

THE JOINT DYNAMICS OF INVESTOR BELIEFS AND TRADING DURING THE COVID-19 CRASH

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Abstract

We analyze how investor expectations about economic growth and stock returns changed during the February-March 2020 stock market crash induced by the COVID-19 pandemic, as well as during the subsequent partial stock market recovery. We surveyed retail investors who are clients of Vanguard at three points in time: (i) on February 11-12, around the all-time stock market high, (ii) on March 11-12, after the stock market had collapsed by over 20%, and (iii) on April 16-17, after the market had rallied 25% from its lowest point. Following the crash, the average investor turned more pessimistic about the short-run performance of both the stock market and the real economy. Investors also perceived higher probabilities of both further extreme stock market declines and large declines in short-run real economic activity. In contrast, investor expectations about long-run (10-year) economic and stock market outcomes remained largely unchanged, and, if anything, improved. Disagreement among investors about economic and stock market outcomes also increased substantially following the stock market crash, with the disagreement persisting through the partial market recovery. Those respondents who were the most optimistic in February saw the largest decline in expectations, and sold the most equity. Those respondents who were the most pessimistic in February largely left their portfolios unchanged during and after the crash.

JEL Codes: G11, G12, R30.

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Competing interests: Stephen Utkus is employed at Vanguard in a research capacity. Giglio, Maggiori, and Stroebe are unpaid consultants at Vanguard in order to access the anonymized data. Vanguard provided anonymized portfolio and survey data as well as survey research services for this project.

Data Availability: All code and aggregated data will be available upon publication on the PNAS website as well as the corresponding author's website at www.matteomaggiori.com. Individual level data and other disaggregated data cannot be shared due to a non-disclosure agreement.

The dynamics of beliefs play a central role in macroeconomics and finance. As a result, analyzing how beliefs vary with changes in the economic environment and how they affect investment choices is important for understanding asset markets and real economic activity. This paper offers a unique picture of the joint dynamics of beliefs and trading during a time of severe market distress, for a relevant set of market participants: retail investors who are clients of Vanguard, one of the world's largest asset managers. To conduct this analysis, we field a large-scale survey to elicit Vanguard investors' beliefs about future economic growth and stock market returns before, during, and after the stock market crash of March 2020, which was triggered by the COVID-19 pandemic. We then describe the evolution of beliefs and disagreement, as well as the relationship between beliefs and investors' trading activity during this period.

This paper is part of an ongoing project that we launched in 2017 in collaboration with Vanguard, with the aim of deepening our understanding of expectations in macroeconomics and finance, and to provide insight into the relationship between beliefs and portfolio decisions (see 1, for details).¹ The heart of this project is a newly-designed survey, the GMSU-Vanguard survey, that elicits beliefs central to macro-finance. These beliefs include expected stock returns and expected GDP growth in both the short run and the long run, as well as respondents' perceived probabilities of economic and stock market disasters. In this paper, we explore three waves of the survey from early 2020. The first wave was administered in mid-February, near the peak of the U.S. stock market; the second wave in mid-March, after the U.S. stock market had declined by about 20% from its peak; and the third wave was administered in mid-April, after the stock market had rallied by 25% from its low point (though it was still about 17% below its peak).

We find that average beliefs about stock returns over the next year turned substantially more pessimistic following the stock market crash; average expectations of GDP growth over the short-term (the next 3 years) also declined, although only moderately. Average expectations of short-run disaster probabilities in stock returns and GDP growth, defined respectively as a stock market drop of 30% or more in the next year and annual real GDP growth of less than -3% over the next 3 years, both spiked during this episode. On the other hand, long-term expectations of GDP growth and stock returns over the next 10 years remained stable or even increased somewhat.

The dispersion of beliefs across investors, often referred to as disagreement, increased substantially during the crash. Interestingly, the beliefs of optimists and pessimists, classified according to their pre-crash beliefs, moved in substantially different ways during this period. Overall, the vast majority of investors became more pessimistic about the short-run outlook of the stock market. However, among those investors who were relatively pessimistic before the crash (i.e., those who, in February, were expecting negative 1-year stock market returns), about half actually revised their expectations upwards in the March and April survey waves.

An important feature of our study is the ability to match survey responses to the respondents' portfolios and daily trading activity at Vanguard. This allows us to conduct a "high-frequency" study of the relationship between beliefs and investment decisions at the individual level. February and March 2020 were periods of elevated trading activity both at Vanguard and more generally

¹Vanguard administers the survey and owns the resulting data. The academic researchers are allowed to analyze the data for research purposes under a non-disclosure agreement. The research was deemed not human subjects research (Harvard IRB15-1792).

in the markets. Consistent with the findings of (1), we show that, before the crash, respondents who were more optimistic about stock market returns had a higher fraction of their portfolio invested in equity, though the differences were smaller in magnitude than those predicted by benchmark frictionless asset pricing models. We document that when the crash occurs at the end of February, Vanguard clients in our sample rebalanced their portfolios away from equities. Those investors who were ex-ante more optimistic sell more equity immediately after the crash. Those investors who were initially more pessimistic keep their portfolios largely unchanged. The trading decisions, therefore, align closely with the differential belief dynamics for initial optimists and pessimists. From a quantitative perspective, the magnitude of trading was smaller than predicted by frictionless asset pricing models, again confirming the results in (1) over this particular period.

The aim of this paper is to document these patterns in the data. We take no stance on whether the expectations measured by our survey are rational or include behavioral elements, or whether the trading decisions that we document were optimal. In Section III we review the main qualitative implications of our findings for asset pricing models; we conclude that the joint dynamics of prices, trading, and beliefs are hard to reconcile with a number of leading asset pricing models. While it is important to acknowledge that each stock market crash has a number of idiosyncratic elements, we believe that focusing on even just one large shock such as the one studied in this paper can be informative for asset pricing theories. Indeed, the dynamics of individual and aggregate expectations after large shocks are a central element of many models of macroeconomics and finance.² This makes it imperative to study these shocks in detail when they occur, in particular because they are so rare. For example, both the Great Recession and the Global Financial Crisis — each of them a specific event with its idiosyncratic components — have spurred large literatures that have advanced our understanding of economics and finance. As a result, we believe that our findings, which rely on newly available panel data on beliefs and portfolios, have the potential to contribute a new important moment that can be used to develop, calibrate, and evaluate different models, especially models that feature rare disasters or belief heterogeneity.

I BRIEF SURVEY DESCRIPTION

We explore responses to three waves of the GMSU-Vanguard survey. This survey elicits the beliefs of Vanguard investors about expected stock returns and expected GDP growth in both the short run and the long run, as well as investors' perceived probabilities of economic and stock market disasters. The SI Appendix presents the full survey flow and the exact wording of the various questions. The survey has been administered to retail and retirement clients of Vanguard every two months since February 2017.³ The surveyed population is one that is relevant for understanding financial markets: retail investors with substantial investments in both equity and fixed

²In the wake of the COVID-19 crisis there is a wave of interesting work measuring expectations with different approaches (see, for example, 2; 3).

³The sample selection rules are described in (1), and we encourage the reader to refer to that paper for more background information on the survey. The only difference to the sample selection approach described in (1) and the one used for the present study is that the flash survey in March 2020 did not add newly selected clients that had never been contacted before by our study. This is consistent with the focus in this article on within-individual changes in beliefs between February and April 2020.

income products. The median respondent has 225,000 USD invested with Vanguard — 70% in equity instruments and 15% in fixed income instruments — and is approximately 60 years of age. (1) provides more detailed summary statistics on the investor population sampled by this survey.

