The Devil is in the Tail: Macroeconomic Tail Risk Expectations of Firms

Manuel Menkhoff*

This paper examines novel survey evidence on firms' beliefs about macroeconomic tail risk and their role in investment decisions. In a large survey of German firms, I elicit (i) the subjective probability of a severe macroeconomic downturn and (ii) firms' exposure to such an event. Firms' subjective probabilities of a severe downturn are widely dispersed and strongly revised over time. Using panel data, a randomized control trial, and hypothetical scenarios, I find that a higher probability of a severe macroeconomic downturn substantially lowers investment, particularly for firms that report higher exposure to the event. I attribute less than half of the investment response to changes in firms' subjective first and second moments. In a quantitative heterogeneous firm model calibrated to match the survey evidence, firms' concern with tail risk makes fiscal policy particularly effective for stabilizing investment.

JEL Classification: D84, E22, E32, G30
Keywords: macroeconomic tail risk, rare events, firm expectations, investment, RCT

*University of Copenhagen, ifo Institute, CEBI, and CESifo, mmk@econ.ku.dk. I am indebted to Andreas Peichl, Mirko Wiederholt, Martin Schneider, and Benjamin Born for the guidance and support throughout this project. I also thank Peter Andre, Shifrah Aron-Dine, Rüdiger Bachmann, Jose Maria Barrero, Juliane Begenau, Kai Carstensen, Ian Dew-Becker, Yuriy Gorodnichenko, Isabel Gödl-Hanisch, Cosmin Ilut, Theresa Kuchler, Sebastian Link, Ben Moll, Gernot Müller, Monika Piazzesi, Chris Roth, Sonja Settele, Claudia Steinwender, Johannes Ströbel, Uwe Sunde, Laura Veldkamp, Johannes Wohlfart, Peter Zorn, and various conference and seminar participants for insightful feedback and discussions. I am grateful to the survey department of the ifo Institute, in particular Katrin Demmelhuber, Felix Leiss, Agnesa Nimanaj, and Klaus Wohlrabe for their help and the opportunity to add new questions to the existing firm surveys. I thank the LMU-ifo Economics & Business Data Center (EBDC) for assistance with the data. This work was supported by a fellowship of the German Academic Exchange Service (DAAD) and partly funded through an Add-On Fellowship from the Joachim Herz Foundation. The activities of CEBI are financed by the Danish National Research Foundation, grant DNRF134. Manuel Menkhoff is affiliated with the Danish Finance Institute (DFI) which financially supports researchers in Finance. Declarations of interest: none. Date: March 2026.

1 Introduction

The global economy has recently faced significant macroeconomic tail events—such as the Great Recession, the COVID-19 pandemic, and the war in Ukraine. Yet, little is known about firms' beliefs about occurrence of these events in the future. Since realized macro tail events are rare, firms have limited information not only about the likelihood of such events, but also about the impact of such events on the firms' business, adding an additional layer of uncertainty.

At the same time, expectations matter for firms' investment. Indeed, firms' subjective expectations and uncertainty—corresponding to the first and second moments of their forecast distributions—are important drivers of investment decisions; see, e.g., Gennaioli, Ma and Shleifer (2016) and Kumar, Gorodnichenko and Coibion (2023), respectively. While macro tail risk is a crucial determinant of asset prices and the business cycle in many quantitative models (e.g., Barro, 2006, Gourio, 2012, Kozlowski, Veldkamp and Venkateswaran, 2020), it remains an open question to what extent the beliefs of firm decision-makers regarding macro tail events influence their investment behavior.

This paper studies the nature, role, and consequences of macroeconomic tail risk beliefs of firms. I elicit the subjective probability of four macro tail events multiple times in a large panel of firms: a drop in GDP of at least 5%, a financial crisis similar in magnitude to the Great Recession, a pandemic, and a geopolitical escalation. On average, firms believe that these macro tail events are fairly likely, but beliefs vary widely across firms and fluctuate significantly over time. Changes in these subjective probabilities co-move strongly with changes in firms' expectations and uncertainty about their own business. Turning to exposure, both structured and open-ended survey questions reveal that managers are highly uncertain about the exposure of their firms to these macro tail events.

