi (2011). House prices, home equity-based borrowing, and the US household leverage crisis. *American Economic Review*, vol. 101 (5), pp. 2132–2156.

Morgan, Donald P., Stavros Peristiani, and Vanessa Savino (2014). The Information Value of the Stress Test. *Journal of Money, Credit and Banking*, vol. 46 (7), pp. 1480–1500.

Mummolo, Jonathan and Erik Peterson (2019). Demand Effects in Survey Experiments: An Empirical Assessment. *American Political Science Review*, vol. 113 (2), pp. 517–529.

Nakamura, Emi and Jón Steinsson (2018). High-Frequency Identification of Monetary Non-Neutrality: The Information Effect. *The Quarterly Journal of Economics*, vol. 133 (3), pp. 1283–1330.

Peterson, Robert A. (2001). On the Use of College Students in Social Science Research: Insights from a Second-Order Meta-analysis. *Journal of Consumer Research*, vol. 28 (3), pp. 450–461.

Public, Kantar (2019). SOEP-Core – 2018: Personenfragebogen, Stichproben A-L3 + N. SOEP Survey Papers.

Roth, Christopher and Johannes Wohlfart (2019). How Do Expectations About the Macroeconomy Affect Personal Expectations and Behavior? *Review of Economics and Statistics*, vol. 102 (4), pp. 731–748.

Schich, Sebastian (2009). Financial crisis: Deposit insurance and related financial safety net aspects. *OECD Journal: Financial Market Trends*, vol. 2008 (2), pp. 1–39.

Schmeling, Maik and Christian Wagner (2019). Does Central Bank Tone Move Asset Prices? CEPR Discussion Paper (13490).

Sims, Christopher A. (2003). Implications of Rational Inattention. *Journal of Monetary Economics*, vol. 50 (3), pp. 665–690.

Svensson, Lars E. O. (2003). Monetary policy and real stabilization. NBER Working Paper (9486).

Tversky, Amos and Daniel Kahneman (1974). Judgment Under Uncertainty: Heuristics and Biases. *Science*, vol. 185 (4157), pp. 1124–1131.

White, Halbert (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*, vol. 48 (4), pp. 817–834.

Woodford, Michael (2005). Central bank communication and policy effectiveness. NBER Working Paper (11898).

Zwane, Alix Peterson, Jonathan Zinman, Eric van Dusen, William Pariente, Clair Null, Edward Miguel, Michael Kremer, Dean S. Karlan, Richard Hornbeck, Xavier Giné, Esther Duflo, Florencia Devoto, Bruno Crepon, and Abhijit Banerjee (2011).

Being Surveyed Can Change Later Behavior and Related Parameter Estimates. *Proceedings of the National Academy of Sciences of the United States of America*, vol. 108 (5), pp. 1821–1826.

10 Appendix

10.1 A: Additional Tables

Table A.1: Missing values

	Missing	Total Obs.	Missing in %
Gender	4	414	0.97
Age	8	414	1.93
Marital status	11	414	2.66
Academic level	6	414	1.45
Risk aversion	0	414	0
Grades	43	414	10.39
Financial literacy	32	414	7.73
Stock ownership	10	414	2.42
Field of studies	8	414	1.93

Note: This table reports the missing values of all control variables that are included in the analysis for which respondents had the option to skip or to refuse to answer on an item-by-item basis. Financial literacy is an aggregate measure for respondents who did not answer at least one of the three questions therein.