As part of our ongoing project, a regular survey was administered on February 11th, 2020, which turned out to be almost exactly the pre-crisis all-time high in the U.S. stock market. At this time, the COVID-19 outbreak in China had already occurred, but its implications had not yet been widely reported or understood. This survey wave therefore offers us a measure of investor beliefs before the subsequent crash. After one of the longest and most pronounced stock market booms on record during 2009-2019, the U.S. stock market then experienced a sudden crash starting on Monday, February 24th. By March 11th, the S&P 500 index had dropped 19.2% from its previous high. On that day, the financial press announced that U.S. stock markets had entered "bear market territory," commonly defined as a drop in value of 20% or more from the high point. Following these dramatic market events, we fielded an unscheduled flash survey on March 11th, 2020, at 6pm EDT, after the close of the market.⁴ After this survey wave, the market fell further, bottoming out at 34% below its peak on March 23, 2020. On April 16th, we fielded another one of the project's regular bi-monthly survey waves. By that date, the stock market had rallied by 25% from its lowest point, though it was still about 17% below its February peak. By this time, newspapers had devoted substantial coverage to the impacts of COVID-19 on the real economy. Figure I shows the dynamics of the S&P 500 index during the this period, as well as the exact timing of our surveys. Our regular survey obtains approximately 2,000 responses per wave, with the majority of responses coming from people who responded to previous waves. The February wave obtained 2,374 responses. The March wave obtained 1,864 responses, and 484 of those responses came from individuals who had also responded to the February wave.⁵ The April wave obtained 2516 responses, and 715 of those responses came from investors who responded to the February wave.

II BELIEF DYNAMICS AND TRADING OVER THE COVID-19 CRASH

Dynamics of Average Beliefs. We begin by documenting the patterns of average beliefs in the data. Figure II shows the time series of average beliefs across all our respondents for the entire period covered by our survey.⁶ Panel A shows the 1-year expected stock market return, Panel B the 10-year expected annual stock market return, Panel C the expected annual real GDP growth over the next three years, Panel D the expected annual real GDP growth over the next ten years,

⁴When we started the GMSU-Vanguard survey, we had anticipated that one of the most interesting questions was how beliefs would change during an economic crisis or a large stock market crash. We had therefore designed the administration of the survey to be able to launch additional flash surveys at short notice following such events. This paper is the outcome of this pre-planned contingent survey administration.

⁵Response rates vary on average between 4% for newly contacted people to above 10% for those who have already responded once. (1) discuss various dimensions of selection bias in who answers the survey.

⁶Similar to (1), we set extreme outlier answers (i.e., responses below the bottom percentile or above the top percentile) for each unbounded expectation question equal to missing. Naturally, there are some critical judgment calls involved in selecting these cutoffs, which involve trading-off retaining true extreme beliefs with excluding answers from individuals who probably misunderstood the question or the units of measurement. (1) conducted extensive sensitivity analysis to confirm that results are robust to a wide range of choices for the cutoff values. We also confirmed that the results are robust to winsorizing extreme answers rather than setting them equal to missing, and to dropping all answers of individuals who report extreme answers to at least one question.

Panel E the probability of stock market disaster (defined as a decline of more than 30% within the next year), and Panel F the probability of a GDP disaster (defined as average annual GDP growth of less than -3% over the next three years).

Many of the panels in Figure II show large changes in beliefs in the two survey waves following the stock market crash, changes of a magnitude not observed in the previous two years. Specifically, in the two years before the crash, expectations about 1-year stock market returns had ranged between 3% and 6%, and were at the high end of that range in February 2020. The crash brought them down to the 1% to 2% range. This pessimism about short-run market returns was not accompanied by pessimism about long run returns of the stock market. Indeed, expected annual stock market returns over the next ten years actually increased modestly after the crash, from 6.9% per year to 7.2% per year.

Panel C of Figure II shows that average expectations of real GDP growth over the next 3 years moved from 2.8% to 2.2% following the crash.⁷ Similar to the expectations for stock returns, a fall in short-run expectations is associated with an increase in long-run expectations: annual 10-year growth expectations increased from 3.0% to 3.5% per year. To provide a sense of the magnitude of expected GDP losses, it is illustrative to compare the expectations to what actually happened during the Global Financial Crisis. Starting at the end of June 2008, real GDP growth in the U.S. over the next three years was 0.3%, with a v-shaped pattern of growth over that period. At least by April 2020, the investors surveyed here were not expecting that the COVID-19 shock would lead to GDP losses as large as those experienced during the financial crisis.⁸

One interesting question is how this relatively moderate drop in GDP expectations can be reconciled with the large movement in stock prices observed during the COVID-19 crash. One possible explanation is related to the fact that our survey does not directly elicit expected dividend growth, but only GDP growth as a plausible proxy for dividend growth. However, (2) and (3) use data on dividend futures and earnings forecasts, respectively, to show that variation in dividend growth expectations also cannot explain the large movement in prices. This is consistent with our findings that expectations of real economic activity had not declined dramatically between February 2020 and April 2020. Based on these results, one might conclude that the decline and subsequent recovery in the stock market must have been caused by an increase and subsequent decline in discount rates. In contrast with this, our survey shows that average expected returns of our respondents actually decreased in March 2020, before recovering somewhat by the April 2020 wave. This is consistent with findings from related work in the behavioral finance literature that has explored the conflict between observed subjective expectations and expectations of a rational observer (4), and presents a challenge to a large class of consumption-based asset pricing models.

Similarly, one can further decompose the variation in discount rates between risk premia and risk-free rates. During the COVID-19 crash, the yield curve decreased by about 1% at the short

⁷The median expectation also moves down from 2.3% in February to 2% in April, so that the change in the average is not driven by changes in outliers over time.

⁸The short-run economic growth expectations elicited in this survey are also considerably higher than those of professional forecasters. In their World Economic Outlook released in April 2020, the IMF forecast U.S. GDP growth of -5.9% in 2020 and 4.7% in 2021. The Wall Street Journal survey of professional forecasters in April 2020 reported average expected annual growth for the period 2020-2022 at 0.88%.

end and 0.5% at the long end. The SI Appendix, Fig. S1 also reports the dynamics of average bond return expectations in our survey during this episode, showing that they decreased by about 0.5% to 0.8%. Given these magnitudes, variation in the risk-free rate alone can also not reconcile the observed changes in expected returns (implying expected risk-premia decreased) and the drastic market movements observed during this period.⁹

Panels E and F of Figure II show large increases in the perceived probabilities of short-run disasters in stock market returns and GDP growth. The probabilities of such disasters increase from 4.3% to 7.9% for the stock market, and from 4.6% to 8.5% for GDP growth. It is these extreme outcomes that the economic policy response is trying to minimize, but our respondents still find their probability to have increased substantially. We discuss the implications of these movements for asset pricing theory in Section III.

Dynamics of Belief Disagreement. Beyond studying the dynamics of average beliefs across investors, our data also allow us to understand the evolution of disagreement among investors. Figure III shows smoothed kernel densities of the cross-section of beliefs, both for the 1-year expected return (Panel A) and for the probability of a stock market disaster (Panel B). In each panel we plot three densities, each corresponding to a different survey wave (February, March, and April).

The dispersion in beliefs across individuals — the level of disagreement — increased substantially after the market crash, as visible from the fattening of densities. The cross-sectional standard deviation (across respondents) of reported 1-year expected stock returns almost doubled from 5.3% to 10.1% between the February and March waves. The April survey shows a level of disagreement very similar to the March one, despite the fact that the stock market had rallied substantially in the meantime. The response of disagreement is asymmetric, with pessimism — the left tail of Panel A — becoming substantially more pronounced in the investor population. Quantitatively, the cross-sectional skewness of beliefs increases in magnitude from -0.32 to -0.47 from February to March. Consistent with this finding, the 10th percentile of the belief distribution moves from 2% to -10%, whereas the 90th percentile remains essentially stable, falling from 12% to 10%. Finally, the 90th percentile of the distribution of perceived disaster probabilities, captured by the right tail of Panel B, doubles from 10% to 20% between the February and March waves of the GMSU-Vanguard survey.

We next refine our understanding of the dynamics of disagreement by studying which people changed their beliefs, and how: did pessimists become more pessimistic, or was the change in disagreement driven largely by investors who were previously optimistic? Our survey is well suited to answering these questions, because we observe a significant number of investors who respond to multiple waves of the survey.