Using a threefold empirical approach based on novel data that exploits (i) firm-level observational panel variation, (ii) experimental variation from a randomized control trial, and (iii) experimental variation from hypothetical scenarios, I examine how changes in macro tail risk beliefs affect firm decisions, focusing on investment as the key outcome variable. Across these different methodologies, a consistent pattern emerges: a higher subjective probability of a macro tail event leads to substantially lower investment. Crucially, at least half of this effect persists after conditioning on subjective first and second moments. The effect is particularly driven by firms that expect to be heavily exposed to macro tail events in worst-case scenarios.

To rationalize the findings and analyze stabilization policies, I explore the role of macro tail risk beliefs in a quantitative heterogeneous firm model. The key mechanism driving investment decisions beyond first and second moments is ambiguity regarding firm-specific exposure to macro tail events. Both fiscal and monetary policy can stabilize investment after an increase in macro tail risk. I find that fiscal policy in the form of generous loss carrybacks is particularly effective in a world with ambiguous exposure to macro tail events.

I shed light on the nature of macro tail risk expectations of firms using the representative German ifo Business Survey, a well-established large firm panel with a high response rate, typically answered by the firm's CEO or owner (Born et al., 2022). Participating firms are well informed about macroeconomic dynamics: macroeconomic point forecasts are closely aligned with those of professional forecasters (Link et al., 2023). In the survey, I introduce a set of questions regarding the subjective probability of macro tail events—the first layer of macro tail risk. I consider four concrete macro tail events, as described above, elicited annually over a period of four years from 2022 to 2025. I mostly focus on the GDP drop scenario, a reduced-form measure that captures a broad range of macro tail events, but results are similar for the three more specific events. Firms consider these events to be fairly likely. For example, in October 2022, the median firm believes that a large decline in GDP ($\geq 5\%$) occurs with a 50% probability within the next five years, corresponding to a 3.4% quarterly arrival rate. This number aligns with a frequentist approach that considers the development of German GDP growth over the last 20 years. During this period, two significant GDP drops occurred within four five-year windows: the Great Recession in 2008/2009 and the COVID-19 pandemic in 2020.

Macro tail risk beliefs are highly dispersed across firms and revised substantially over time. Continuing with the example, the interquartile range (IQR) spans from a subjective probability of 20% to a subjective probability of 80%. In subsequent years, the median subjective probability of a large GDP drop is lower, at around 20%. Nevertheless, there remains substantial heterogeneity across firms, as well as sizable within-firm revisions over time. For example, p10-to-p90 revisions range from -30 to $+30$ pp from 2024 to 2025, despite little change in the median firm's belief.[1] An increase in the subjective probability of macro tail events is closely associated with lower business expectations and higher business

[1]For the financial crisis scenario, the median subjective probability is slightly lower and the IQR more narrow. The pandemic and geopolitical escalation scenarios are perceived to be less likely, but still show substantial dispersion.

uncertainty, both in the cross-section and within a given firm over time. This is consistent with the notion that macro tail risk shifts firms' subjective expectations and uncertainty.

A second layer of macro tail risk for firms is how severely they will be affected if a macro tail event materializes. Therefore, I also elicit firms' beliefs about their exposure to macro tail events with both structured and open-ended survey questions. In the structured survey question, I elicit firms' beliefs about the change in their real sales in the event of a 5% drop in GDP. I ask them about the change in their real sales in the best-case, on average, and in the worst-case. Beliefs about the average exposure scenario range from a 30% decrease in sales at the 90th percentile to no change in sales at the 10th percentile. For the median firm, there is a 20 percentage point range between the best- and worst-case scenarios, indicating high uncertainty about exposure to macro tail events. This range increases with the level of expected average-case exposure.