Table A.2: Test of equality for main variables

	Full Sample	Control	T^{GW}	T^{EWI}	P-value
A: Crisis beliefs					
$Pr(crisis)^{pre}$	36.54	36.13	38.39	35.50	0.637
	(23.77)	(23.89)	(24.62)	(22.82)	
$Pr(crisis)^{post}$	38.63	35.36	40.70	42.58	0.023
	(23.96)	(23.65)	(23.62)	(24.23)	
$\Delta\, Pr(crisis)$	2.09	–0.77	2.30	7.08	0.000
	(9.52)	(6.91)	(9.45)	(11.46)	
B: Investment share					
Inv. share^{pre}	53.28	53.73	51.09	54.55	0.695
	(31.45)	(31.81)	(29.79)	(32.51)	
Inv. share^{post}	50.44	52.96	45.81	50.29	0.176
	(31.81)	(31.67)	(30.43)	(33.11)	
Δ*Inv. share*	–2.84	–0.77	–5.28	–4.25	0.044
	(16.50)	(17.41)	(15.04)	(15.79)	
C: Return expectations					
$E(R)^{pre}$	1.39	1.63	1.27	1.08	0.646
	(5.24)	(5.38)	(4.66)	(5.51)	
$E(R)^{post}$	1.05	1.63	0.76	0.28	0.110
	(5.63)	(5.63)	(5.12)	(6.01)	
$\Delta E(R)$	–0.34	–0.01	–0.51	–0.79	0.012
	(2.33)	(1.87)	(2.72)	(2.60)	
D: Savings share					
Savings share^{pre}	58.51	58.30	58.16	59.24	0.963
	(32.66)	(33.06)	(30.68)	(34.03)	
Savings share^{post}	54.77	58.37	53.80	49.17	0.060
	(33.03)	(32.89)	(31.37)	(34.26)	
Δ*Savings share*	–3.75	0.07	–4.36	–10.06	0.000
	(14.42)	(8.23)	(12.71)	(21.05)	
Observations	414	199	105	110	

Note: Means of continuous variables reported. Standard errors in parentheses. The p-value features the one-way ANOVA test of equality of each row variable across the three groups (Control, GW, EWI).

Table A.3: Bayesian updating of crisis beliefs - unpooled treatment groups

Dependent variable: $\Delta Pr(crisis)_i$ *(pp)*

	General Warning Treatment (GW)				Early Warning Indicator Treatment (EWI)			
	Categorical Gap-measure		Binary Gap-measure		Categorical Gap-measure		Binary Gap-measure	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment (T_i)	-4.955	-6.813	0.325	-0.218	-5.630	-3.762	2.394	4.542
	(7.156)	(5.781)	(5.263)	(4.210)	(5.558)	(4.976)	(3.251)	(2.763)
Gap (G_i)	-2.791	-2.195	-5.787	-3.480	-3.346	-2.195	-7.770**	-3.480
	(1.925)	(1.547)	(3.591)	(2.583)	(2.204)	(1.547)	(3.793)	(2.582)
Confidence (C_i)	-0.062	-0.046	-0.034	-0.025	-0.051	-0.046	-0.023	-0.025
	(0.045)	(0.037)	(0.027)	(0.023)	(0.049)	(0.037)	(0.028)	(0.023)
$T_i \times G_i$	5.154	6.520**	5.731	6.406	11.372***	9.345**	23.268***	13.712*
	(3.874)	(3.056)	(7.727)	(5.875)	(4.067)	(3.905)	(8.134)	(7.320)
$T_i \times C_i$	0.099	0.100	0.045	0.040	0.149*	0.131*	0.057	0.035
	(0.098)	(0.079)	(0.072)	(0.059)	(0.080)	(0.071)	(0.051)	(0.043)
$G_i \times C_i$	0.040	0.027	0.084*	0.046	0.043	0.027	0.106**	0.046
	(0.027)	(0.021)	(0.050)	(0.036)	(0.031)	(0.021)	(0.052)	(0.036)
$T_i \times G_i \times C_i$	-0.055	-0.057	-0.070	-0.047	-0.139**	-0.105**	-0.302**	-0.152
	(0.053)	(0.041)	(0.105)	(0.081)	(0.056)	(0.053)	(0.117)	(0.105)
Constant	0.524	2.733	-0.668	0.891	-2.048	2.733	-4.449	0.891
	(5.072)	(2.550)	(4.459)	(1.472)	(5.120)	(2.550)	(4.591)	(1.472)
Demographics	Yes	No	Yes	No	Yes	No	Yes	No
Economic knowledge	Yes	No	Yes	No	Yes	No	Yes	No
R^2	0.10	0.07	0.09	0.05	0.29	0.19	0.29	0.18
N	241	304	241	304	243	309	243	309