In Table I, we study the subset of investors that responded to the February wave as well as to at least one of the March or April waves of the GMSU-Vanguard survey. Panel A focuses on 1-year expected returns and Panel B focuses on the probability of a stock market disaster. In Panel A, we group respondents into four buckets based on their beliefs about 1-year stock returns before the

⁹While it is beyond the scope of this paper to propose alternative asset pricing models that can reconcile our findings, promising directions include exploring the potential role of changing disagreement, of changes in the identity of the marginal investor, and of intermediation frictions in these markets.

crash in the February wave; each row corresponds to a different group. Those investors that, in the February wave, were most pessimistic are shown in the top row; this group expected negative returns going forward. The bottom row, instead, includes the most optimistic investors, those that in February expected 1-year stock returns above 10%. The columns report the change in beliefs (equally weighted) in percentage points between February and March in Panel A.I, and between February and April in Panel A.II. Each entry reports the fraction of investors within each row that experienced a changed in belief in the range expressed in the corresponding column. For example, the first row shows that of those investors that expected negative returns in February, 3% lowered their expectations by 10 to 20 percentage points; 9% lowered their expectations by 5 to 10 percentage points; and 44% increased their expected stock returns by more than 5 percentage points.

Panel A of Table I shows a widespread transition toward more negative beliefs across most investors.¹⁰ For example, 87% of the previously-most-optimistic group became more pessimistic in March. One exception is the group that includes the most pessimistic respondents in February; for this group, 63% of the respondents increased their expectations between February and March, and 73% of that group became more optimistic between February and April. One interpretation of these results is that in February, after the spread of the Coronavirus had already started, a set of individuals (the pessimists) thought a stock market crash was likely to occur over the next year. As this scenario actually unfolded, about half of these individuals thought that stock prices had fallen far enough as to increase their expected returns going forward; the other half expected further stock market declines. On the other hand, the vast majority of optimists revised their expectations downwards in light of the market crash that they did not anticipate in February.

This view is also supported by Panel B of Table I, which presents an analogous analysis for the perceived probability of a stock market disaster (in this panel, initial pessimists are in the last row). Those who ex-ante reported the highest probabilities of a large stock market decline are also those who decreased their perceived probability the most following the actual realization of such a decline: just over half the pessimists become more optimistic.

Trading Behavior. We find that both the levels and dynamics of beliefs are reflected in portfolio choice and trading activity. Figure IV shows the dynamics of portfolios over February and March for the respondents to the February wave of the GMSU-Vanguard survey, grouped by the level of their expected 1-year stock returns in February. We label those respondents who are in the top tercile of the February belief distribution as "optimists," those in the middle tercile as "neutrals," and those in the bottom tercile as "pessimists."¹¹ The percentage of each individual's portfolio that is invested in equity is associated with her expected stock returns. On January 31st, 2020, the date

¹⁰Despite this large time-series decline in expected returns, Fact 3 from (1) — which emphasized that the panel variation in beliefs is best explained by individual fixed effects and not time fixed effects — continues to hold. Focusing on individuals who have responded to at least three survey waves since February 2017, the R^2 of a regression of panel beliefs on individual fixed effects is 50.8%, while it is 5.7% for a regression of the panel beliefs on time fixed effects. Similar patterns hold for all beliefs elicited in the GMSU-Vanguard survey.

¹¹We group in terciles, rather than the finer groups in Table I, to maintain equal sized groups and sufficient statistical power given that most people do not trade. The average expected stock market returns over the next year (February wave) for the three groups are: 12.2% for the optimists, 7% for the neutrals, and 2.1% for the pessimists. Thus the "pessimists" in this analysis are not as pessimistic as the lowest group in Table I.

at which we measure the portfolios using market values, optimists had, on average, 73% of their portfolio invested in equity. The average equity percentage is 66% for neutrals and 62% for pessimists. This result is consistent with the findings in (1), who documented that individual beliefs are associated with portfolio choice, but also that the relationship is quantitatively more muted than in frictionless benchmark models; (1) identify a number of frictions — such as inattention and capital gains taxes — that help explain this discrepancy.

For February and March, we construct portfolios for each respondent keeping prices constant at their January 31st levels. As a result, the portfolio dynamics in Figure IV reflect active trading, as opposed to changes in market values.¹² Panel A of Figure IV focuses on all respondents and shows that, in accordance with the differential belief dynamics by group described above, the optimists sell the most equity (on average, they actively decrease their equity share by 1.05%), followed by the neutrals (active decrease of 0.98%). Initial pessimists had the lowest active change in the equity share, with an active decrease of 0.63%. To inspect this mechanism further, Panel B focuses exclusively on those respondents who actively change their portfolios during the period.¹³ Similar patterns appear, but they are now more pronounced, reflecting the fact that a substantial portion of respondents (67% of optimists, 73% of neutrals, and 70% of pessimists) did not change their portfolios during this period. The optimists who trade move their equity percentage from a high of 68% to a low of 64% by the end of March; initial neutrals with active trading move their equity share from 60% to 57%; and initial pessimists from 58% to 56%. There is also an interesting higher-frequency dynamic: the optimists sell their equity during the crash between end of February and early March, and by end of March, after the market rebounds, they buy back part of that equity.

Correlations Across Belief Changes. Our final analysis uses our panel data to investigate the joint dynamics of changes in expectations about economic growth and stock market returns across individuals. Table II reports the correlation of individual-level changes in beliefs between the February and March (Panel A) and February and April (Panel B) waves of the GMSU-Vanguard survey. For example, the table shows (row 6, column 3) that investors who increased their perceived probability of a stock market disaster also increased their perceived probability of GDP growth disaster.

The first column also highlights that, on average, those investors who became more pessimistic about average stock returns also became more pessimistic about the probability of a stock market crash and a GDP disaster (rows 3 and 6), as well as about the short-run outlook for GDP growth (row 4). However, changes in beliefs about long-run GDP growth and long-run stock market returns (rows 2 and 5) are essentially uncorrelated with changes in short-run expected returns.

¹²One exception is that when respondents trade we value the trade at the actual transaction price. In the context of our study this is likely to be conservative in the sense that it underestimates the change in portfolio allocation. This occurs because when agents sell equity after the crash they do so at lower prices. Similarly, the share of portfolio equity at market value is falling during this period also for those who do not trade. While we focus on active trading, we also stress that “not trading” to rebalance a portfolio after market changes is also an endogenous decision and might reflect respondents’ assessments that a lower equity share in their portfolio is consistent with their belief changes.

¹³We include only those respondents to the February survey who actively change their portfolio equity share by at least 1% between January 31st and March 31st.

Limitations. Before concluding, we point out a number of possible limitations of the current study. First, like all survey-based studies, the presence of measurement error is a potential concern, especially for the quantitative interpretation of the results. Second, the population of investors we survey is selected both in terms of being Vanguard clients and in terms of choosing to answer the survey. Both of these concerns are extensively discussed in our previous work (1) and we limit ourselves here to pointing out that (i) Vanguard is one of the world’s largest asset managers with assets of \$6 trillion and over 30 million investors globally (our study draws from the U.S. population of individual retail investors and retirement plan participants, approximately 10 million investors), thus making it an interesting population to study, and (ii) while measurement error and selection are present, we have found our surveys to reveal beliefs that are actually reflected in investors trading decisions. A final concern, more specific to this paper, is that the COVID-19 crisis is a particular shock with a number of idiosyncratic components. It is therefore unclear how many of the patterns here might generalize to other large economic shocks. However, as we have already discussed, shocks of this magnitude are so rare that some advancement in our understanding can be achieved by their study even after considering their idiosyncratic limitations.

III IMPLICATIONS FOR ECONOMIC THEORY

Our purpose in this paper is to document novel patterns of belief dynamics and trading activity during a substantial market crash. These patterns represent new data moments that can be useful to design, calibrate, and evaluate economic models. In this section, we briefly highlight the main qualitative implications for various models, while leaving a quantitative exploration that requires more theoretical structure to future research.