I also design an open-ended survey question that allows firms to freely express their thoughts on exposure to macro tail events. Three main narratives emerge that corroborate the substantial uncertainty in exposure identified in the structured question: (i) firms directly express significant difficulties in forecasting exposure, (ii) when discussing beliefs about exposure in terms of sales, they tend to express it in ranges or max/min scenarios rather than average exposure, (iii) firms often refer to past macro tail events, underscoring the limited set of experiences available to predict exposure.

To study the role of macro tail risk beliefs for investment, I link these beliefs to firm decisions. To fix ideas, I present a stylized firm choice model, which later forms the core of the quantitative model. In the model, consistent with the design of the survey questions, macro tail risk is characterized by two layers: the subjective probability of a macro tail event and firm-specific exposure conditional on the event. Motivated by the empirical evidence, I assume incomplete knowledge about the firm-specific exposure to a macro tail event: firms have scenarios in mind regarding the extent to which they might be exposed in this case. However, they are not able to assign probabilities to the respective scenarios, making the exposure ambiguous—also known as Knightian uncertainty (Keynes, 1921, Knight, 1921).[2] If firms are ambiguity averse, i.e. they prefer to know the likelihood of events, they act *as if* they are relatively pessimistic about their exposure to macro tail events. Specifically, they choose the capital stock for the next period *as if* their worst-case exposure will be realized in the macro tail event, see Ilut and Schneider (2022) for a review on ambiguity. Hence, an

[2] Bachmann et al. (2020) document that Knightian uncertainty is pervasive among firms.

increase in the subjective probability of a macro tail event results in a significant decline in investment beyond the first-moment effect, even when firms are risk neutral.

I employ three complementary empirical approaches to examine the role of macro tail risk expectations for firm decisions, focusing on investment. The first approach exploits firm-level observational variation in macro tail risk beliefs to estimate the effect on firm investment. As outcome variable, I construct an indicator for a planned decrease in investment in the next year, elicited one month after the macro tail risk beliefs.[3]

A one standard deviation increase in the subjective probability of a drop in GDP of at least 5% predicts a 6 percentage points higher probability of reducing investment in the next year, corresponding to a 25% increase relative to the mean. When accounting for firms' subjective first and second moments, specifically adjustments in forecasts and uncertainty about their own business, at least half of this relationship persists. To rule out the influence of any time-invariant firm characteristics, I next exploit within-firm revisions in the subjective probability of a macro tail event over time. I still find a sizable and significant negative effect of macro tail risk expectations on investment. The negative coefficient on investment is particularly pronounced for firms with substantial expected worst-case exposure to a macro tail event, consistent with the theoretical predictions outlined above. The results hold for a battery of robustness checks, including different measures of subjective first and second moments.

The second approach generates exogenous variation using a randomized control trial (RCT), in which I provide a randomly selected group of firms with information based on unpublished survey evidence on other managers' macro tail risk beliefs. This design establishes causality in a real-world setting and allows me to study how firms update macro tail risk beliefs when confronted with new information. Firms with low prior subjective probabilities revise their macro tail risk beliefs significantly upward, whereas firms with high prior beliefs—more pessimistic than the information provided—do not revise downward. This implies an asymmetric response to news, consistent with conservative updating: managers treat negative news as more precise than positive news.

Among firms with below-median prior macro tail risk beliefs, the subjective probability of a large GDP drop increases by 2.7 pp after the information treatment. In the subsequent survey wave, treated firms are about 8 pp more likely to plan an investment cut. The results

[3]To study how the survey responses translate into actual decisions, I relate the survey responses on investment to changes in the capital stock in balance sheet data. A planned decrease in investment reported in the survey implies a 5% decline in the capital stock in the following year.

remain robust when controlling for subjective first and second moments, underlining that macro tail risk beliefs matter in their own right and do not operate solely through changes in first and second moments. The implied effect size is substantially larger than in the observational approach, consistent with cleaner, experimentally induced belief shifts that are less affected by measurement error.