Note: The table shows OLS estimates based on Equation 3 for each of the two treatments T_i^{GW} (columns 1-4) and T_i^{EWI} separately. *Treatment* expresses the effect of the respective treatment relative to the control group. The Gap_i parameter is based on the perception gap regarding the past development of the likelihood of a financial crisis over the past few years, which is elicited on a qualitative 1-5 scale, where 1 equals "increased considerably" and 5 "decreased considerably". Both treatments state that the risks increased considerably (equivalent to category 1). In columns 1-2 and 5-6, Gap_i is then computed as the distance between the perceived past development of the likelihood of a financial crisis and the description that risks to financial stability increased considerably (past perception - 1). In columns 3-4 and 7-8, Gap_i is coded as a binary indicator that equals one for all individuals with a perception gap of a size larger than one, and zero otherwise. $Confidence_i$ measures on a scale from 0 to 100 percent how confident respondent i is in her crisis belief. *Demographics* contains individual-specific controls (gender, age group, not married, academic level, above-median risk aversion, and above-median grading). *Economic background* includes indicators for high levels of financial literacy, stock ownership, and being a business or economics student. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

Table A.4: Heterogeneity in treatment effects - unpooled treatment groups

Dependent variable: $\Delta Pr(crisis)_i$ *(pp)*

	Aggregate	By stock ownership		By field of studies		By grades		By gender		By risk aversion	
		None	Some	Others	Economics	good	poor	Female	Male	Low	High
A: TE											
T_i^{GW}	3.24***	5.51***	1.00	6.88***	1.36	2.27	4.98***	4.90***	1.56	2.76*	3.53***
	(1.01)	(1.50)	(1.44)	(2.33)	(0.98)	(1.50)	(1.46)	(1.57)	(1.28)	(1.56)	(1.33)
T_i^{EWI}	7.81***	10.09***	5.49***	10.96***	6.42***	6.45***	8.99***	14.23***	3.99***	4.45***	10.29***
	(1.19)	(1.60)	(1.83)	(2.38)	(1.38)	(1.64)	(1.89)	(2.20)	(1.21)	(1.64)	(1.62)
N	414	191	213	117	289	187	184	181	229	174	240
B: EM											
T_i^{GW}	0.09	0.11	0.10	0.07	0.08	0.02	0.16*	0.14	0.06	-0.04	0.16**
	(0.06)	(0.09)	(0.09)	(0.11)	(0.07)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)
T_i^{EWI}	0.20***	0.29***	0.14*	0.19*	0.19***	0.23***	0.20**	0.40***	0.12	0.13	0.26***
	(0.06)	(0.08)	(0.08)	(0.10)	(0.07)	(0.09)	(0.09)	(0.07)	(0.08)	(0.09)	(0.07)
N	414	191	213	117	289	187	184	181	229	174	240
C: IM											
T_i^{GW}	5.93***	10.50***	1.34	9.59***	3.01	4.58	8.75***	7.77***	3.16	6.05*	6.71***
	(1.83)	(2.77)	(2.65)	(3.45)	(2.04)	(2.93)	(2.48)	(2.54)	(2.51)	(3.43)	(2.07)
T_i^{EWI}	12.07***	15.54***	8.53***	14.07***	10.63***	9.31***	14.58***	16.51***	7.39***	7.71**	14.84***
	(1.77)	(2.48)	(2.92)	(3.04)	(2.23)	(2.41)	(2.90)	(2.60)	(2.28)	(2.97)	(2.14)
N	225	108	110	80	141	100	102	114	110	82	143