Our data is perhaps most directly suited to evaluating rare-disaster model of macro-finance (5; 6). Our data supports a central feature of versions of these models with time-varying disaster probabilities (7; 8): the prediction that the occurrence of a crash is associated with higher (perceived) probability of future disasters closely aligns with our survey evidence. However, these models also imply that, precisely because the probability of disasters increases, expected returns should also increase following a stock market crash.¹⁴ This latter prediction is not supported by our data. The prediction of higher expected excess returns following a stock market crash is a shared feature of many rational-expectation asset pricing models, and in this sense, the empirical failure is common across this class of models.¹⁵ Our paper offers a useful testing ground and

¹⁴More precisely, risk premia should increase. In these models, like in the data, the risk-free rate decreases with the crash. In our data expected returns decreased from 6.37% to 1.3%, while short-term rates (1 year treasury bills) decreased from 1.44% (February 11th) to 0.39% (March 11th). We conclude that expected excess returns (a form of risk premium) decreased in the data with the crash.

¹⁵The literature’s focus on representative agent models makes the mapping with our data difficult in the absence of an explicit aggregation theorem. Nonetheless, the literature that documented the negative correlation between expected rational returns and those elicited via surveys routinely equates average beliefs obtained from survey to those of representative agents (see 4). One exception is (9), who explicitly model heterogeneous beliefs about time-varying rare disasters. In that model, the optimists underestimate the probability of a disaster and, therefore, expect higher returns than the pessimists. When the probability of a disaster increases, expected returns for both types of agents increase. In the data, with the exception of a portion of the most pessimistic investors, all investors lower their expected returns after the crash.

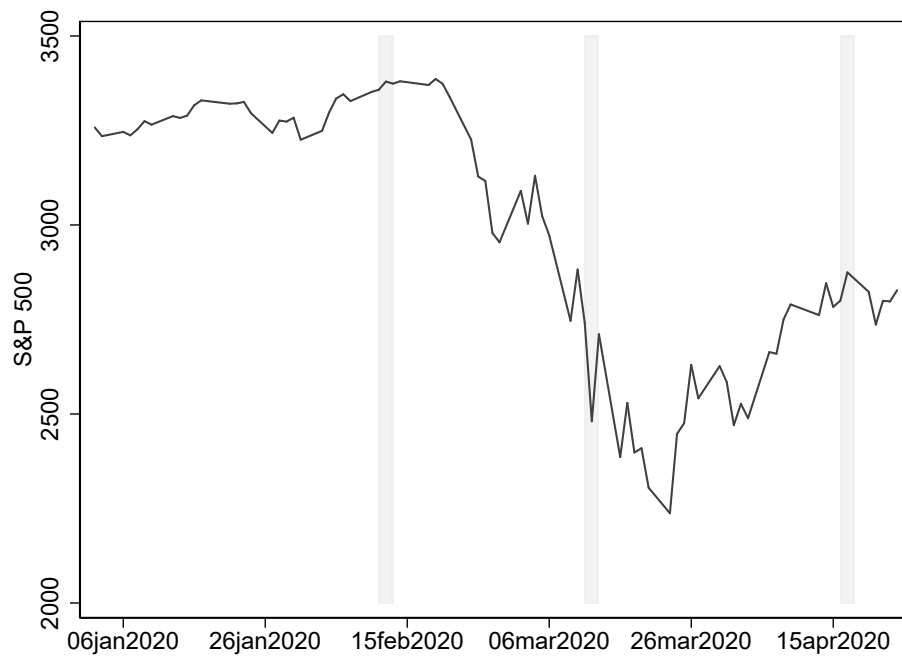
guidance for future evolution of these theories.

Our data also highlight the importance of mechanisms that are at the core of the theoretical literature on heterogeneous beliefs and trading (10; 11; 12). Ex-ante optimists have more exposure to equity than ex-ante pessimists and, as a result, they lose more wealth when the crash occurs. In those models, changes of beliefs play a crucial role in generating trading activity when investor beliefs "cross" each other. Consistent with such mechanisms, we find that ex-ante optimists lower their beliefs the most after the crash, and correspondingly sell the most equity. While a full quantitative evaluation of the correspondence between these models and our data is outside the scope of this paper, our analysis suggests that this class of models can be a promising direction to explain the patterns of beliefs and trading that we document. In addition, in much of the existing literature, belief changes for different agents are idiosyncratic. We show in Table I that in addition to such idiosyncratic belief changes, the COVID-19 crisis induced correlated belief changes among all of our agents. Furthermore, different individuals' exposures to these correlated belief changes varied with the level of their initial beliefs. These patterns provide directions for future iterations of models with heterogeneous beliefs.

Finally, we confirm in this paper the low sensitivity of portfolios to beliefs documented originally in (1). Strikingly, this low sensitivity holds even during a major market crash, when beliefs are changing significantly and many retail investors were paying substantial attention to developments in the stock market. This pattern has important implications for both rational and behavioral models, since it informs us about the way changes in expectations affect individual actions. For example, simple behavioral models, like those reviewed by (13), imply a strong passthrough of belief changes to portfolios of behavioral agents. These models would explain a large drop in asset prices via a turn to pessimism in expectations and an attempt to sell large parts of the equity portfolio. Our work cautions against this simple modeling, which implies too strong a link between beliefs and portfolios. Ongoing research by (14) shows possible avenues to match our evidence by adding additional elements, like inelastic demand by institutional investors, which can amplify the price effects of small portfolio changes.

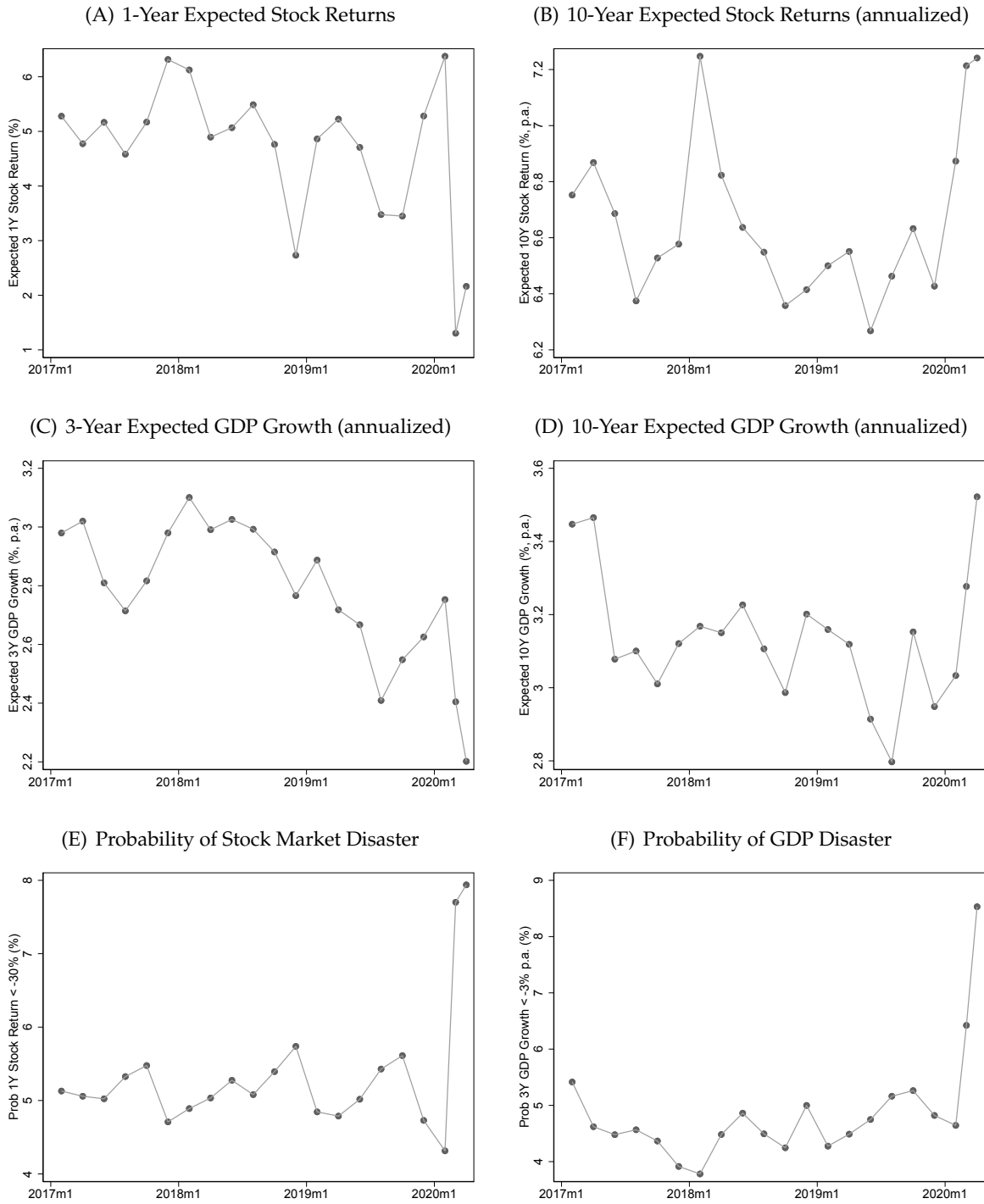
To conclude, our study provides a unique real-time look inside the mind of stock market participants during the COVID-19 crisis, and the associated stock market crash. It shows that investors turned more pessimistic and increased their perceived probabilities of catastrophic events in terms of real economic outcomes and further stock market declines. We also find that investors reduced their equity exposures according to changes in their expectations. At the same time, we find that investors also formed a nuanced view of long term prospects. Short-term pessimism was matched with unchanged or even improved long-run expectations. By documenting these dynamics of beliefs and trading during a large market crash, and by characterizing their heterogeneity across investors, we hope to bring useful additional moments that can help test and calibrate macro-finance theories.