In the third approach ("experimental approach"), I conduct another survey experiment, where I confront firms with different hypothetical macroeconomic outlooks in a vignette using the ifo Management Survey. This allows me to test the proposed mechanism on ambiguity about firm exposure, as explained above. The outlooks have the same mean and variance, but varying higher-order moments such as skewness, resulting in different macro tail risk. Firms decide in which outlook they would invest more. Consistent with the results of the other two approaches, firms are significantly less likely to invest when there is substantial macro tail risk. A key advantage of the vignettes is that the outlooks fix the probability of a macro tail event, allowing me to isolate the role of firms' exposure beliefs, the second layer of macro tail risk. I relate the firms' investment decisions in the vignette to their expected exposure scenarios in the case of a macro tail event. As predicted by the model, strongly negative worst-case exposure is highly associated with investing less in the outlook incorporating substantial macro tail risk, controlling for average and best-case exposure.

To rationalize the empirically documented negative effect of macro tail risk beliefs on investment, explore the aggregate consequences, and draw policy implications, I propose a quantitative heterogeneous firm model. In the model, firms choose their optimal capital stock exposed to stochastic aggregate and idiosyncratic productivity as well as capital adjustment costs. As introduced in the stylized model, firms differ in their expected exposure scenarios in the presence of a macro tail event, which corresponds to low aggregate productivity. I calibrate the model using standard parameters and my empirical estimates. I then simulate an increase in macro tail risk expectations without an actual realization of the macro tail event: news of higher macro tail risk strongly dampens investment. Aggregating across firms informs about macroeconomic dynamics: higher macro tail risk generates a recession, where the distribution of firm investment growth is left skewed with a fat left tail due to the reaction to different worst-case exposures embedded in the policy functions.

Next, I study how monetary and fiscal policy can stimulate investment after an increase in macro tail risk, comparing a world with and without ambiguous exposure. I conduct counterfactual analyses with credible policy rule changes that act as automatic stabilizers

(Dolls, Fuest and Peichl, 2012, Edgerton, 2010). Counteracting monetary policy in the form of an interest rate cut in a macro tail event significantly stimulates investment in both worlds. For fiscal policy, I consider a rule-based switch to symmetric corporate taxation—similar to generous loss carrybacks that allow firms to offset current losses against past profits to obtain tax refunds—in macro tail events. This policy mitigates the negative investment response to higher macro tail risk beliefs by 20–25% in the world with ambiguous exposure, while having little effect without ambiguity, as firms expecting large worst-case losses benefit most from the switch to symmetric taxation.

Related literature I contribute to five strands of the literature. First, the paper adds to the literature examining macro tail risk beliefs. The approach of directly eliciting macro tail risk beliefs was pioneered by Shiller (2000), who elicits stock market crash expectations. Subsequent surveys have also captured other macro tail event beliefs of investors (Giglio et al., 2021, Goetzmann, Kim and Shiller, 2024) or households (Beutel and Stockerl, 2023, Dietrich, Müller and Schoenle, 2023).[4] This study is the first to ask firms about their beliefs regarding a range of macro tail events and their expected exposure in a large panel.

Second, I contribute to the literature on the importance of firm expectations for decision-making, focusing on investment. Most of the evidence is based on firm-level expectations and uncertainty about the business outlook, often measured by firms' sales growth forecasts. For instance, Gennaioli, Ma and Shleifer (2016) document a dominant role for sales growth expectations in explaining changes in investment. Guiso and Parigi (1999) and Fiori and Scoccianti (2023) show negative effects of higher subjective sales growth uncertainty on investment. Alfaro, Bloom and Lin (2023) measure uncertainty using realized and option-implied volatility and also find a negative impact on investment. Bachmann, Elstner and Sims (2013) exploit time-series variation in firm-level uncertainty and document a negative effect on economic activity.[5] Evidence is more limited regarding the influence of firms' macro expectations on decision-making. An exception is Kumar, Gorodnichenko and Coibion (2023), who provide causal evidence for the negative effects of aggregate uncertainty on

[4] Roth and Wohlfart (2020) elicit household expectations on the likelihood of a fall in GDP. They find elevated recession expectations and show that people extrapolate to their personal unemployment prospects.