Note: Panel A presents the average effects of the individual treatments for selected subsamples, which are split along binary individual-specific characteristics of respondents (dummies on respondents' stock ownership, field of studies, grades, gender and risk aversion). The parameters are expressed relative to the average effects of the specific subgroup which is allocated into the control group. Panel B displays the extensive margin of the treatment effects. Panel C contains the intensive margin of treatment effects. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

Table A.5: Causal effects of financial stability beliefs - alternative instrument

	Δ Inv. share		$\Delta E(R)$		Δ*Savings share*	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Pr(crisis)_i$	-0.40	-0.47**	-0.13***	-0.11***	-1.31***	-1.29***
	(0.27)	(0.22)	(0.04)	(0.04)	(0.27)	(0.27)
$Pr(crisis)_i^{pre}$	-0.16***	-0.17***	-0.02**	-0.02**	-0.11***	-0.13***
	(0.05)	(0.04)	(0.01)	(0.01)	(0.04)	(0.04)
$Inv.share_i^{pre}$	-0.16***	-0.14***				
	(0.04)	(0.03)				
$E(R)_i^{pre}$			-0.07*	-0.05		
			(0.04)	(0.03)		
$Savings\ share_i^{pre}$					-0.10***	-0.12***
					(0.03)	(0.03)
Constant	8.82	11.77***	0.05	0.60*	12.26*	10.29***
	(7.28)	(2.76)	(1.17)	(0.34)	(7.34)	(2.72)
Initial corner solution	Yes	No	No	No	Yes	No
Demographics	Yes	No	Yes	No	Yes	No
Economic knowledge	Yes	No	Yes	No	Yes	No
N	331	414	331	414	331	414
$First\ stage\ F-Stat$	17.76	23.44	17.39	23.14	17.48	23.42

Note: The table presents alternative IV estimates of Equation 4, (columns 1-2), Equation 10 (columns 3-4) and Equation 14 (columns 5-6). The two treatment group dummies (T_i^{GW}, T_i^{EWI}) are used individually as instruments. *Initial corner solution* is a dummy variable that indicates whether respondents have an extreme (0 or 100%) asset (columns 1-2) or savings allocation (columns 5-6) prior to the treatment. Asterisks ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are reported in parentheses.

10.2 B: Variable Description

Table A.6: Variable description

Name	Description	Based on question
	Main variables	
Pr(crisis)	A point estimate of a respondent's perceived likelihood of a financial crisis occurring in Germany within the next two years (by the end of November 2021). The variable is elicited as a percentage point on a scale from 0 to 100.	pre-treatment: [PR04, PR06] and post-treatment: [PT03, PT04]
Gap	A qualitative measure, describing the intensity of the shock to a respondent's perception of the past development of the *crisis* probability. Scaled from 0 - 4, where 0 indicates no perception gap and 4 a substantial shock regarding the historical crisis probability development.	pre-treatment: [PR23]
Confidence	A measure describing a respondent's confidence in her *crisis* estimate. The variable is expressed in percentage points and is defined on the interval [0,100].	pre-treatment: [PR05, PR16]
Inv. share	The variable denotes the imputed fraction, defined on the interval [0,100], of the total amount allocated to the risky asset within a hypothetical standard portfolio choice problem, where individuals invest either in the stock market (DAX) or a risk-less asset. $Inv.share_i^{pre,post} \equiv \frac{Inv.\ risky\ asset_i^{pre,post}}{Total\ Endowment}$	pre-treatment: [PR11] and post-treatment: [PT11]
E(R)	Derived from a point estimate of the expected future level of the German stock market index (DAX) in two years, at the end of November 2021. Based on that value, the annualized rate of return is computed as:[21] $E\left(R_{t+2}\right)_i^{pre,post} \equiv \left[\frac{E\left(DAX_{t+2}\right)_i^{pre,post}}{DAX_t}\right]^{\frac{1}{2}} - 1$	pre-treatment: [PR08] and post-treatment: [PT05]

[21] The German stock market index DAX is a total return index. Respondents were asked to provide an estimate of the level of the DAX in two years (November 2021). Before eliciting their estimate of the future level, respondents are informed that the DAX had a value of around 13,000 points at the end of November 2019. We transform their answer into the implied annualized rate of return relative to this initial level.