Figure I: S&P 500 and Dates of GMSU-Vanguard Survey



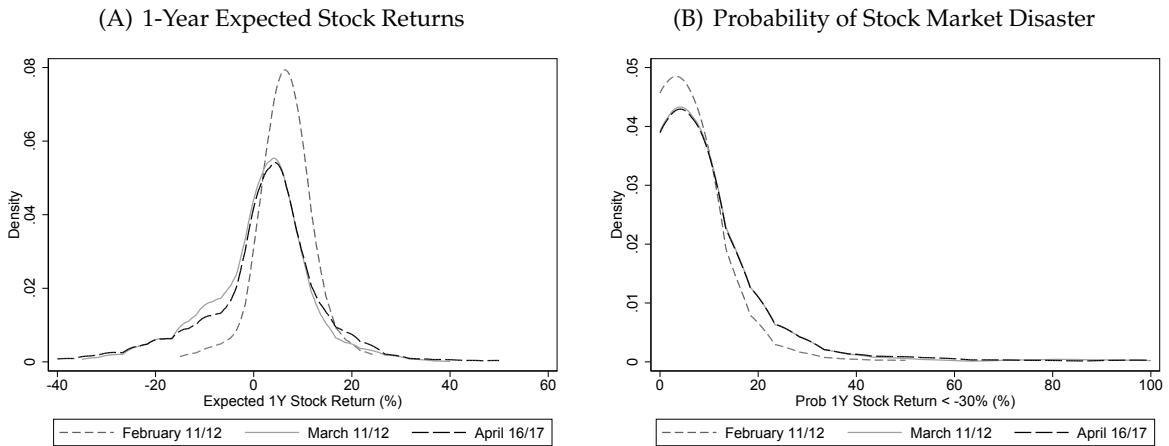
Note: Figure shows the development of the S&P 500 index between January 2, 2020, and April 24, 2020. The three shaded regions correspond to the dates of the February, March, and April waves of the GMSU-Vanguard survey.

Figure II: Average Responses to GMSU-Vanguard Survey



Note: Figure shows average beliefs across all respondents in each wave of the GMSU-Vanguard survey. Panel A shows the 1-year expected stock market return, Panel B the 10-year expected stock market return (annualized), Panel C the expected real GDP annual growth over the next 3 years, Panel D the expected real GDP annual growth over the next 10 years, Panel E the probability of stock market returns being lower than -30% over the next year, and Panel F the probability of GDP growth being less than -3% on average over the next 3 years.

Figure III: Distribution of Responses to GMSU-Vanguard Survey



Note: Figure shows kernel density distributions over responses on the February 11-12, 2020, the March 11-12, 2020, and the April 16-17, 2020 waves of the GMSU-Vanguard survey. The left panel shows the distribution of beliefs about 1-year expected stock returns, the right panel shows the distribution of beliefs about the probability of a stock market decline of more than 30 percent over the coming 12 months.

Table I: Changes in Beliefs by Initial Belief

<i>Panel A.I.</i>		Change in Expected 1y Stock Returns (Feb - Mar, ppt)					
		Less than -20	Between -20 and -10	Between -10 and -5	Between -5 and 0	Between 0 and 5	Greater than 5
Expected 1y Stock Returns (%), Feb	Less than 0	0.0%	3.1%	9.4%	25.0%	18.8%	43.8%
	Between 0 and 5	8.8%	17.6%	10.8%	35.3%	17.6%	9.8%
	Between 5 and 10	10.0%	13.1%	12.4%	41.3%	13.9%	9.3%
	Greater than 10	3.8%	29.5%	29.5%	24.4%	5.1%	7.7%

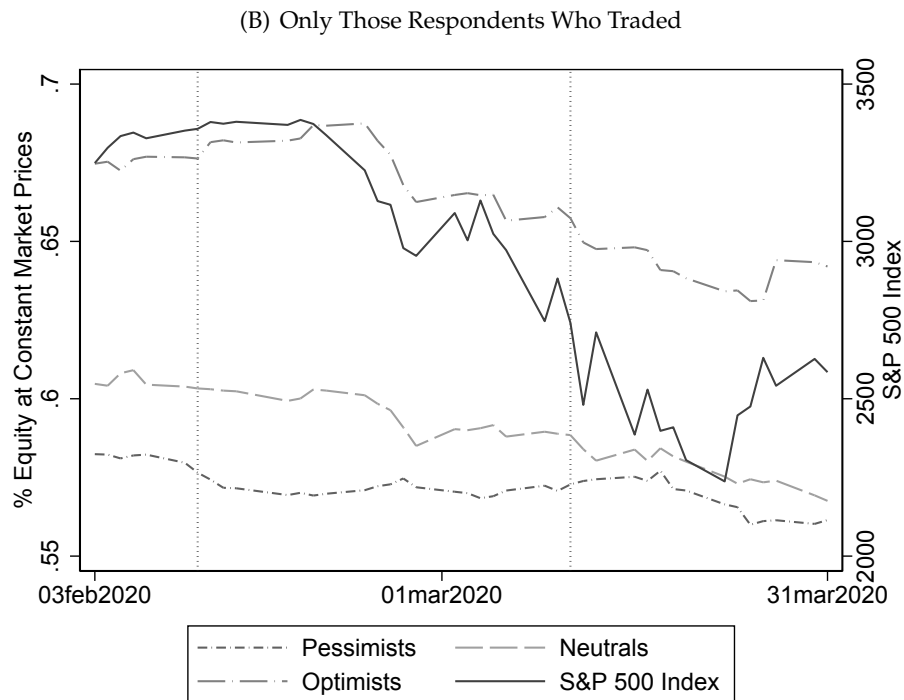
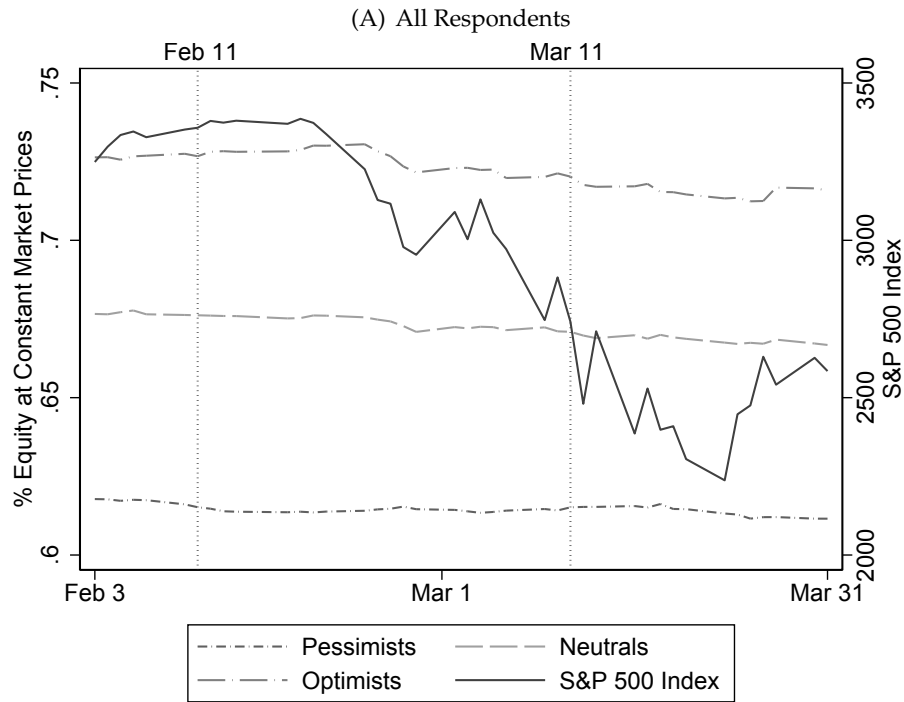
<i>Panel A.II.</i>		Change in Expected 1y Stock Returns (Feb - Apr, ppt)					
		Less than -20	Between -20 and -10	Between -10 and -5	Between -5 and 0	Between 0 and 5	Greater than 5
Expected 1y Stock Returns (%), Feb	Less than 0	0.0%	5.8%	15.4%	5.8%	19.2%	53.8%
	Between 0 and 5	7.3%	14.5%	8.5%	29.1%	27.3%	13.3%
	Between 5 and 10	6.1%	12.2%	15.0%	36.3%	17.2%	13.3%
	Greater than 10	10.3%	18.3%	18.3%	30.2%	10.3%	12.7%