. . . continued

Name	Description	Based on question
Savings share	The variable denotes the imputed fraction, defined on the interval [0,100], of the total amount allocated to the more risky bank branch A within a hypothetical portfolio choice problem, where the expected rate of return depends on *Pr(crisis)*.	pre-treatment: [PR18] and post-treatment [PT12].
Upper tail	The perceived chance of an upper-tail stock market scenario. The scenario states that the DAX closes in two years more than 3,000 points above the November 2019 level (implied annualized rate of return of around +12%).	post-treatment: [PR14]
Lower tail	The perceived chance of a lower-tail stock market scenario. The scenario states that the DAX closes in two years more than 3,000 points below the November 2019 level (implied annualized rate of return of around -11%).	post-treatment: [PR15]
	Demographics	
Male	A dummy variable that equals one if the respondent reports to identify as male, zero otherwise. Respondents who identify as non-binary are consequently added to the female category.	pre-treatment: [SD01]
Age group	A categorical variable, for age groups of "<18", "18-20", "21-23", "24-26","27-29", and ">30".	post-treatment: [SD02]
Not married	A dummy variable that equals one if a respondent reports that she is not or has not been married, zero otherwise.	post-treatment: [SD21]
Academic level	A categorical variable, which indicates whether the respondent is enrolled in a Bachelor's program (or equivalent), a Master's programm (or equivalent), or a Ph.D. program (or equivalent).	post-treatment: [ST01]

. . . continued

Name	Description	Based on question
Above-median risk aversion	A dummy variable based on a sample split along the self-reported level of risk aversion, on a qualitative scale of 0 to 10, where 0 indicates "risk-averse" and 10 "fully prepared to take on risks". The question is taken from the SOEP survey (see, e.g. Public, 2019). The variable equals one if a respondent's reported risk aversion is at or above the median, zero otherwise.	pre-treatment: [CN02]
Above-median grading	A dummy variable based on a sample split along the self-reported average grades of students according to the German grading system. Grades are elicited in seven buckets (1.0-1.5, 1.5-2.0, ..., 3.5-4, >4). The variable equals one if a respondent's reported grades are higher than the median grade, zero otherwise.	post-treatment: [ST03]
	Economic knowledge	
High financial literacy	A dummy variable based on a respondent's understanding of three basic economic concepts (compounding interest, inflation, diversification). The dummy variable equals one for respondents who answer all questions correctly, zero otherwise.	post-treatment: [CN03, CN04, CN05]
Stockholder	A dummy variable that equals one if a respondent self-reports holding some form of equity (stock, equity options, mutual funds, ETF).	post-treatment: [CN06_05]
Economics/ Business studies	A dummy variable that equals one if the respondent is enrolled in a business or economics program	post-treatment: [ST05]

Note: This table summarizes all the variables applied in this paper. All variables are elicited from the self-developed survey (c.f. appendix C).

10.3 C: Survey

Appendix C presents a printout of the English version of the survey.

Thank you for participating in this online survey!

We would like to ask you about your expectations regarding the German financial system and its stability. The survey is conducted as a part of a master thesis project. It will take approximately 20 minutes to complete the survey.

Most questions have no right or wrong answer – we are interested in your personal views. Your answers will be treated confidential. It is very important to us that you answer the questions very carefully. If you cannot or do not want to answer a question, click “Next”, until a new question pops up.

Best regards

Valentin Stockerl

Important advice:

- Please use the **"Next"** button at the bottom of the question. Please do not use the navigation symbols of your browser or the **"Return"** button of your mobile device.
- You should use the most recent version of your browser (e.g. Google Chrome, Mozilla Firefox, Opera, Microsoft Edge, Safari). The user-friendliness of the survey can be impaired when using older browser versions (especially Internet Explorer 8 and earlier).
- For an optimized visualization of the survey, you need to activate Javascript in your browser.

In case you run into some problems or have comments regarding the content, useability and design of the survey, please do not hesitate to contact us via [redacted].

Next

Data Privacy

The collected data will be used for the sole purpose of academic, not-for-profit research.The obtained data will be anonymized before it is saved and processed such that it cannot be linked to any personal information.

By participating in this survey you agree that your data will be saved, processed and used for research purposes.

If you have any questions, comments or remarks, please contact [redacted].

I agree that the data will be saved, processed and used for research purposes.

- ○ Yes
- ○ No

Next

Which of these describe you more accurately?

- ○ female
- ○ male
- ○ diverse
- ○ Choose not to answer

Next

To begin with, we would like you to conduct an evaluation of yourself: are you in general a more risk taking (risk prone) person, or do you try to avoid risks (risk-averse)?

Please tick a box on the scale, where the value of 0 means risk averse and the value 10 means fully prepared to take risks (risk prone)

- ○ 0 (risk averse)
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (fully prepared to take on risks)

- ○ Choose not to answer

Next

We would like to introduce some concepts to you that are important for the following questions.

Please review the information carefully.

Next

Probabilities

In some of the following questions, we will ask you to think about the percent chance of something happening in the future. Your answers can range from **0 to 100,** where 0 means there is *absolutely no chance*, and 100 means that it is absolutely certain.

For example, numbers like:

- 2 and 5 percent may indicate "almost no chance";
- 18 percent or so may mean "not much chance";
- 47 or 52 percent chance may be a "pretty even chance";
- 83 percent or so may mean a "very good chance";
- 95 or 98 percent chance may be "almost certain".

Next

We would like to ask you about your view regarding the **future development of the German stock market**. The questions will ask you about the DAX, a stock index which summarizes the development of the 30 biggest German companies.

Stock Market Expectations

The German stock market index (DAX) stood at around 13,000 points on 11/30/2019. What do you think will be the level of the stock market index in 2 years on the 11/30/2021?"

Please round your answer to a full point. An increase (decrease) of 260 points is equivalent to around +1% (-1%) annual return.

On 11/30/2021, the DAX will stand at... [14000] points.

Next

Your answer of **14000 points** indicates an annual **increase of 3.77 %** (= return).

Are you sure you want to proceed?

If you want to change your answer, please press the "Back" button. Otherwise please continue by clicking "Next".

Back Next

Investment Decision

Consider a situation where you decide to invest **5000 €** for 2 years. You can invest the money in two different assets:

- **Asset A**: A bundle of stocks that pays an annual return equal to the development of the German stock market index (DAX).
- **Asset B** pays a fixed 1% annual return.

Please indicate the exact amount you would invest in each asset.

You have to distribute the exact amount of 5000 € before you can continue with the survey.

Asset A		€
Asset B		€
Total Amount	0	€

Next

Financial Crisis

A financial crisis is a severe disruption to the functioning of the financial system, which comprises financial intermediaries (banks, pension funds, insurance companies etc.) and markets (market for stocks, bonds etc.). A financial crisis is often associated with an overall decline in economic activity and higher unemployment. In a financial crisis, a large part of the banking sector is in distress, businesses and consumers are increasingly unable to pay their debts, and there is a sharp fall in the stock market and other asset prices (e. g. real estate).

What do you think is the probability that a "financial crisis" will occur within the next 2 years in Germany?

Please give your best guess.

0% (certainly not) —— 100% (absolute certainty)

Next

How sure are you about your answer to the previous question regarding the likelihood of a financial crisis?