<i>Panel B.I.</i>		Change in Probability of Crash (Feb - Mar, ppt)					
		Less than -5	Between -5 and 0	Between 0 and 5	Between 5 and 10	Between 10 and 20	Greater than 20
Expected Probability of Crash (%), Feb	Between 0 and 2.5	0.0%	4.9%	64.8%	14.8%	9.8%	5.7%
	Between 2.5 and 5	0.0%	50.0%	21.4%	14.3%	14.3%	0.0%
	Between 5 and 10	1.8%	23.6%	42.7%	19.1%	9.1%	3.6%
	Greater than 10	35.9%	18.5%	18.5%	5.4%	14.1%	7.6%

<i>Panel B.II.</i>		Change in Probability of Crash (Feb - Apr, ppt)					
		Less than -5	Between -5 and 0	Between 0 and 5	Between 5 and 10	Between 10 and 20	Greater than 20
Expected Probability of Crash (%), Feb	Between 0 and 2.5	0.0%	6.1%	65.6%	12.9%	10.9%	4.6%
	Between 2.5 and 5	0.0%	28.1%	37.5%	15.6%	12.5%	6.3%
	Between 5 and 10	0.7%	24.7%	34.2%	22.6%	12.3%	5.5%
	Greater than 10	40.1%	20.4%	16.1%	6.6%	10.2%	6.6%

Note: Panel A shows the transition density between the level of ex-ante expectations about 1-year stock market returns (rows) and ex-post changes in these expectations (columns). Panel A.I focuses on the transition between February 2020 and March 2020; Panel A.II focuses on the transition between February 2020, and April 2020. Panel B shows an analogous analysis for the perceived probability of the stock market return over the coming year being lower than -30%. The interior buckets in both rows and columns are closed on the left and open on the right.

Figure IV: Portfolio and Trading Activity



Note: Figure shows portfolio dynamics at constant market prices (from January 31st 2020). We group respondents to the February survey by their level of expected 1-year stock market returns, with the optimists being the top tercile, and trace their portfolio activity daily over February and March. Panel A includes all February respondents. Panel B includes only those who actively change their portfolio equity share by at least 1% between January 31st and March 31st. Both panels include for reference the dynamics of the S&P 500 index (right axis).

Table II: Correlation Across Belief Changes

Panel A: February - March	(1)	(2)	(3)	(4)	(5)	(6)
(1) Δ Expected 1Y Stock Return (%)	1					
(2) Δ Expected 10Y Stock Return (% p.a.)	0.061	1				
(3) Δ Prob 1Y Stock Return < -30% (%)	-0.363	0.094	1			
(4) Δ Expected 3Y GDP Growth (% p.a.)	0.155	0.140	-0.063	1		
(5) Δ Expected 10Y GDP Growth (% p.a.)	0.010	0.276	-0.048	0.446	1	
(6) Δ Prob 3Y GDP Growth < -3% p.a. (%)	-0.188	0.004	0.230	-0.184	-0.037	1

Panel B: February - April	(1)	(2)	(3)	(4)	(5)	(6)
(1) Δ Expected 1Y Stock Return (%)	1					
(2) Δ Expected 10Y Stock Return (% p.a.)	0.113	1				
(3) Δ Prob 1Y Stock Return < -30% (%)	-0.332	0.017	1			
(4) Δ Expected 3Y GDP Growth (% p.a.)	0.234	0.112	-0.159	1		
(5) Δ Expected 10Y GDP Growth (% p.a.)	0.074	0.254	-0.019	0.403	1	
(6) Δ Prob 3Y GDP Growth < -3% p.a. (%)	-0.155	0.025	0.362	-0.243	-0.006	1

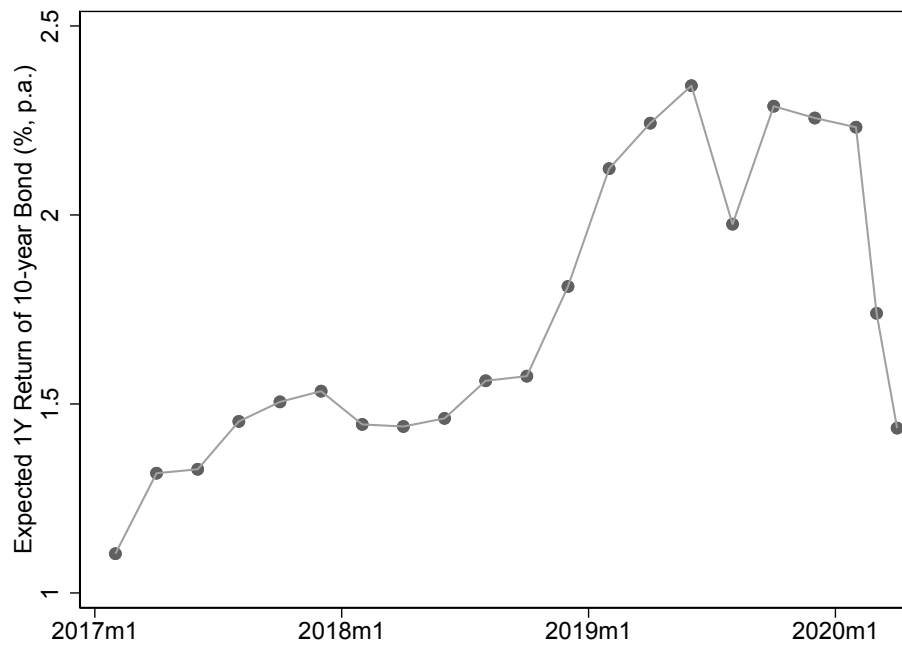
Note: Table shows cross-sectional correlation of changes in individual beliefs between the February 2020 and March 2020 waves of the GMSU-Vanguard survey (Panel A), and between the February 2020 and April 2020 waves (Panel B).