0% (absolutely uncertain) —— 100% (absolute certain)

Next

What do you think: How did this probability develop in the past 5 years?

Over the past 5 years, the probability of a financial crisis in Germany in the next 2 years...

- ○ strongly increased
- ○ somewhat increased
- ○ remained at the same level
- ○ somewhat decreased
- ○ strongly decreased

Next

Saving Decision

Consider a situation where you decide to deposit **5000 €** for 2 years. You can allocate the money across the saving accounts of two different branches of the same bank:

- **Branch A** pays a fixed 3% interest rate per year. If there is a financial crisis, you will get back *three quarters of your deposits*.
- **Branch B** pays a fixed 0.25% interest rate per year. If there is a financial crisis, you are *guaranteed* to get the *deposit back in full*.

Please indicate the exact amount you would deposit into each savings account.

You have to distribute the exact amount of 5000 € before you can continue with the survey.

Branch A		€
Branch B		€
Total Amount	0	€

Next

We now would like to provide you with an assessment by Deutsche Bundesbank regarding the current state of the German financial system.

The following information is derived from the "Financial Stability Review 2019" by Deutsche Bundesbank which was published on the 11/21/19.

The vulnerability of the German financial system has increased considerably in the past few years. Future credit risks may potentially be underestimated and the value of collateral like real estate overestimated.

Note: Please review the information *carefully*. You will be able to go to next page after you have spent at least 15 seconds on this page.

13 Sek.

We now would like to provide you with an assessment by Deutsche Bundesbank regarding the current state of the German financial system.

The following information is derived from the "Financial Stability Review 2019" by Deutsche Bundesbank which was published on the 11/21/19.

The early warning indicator of Deutsche Bundesbank provides information on how the current situation compares to the developments that typically preceded previous financial crises. An increase in the indicator suggests that the estimated likelihood of a financial crisis in Germany within the next 1-3 years has risen.

The early warning indicator for financial crises has been rising sharply for several years.

Note: Please review the information *carefully*. You will be able to go to next page after you have spent at least 15 seconds on this page.

12
Sek.

Stock Market Expectations

We would like to ask you about your personal assessment of two future scenarios. Please indicate the percent chance for each event. Each value must lie between 0 and 100 %.

How likely do you think is it that the German stock index DAX will be above 16,000 points by 11/30/2021?

*On 11/30/2019, the German stock index DAX stood at around 13.000 points. An increase of 3,000 points indicates an **annual return of +11%**.*

Please give your best guess. ☐

0% (certainly not) ——————— 100% (absolute certainty)

How likely do you think is it that the German stock index DAX will be below 10,000 points by 11/30/2021?

*On 11/30/2019, the German stock index DAX stood at around 13,000 points. A decrease of 3,000 points indicates an **annual return of -12%**.*

Please give your best guess. ☐

0% (certainly not) ——————— 100% (absolute certainty)

Next

Since you had more time to deliberate, we wonder whether your positions have changed. We would therefore like to briefly **ask again some of the previous questions**.

Next

What do you think is the probability that a "financial crisis" will occur within the next 2 years in Germany?

Please give your best guess. ☐

0% (certainly not) ——————— 100% (absolute certainty)

Next

Investment Decision

Consider a situation where you decide to invest **5000 €** for 2 years. You can invest the money in two different assets:

- **Asset A**: A bundle of stocks that pays an annual return equal to the development of the German stock market index (DAX).
- **Asset B** pays a fixed 1% annual return.

Please indicate the exact amount you would invest in each asset.

You have to distribute the exact amount of 5000 € before you can continue with the survey.

Asset A		€
Asset B		€
Total Amount	0	€

Next

Saving Decision

Consider a situation where you decide to deposit **5000 €** for 2 years. You can allocate the money across the saving accounts of two different branches of the same bank:

- **Branch A** pays a fixed 3% interest rate per year. If there is a financial crisis, you will get back *three quarters of your deposits.*
- **Branch B** pays a fixed 0.25% interest rate per year. If there is a financial crisis, you are *guaranteed* to get the *deposit back in full.*

Please indicate the exact amount you would deposit into each savings account.

You have to distribute the exact amount of 5000 € before you can continue with the survey.

Branch A		€
Branch B		€
Total Amount	0	€

Next

Financial market expectations

The German stock market index (DAX) stood at around 13,000 points on 11/30/2019. What do you think will be the level of the stock market index in 2 years on the 11/30/2021?"

Please round your answer to a full point. An increase (decrease) of 260 points is equivalent to around +1% (-1%) annual return.

On 11/30/2021, the DAX will stand at... 14500 points.

Next

Your answer of **14500** indicates an annualized **increase of 5.61 %.**

Are you sure you want to succeed?

If you want to change your answer, please press the "Back" button. Otherwise please continue by clicking "Next".

Back Next

The next section of the questionnaire is more like a **quiz**. The questions are not designed to catch you out, so if you think you have the right answer, you probably do. If you don't know the answer, just say so.

Suppose you had 100 € in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- ○ More than 102 €
- ○ Exactly 102 €
- ○ Less than 102 €
- ○ Do not know

Next

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

- ○ More than today
- ○ Exactly the same
- ○ Less than today
- ○ Do not know

Next

Please tell me whether you agree or disagree with the following statement:

"Buying a single company's stock usually provides a safer return than a stock mutual fund."

- ○ Yes
- ○ No
- ○ Do not know

Next

At the end of the survey, we would like to get a better understanding of you as a person.

What is your marital status?

Not married	Divorced	Widowed
Married	Separated	

Choose not to answer

Next

Do you own any of the following savings or investment securities?

Please select all items that apply.

- ☐ Savings account (Spargirokonto/Tagesgeldkonto)
- ☐ Savings plan to build a home (Bausparvertrag)
- ☐ Life insurance
- ☐ Fixed-interest securities (e.g., saving bonds, mortgage bonds, federal savings bonds)
- ☐ Other securities (e.g., stocks, funds, ETF, bonds, equity options)
- ☐ Company assets (in your own company, other companies)

- ☐ None of the above
- ☐ Choose not to answer

Next

The last few questions are designed for students that are currently enrolled at a German university in an undergraduate, graduate or post-graduate program. Are you a student at a German university?

I am

- ○ a student at a German university.
- ○ not a student at a German university.

Next

How old are you?

Please select the category that is most appropriate.

- ○ below 18
- ○ 18-20
- ○ 21-23
- ○ 24-26
- ○ 27-29
- ○ 30 and above

- ○ Choose not to answer

Next

Which university do you attend?

Next

What is the degree level you are currently enrolled at?

Undergraduate (Bachelor)	Graduate (Master)	Post-Graduate (PhD)

Choose not to answer

Next

What is your field of study?

- ○ Education
- ○ Humanities and Arts
- ○ Social sciences and law (excluding business and economics)
- ○ Science
- ○ Engineering, manufacturing and construction
- ○ Agriculture
- ○ Health and welfare
- ○ Services
- ○ Other
- ○ Business and economics

- ○ Choose not to answer

Weiter

What have most of your grades been up to in your enrolled program?

In case your program uses a different grading system, please transfer your grade correspondigly onto the German scale.

- ○ < 1.5 (very good)
- ○ 1.5 – 2 (good)
- ○ 2 – 2.5 (good)
- ○ 2.5 – 3 (satisfactory)
- ○ 3 – 3.5 (satisfactory)
- ○ 3.5 – 4 (sufficient)
- ○ > 4.0 (insufficient/failed)

- ○ Choose not to answer

Next

Thank you for completing this questionnaire!

We would like to thank you very much for helping us.

Your answers were transmitted, you may close the browser window or tab now.