REFERENCES

1. S. Giglio, M. Maggiori, J. Stroebel, and S. Utkus, "Five facts about beliefs and portfolios," *Working Paper*, 2019.
2. N. J. Gormsen and R. S. Kojien, "Coronavirus: Impact on stock prices and growth expectations," *University of Chicago, Becker Friedman Institute for Economics Working Paper*, no. 2020-22, 2020.
3. A. Landier and D. Thesmar, "Earnings expectations in the covid crisis," *Available at SSRN*, 2020.
4. R. Greenwood and A. Shleifer, "Expectations of returns and expected returns," *The Review of Financial Studies*, vol. 27, no. 3, pp. 714–746, 2014.
5. T. A. Rietz, "The equity risk premium a solution," *Journal of Monetary Economics*, vol. 22, no. 1, pp. 117–131, 1988.
6. R. J. Barro, "Rare disasters and asset markets in the twentieth century," *Quarterly Journal of Economics*, vol. 121, no. 3, pp. 823–866, 2006.
7. X. Gabaix, "Variable rare disasters: An exactly solved framework for ten puzzles in macro-finance," *Quarterly Journal of Economics*, vol. 127, no. 2, pp. 645–700, 2012.
8. J. A. Wachter, "Can time-varying risk of rare disasters explain aggregate stock market volatility?," *The Journal of Finance*, vol. 68, no. 3, pp. 987–1035, 2013.
9. H. Chen, S. Joslin, and N.-K. Tran, "Rare disasters and risk sharing with heterogeneous beliefs," *The Review of Financial Studies*, vol. 25, no. 7, pp. 2189–2224, 2012.
10. J. M. Harrison and D. M. Kreps, "Speculative investor behavior in a stock market with heterogeneous expectations," *The Quarterly Journal of Economics*, vol. 92, no. 2, pp. 323–336, 1978.
11. J. A. Scheinkman and W. Xiong, "Overconfidence and speculative bubbles," *Journal of Political Economy*, vol. 111, no. 6, pp. 1183–1220, 2003.
12. A. Simsek, "Belief disagreements and collateral constraints," *Econometrica*, vol. 81, no. 1, pp. 1–53, 2013.
13. N. Barberis, "Psychology-based models of asset prices and trading volume," *Handbook of Behavioral Economics-Foundations and Applications 1*, p. 79, 2018.
14. X. Gabaix and R. Kojien, "In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis," working paper, 2020.

SI.1 ADDITIONAL RESULTS

Figure S1: Average Expected Bond Returns

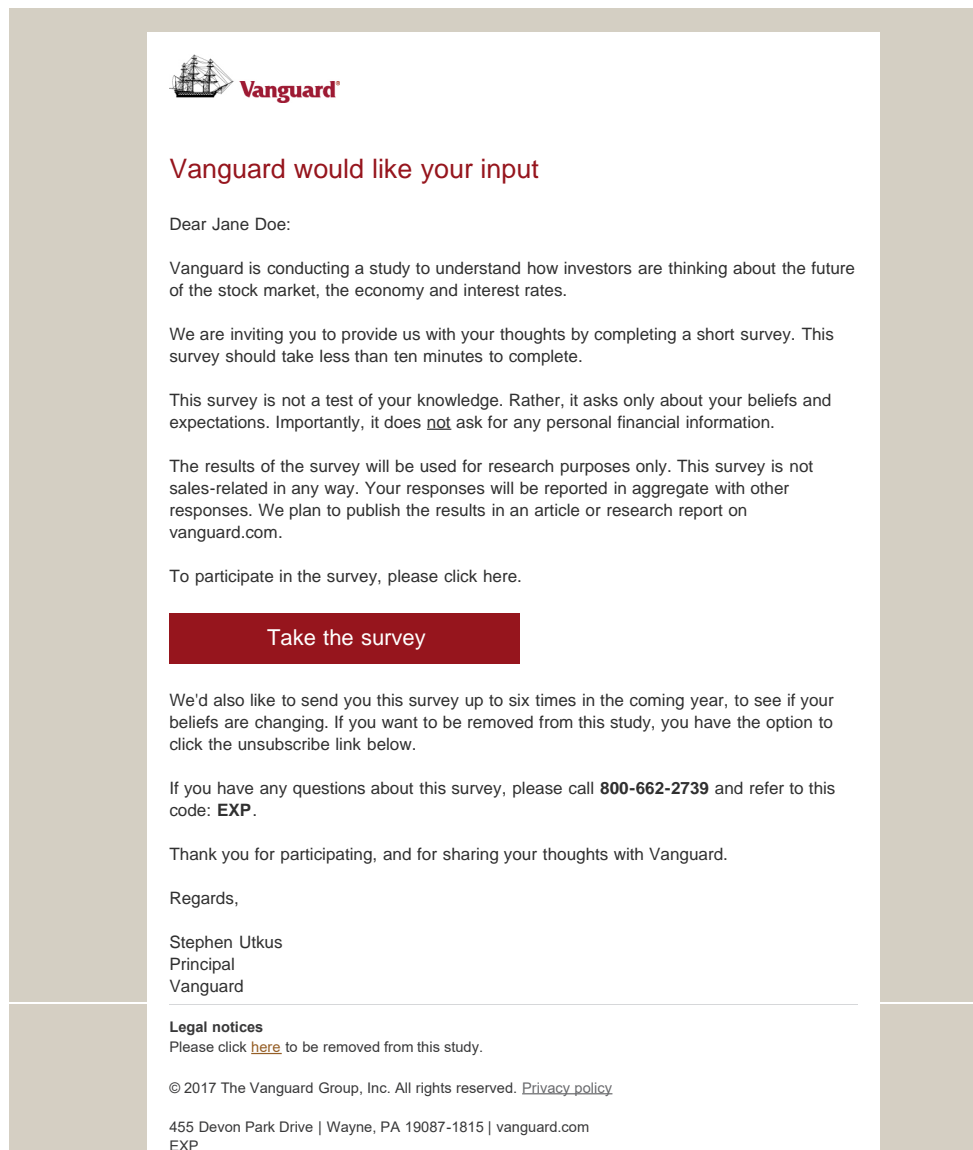



Note: Figure shows average beliefs about 1-year expected returns of 10-year government bonds across all respondents in each wave of the GMSU-Vanguard survey.

SI.2 INVITATION EMAIL AND SURVEY FLOW

In this Appendix, we present screenshots of one complete survey flow. In this iteration of the flow, questions about expected stock returns were asked ahead of questions about expected GDP growth; the survey implementation randomizes across these two blocks of questions. We begin by reviewing the invitation email sent to individuals from Vanguard.

Subject:	[TEST]We need your help, Jane Doe
From:	Vanguard (vanguard@eonline.e-vanguard.com)
To:	oea_test@yahoo.com;
Date:	Monday, February 13, 2017 10:58 AM



 Vanguard

Vanguard would like your input

Dear Jane Doe:

Vanguard is conducting a study to understand how investors are thinking about the future of the stock market, the economy and interest rates.

We are inviting you to provide us with your thoughts by completing a short survey. This survey should take less than ten minutes to complete.

This survey is not a test of your knowledge. Rather, it asks only about your beliefs and expectations. Importantly, it does not ask for any personal financial information.

The results of the survey will be used for research purposes only. This survey is not sales-related in any way. Your responses will be reported in aggregate with other responses. We plan to publish the results in an article or research report on vanguard.com.

To participate in the survey, please click here.

[Take the survey](#)

We'd also like to send you this survey up to six times in the coming year, to see if your beliefs are changing. If you want to be removed from this study, you have the option to click the unsubscribe link below.

If you have any questions about this survey, please call **800-662-2739** and refer to this code: **EXP**.

Thank you for participating, and for sharing your thoughts with Vanguard.

Regards,

Stephen Utkus
Principal
Vanguard

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455 Devon Park Drive | Wayne, PA 19087-1815 | vanguard.com
EXP



Dear Investor,

Thank you for participating in this study.

At Vanguard we are interested in understanding investor views on the future of the stock market, the economy and interest rates. We plan to create an investor sentiment index to share these findings with the investing public.

This is a short survey that should take you no more than 5-10 minutes to complete.

The survey does not collect any personal information. It relies on your general knowledge.

If you feel you are not familiar with a topic, that is fine. Please just give us your best prediction.

Please do not use the browser's navigation button to move through the survey.

Next

For these questions, we would like to know what you are expecting the future returns of the US stock market to be.

Next

Powered by CONSENT

What do you expect the return of the US stock market to be **over the next 12 months**?

Note: This expected return is the change in value, in percent, that you expect to receive **over the next 12 months** from investing in a portfolio that holds all stocks listed on the US stock market. It includes both dividends and capital gains/losses.

(Please answer only with a positive or negative numeric value, with at most 1 decimal.)

% over the next 12 months

Next

Powered by CONSENT

What do you expect the **average** annual return of the US stock market to be **over the next 10 years**?

Note: This expected return is the change in value, in percent, that you expect to receive **each year on average over the next 10 years** from investing in a portfolio that holds all stocks listed on the US stock market. It includes both dividends and capital gains/losses.

(Please answer only with a positive or negative numeric value, with at most 1 decimal.)

% per year, over the next 10 years

Next

In this question we present you with five possible scenarios for US stock market returns **over the next 12 months**:

The US stock market return will be...

- Scenario 1: **more than 40%** over the next year.
- Scenario 2: **between 30% and 40%** over the next year.
- Scenario 3: **between -10% and 30%** over the next year.
- Scenario 4: **between -30% and -10%** over the next year.
- Scenario 5: **less than -30%** over the next year.

Please let us know how likely you think it is that each scenario will occur.

Please type in the number to indicate the probability, in percent, that you attach to each scenario. The probabilities of the five scenarios have to sum up to 100%. The graphic bar chart on the right updates automatically to reflect your answers.

(Please answer only with a positive numeric value, with at most 1 decimal.)

more than 40%	<input type="text"/>	%
between 30% and 40%	<input type="text"/>	%
between -10% and 30%	<input type="text"/>	%
between -30% and -10%	<input type="text"/>	%
less than -30%	<input type="text"/>	%
Total		0.0%



Remaining probability to fill in: 100.0%

Next

In this question we present you with five possible scenarios for US stock market returns **over the next 12 months**:

The US stock market return will be...

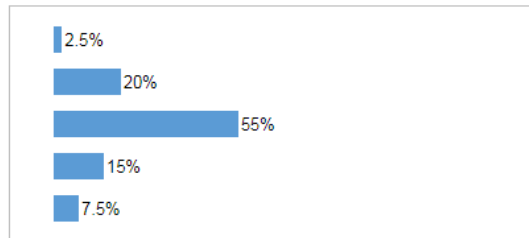
- Scenario 1: **more than 40%** over the next year.
- Scenario 2: **between 30% and 40%** over the next year.
- Scenario 3: **between -10% and 30%** over the next year.
- Scenario 4: **between -30% and -10%** over the next year.
- Scenario 5: **less than -30%** over the next year.

Please let us know how likely you think it is that each scenario will occur.

Please type in the number to indicate the probability, in percent, that you attach to each scenario. The probabilities of the five scenarios have to sum up to 100%. The graphic bar chart on the right updates automatically to reflect your answers.

(Please answer only with a positive numeric value, with at most 1 decimal.)

more than 40%	<input type="text" value="2.5"/>	%
between 30% and 40%	<input type="text" value="20"/>	%
between -10% and 30%	<input type="text" value="55"/>	%
between -30% and -10%	<input type="text" value="15"/>	%
less than -30%	<input type="text" value="7.5"/>	%
<hr/>		
Total	100.0%	



Remaining probability to fill in: 0.0%

Next

POWERED BY CONFIRMIT

How difficult were the questions about the stock market that you were just asked?

- Not at all difficult
- Not very difficult
- Somewhat difficult
- Very difficult
- Extremely difficult

Next

POWERED BY CONFIRMIT

How confident are you with your answers to the questions about the stock market that you were just asked?

- Extremely confident
- Very confident
- Somewhat confident
- Not very confident
- Not at all confident

Next

POWERED BY CONFIRMITY

In the next questions, we would like to know what you are expecting future economic growth in the US to be.

Again, even if you feel that you are not familiar with the topic, please give us your best prediction.

Next

POWERED BY CONFIRMITY

What do you expect the **average** annual growth rate of real GDP in the US to be **over the next 3 years**?

Note: Real Gross Domestic Product (GDP) is a measure of economic activity. Real GDP is the total real value of goods and services produced in the US in a year.

(Please answer only with a positive or negative numeric value with at most 1 decimal.)

% per year, over the next 3 years

Next

POWERED BY CONFIRMITY

What do you expect the **average** annual growth rate of real GDP in the US to be **over the next 10 years**?

Note: Real Gross Domestic Product (GDP) is a measure of economic activity. Real GDP is the total real value of goods and services produced in the US in a year.

(Please answer only with a positive or negative numeric value with at most 1 decimal.)

% per year, over the next 10 years

Next

POWERED BY CONFINIT

In this question we present you with five possible scenarios for US real GDP **average annual growth rate, over the next 3 years**:

US real GDP average annual growth rate over the next 3 years will be...

- Scenario 1: **more than 9%** per year.
- Scenario 2: **between 3% and 9%** per year.
- Scenario 3: **between 0% and 3%** per year.
- Scenario 4: **between -3% and 0%** per year.
- Scenario 5: **less than -3%** per year.

Please let us know how likely you think it is that each scenario will occur.

Please type in the number to indicate the probability, in percent, that you attach to each scenario. The probabilities of the five scenarios have to sum up to 100%. The graphic bar chart on the right updates automatically to reflect your answers.

(Please answer only with a positive numeric value, with at most 1 decimal.)

more than 9%	<input type="text"/>	%	
between 3% and 9%	<input type="text"/>	%	
between 0% and 3%	<input type="text"/>	%	
between -3% and 0%	<input type="text"/>	%	
less than -3%	<input type="text"/>	%	
<hr/>			
Total		0.0%	

Remaining probability to fill in: 100.0%

Next

POWERED BY CONFINIT

How difficult were the questions about real GDP growth that you were just asked?

- Not at all difficult
- Not very difficult
- Somewhat difficult
- Very difficult
- Extremely difficult

Next

POWERED BY CONFIRMIT

How confident are you with your answers to the questions about real GDP growth that you were just asked?

- Extremely confident
- Very confident
- Somewhat confident
- Not very confident
- Not at all confident

Next

POWERED BY CONFIRMIT

In these final questions, we would like to know what you are expecting future returns on US bonds and future US interest rates to be.

Again, even if you feel that you are not familiar with the topic, please give us your best prediction.

Next

POWERED BY CONFIRMIT

Suppose that you were to buy a 10-year US Treasury bond today that makes all of its payments at maturity 10 years from now.

Suppose that you were to sell this bond a year from today. What do you expect the return from this bond investment to be **over the next 12 months**?

Note: This expected return is the change in price of the bond that you expect to occur during the next 12 months.

(Please answer only with a positive or negative numeric value with at most 1 decimal.)

% over the next 12 months

Next

POWERED BY CONFIRMIT

How difficult were the questions about bonds and interest rates that you were just asked?

- Not at all difficult
- Not very difficult
- Somewhat difficult
- Very difficult
- Extremely difficult

Next

POWERED BY CONFIRMIT

How confident are you with your answers to the questions about bonds and interest rates that you were just asked?

- Extremely confident
- Very confident
- Somewhat confident
- Not very confident
- Not at all confident

Next

POWERED BY CONFIRMIT