[5] Hassan et al. (2019) construct a firm-level measure of political uncertainty based on earnings calls and document a negative impact on firms' investment. Hassan et al. (2023) develop a similar measure capturing firms' exposure to epidemic-related uncertainty and report a negative impact on stock returns. Relatedly, newspaper-based macro indices show that economic policy uncertainty (Baker, Bloom and Davis, 2016) and geopolitical risk (Caldara and Iacoviello, 2022) are associated with lower investment.

firm decisions.[6] In this paper, I show that firms' subjective beliefs about macro tail events are also an important driver of investment decisions. This effect persists after conditioning on subjective first and second moments.

Third, there is a rapidly growing literature highlighting the importance of higher-order moments for economic dynamics. A consistent finding is the procyclical skewness of economic outcomes, which drives the business-cycle (Iseringhausen, Petrella and Theodoridis, 2023). Most closely connected is the work by Salgado, Guvenen and Bloom (2023), who focus on firm growth rates and also document procyclical skewness.[7] Complementary to this, I provide direct firm-level evidence that subjective higher-order macro moments significantly influence decision-making. Based on my empirical results, I propose a mechanism in a quantitative model that generates a fat left tail in recessions after a macro tail risk news shock.

Fourth, motivated to explain the equity premium puzzle, there is a large body of work introducing rare disasters into asset pricing models (e.g., Barro, 2006, Gabaix, 2012, Longstaff and Piazzesi, 2004, Rietz, 1988, Wachter, 2013) and business cycle models (e.g., Gourio, 2012, Kozlowski, Veldkamp and Venkateswaran, 2020). Backus, Chernov and Martin (2011) and Kelly and Jiang (2014) infer macro tail risk from financial markets, using option prices and the cross-section of returns, respectively.[8] I add to this literature by providing direct empirical evidence on the effects of macro tail risk on investment by exploiting variation in macro tail risk beliefs of firm decision makers.

Fifth, the heterogeneous firm model builds on Cooper and Haltiwanger (2006) and is a stripped-down version of more general models that carefully analyze the effects of uncertainty shocks at the firm level on investment and economic dynamics (e.g., Alfaro, Bloom and Lin, 2023, Bachmann and Bayer, 2014, Bloom, 2009, Bloom et al., 2018). I introduce heterogeneous exposure to aggregate downside risk into this model class. The mechanism in the model is based on ambiguity aversion, which has already been shown to be an important driver of the business cycle and portfolio decisions (e.g., Bianchi, Ilut

[6]For inflation expectations, there is more causal evidence regarding the effects on firms' decisions (Coibion, Gorodnichenko and Kumar, 2018, Coibion, Gorodnichenko and Ropele, 2020, Ropele, Gorodnichenko and Coibion, 2022).

[7]Procyclical skewness is also documented for income risk (Busch et al., 2022, Guvenen, Ozkan and Song, 2014) and option-implied stock returns (Dew-Becker, 2024).

[8]This also touches on the empirical asset pricing literature, which shows that investors care more about downside than upside risk sensitivity (Ang, Chen and Xing, 2006, Lettau, Maggiori and Weber, 2014). Relatedly, Fiore, Martin and Nagler (2024) show that corporate investment decisions are affected through a risk-based disaster-vulnerability channel.

and Schneider, 2018, Dimmock et al., 2016, Ilut and Schneider, 2014, Ilut, Luetticke and Schneider, 2025). In the literature, ambiguity is typically about aggregate technology, while I introduce ambiguity about idiosyncratic exposure to macro tail events. Hence, the effects of ambiguity scale with increases in macro tail risk, with implications for, among other things, the effectiveness of policy.

The remainder of this paper is organized as follows. In Section 2, I introduce the data and characterize the nature of macro tail risk beliefs. Section 3.1 provides a conceptual framework. Section 3.2 then relates macro tail risk beliefs to firm investment decisions using observational variation, while Section 3.3 presents experimental evidence from an RCT (Section 3.3.1) and from hypothetical scenarios (Section 3.3.2), respectively. In Section 4, I present a quantitative heterogeneous firm model and analyze the effects of macro tail risk news shocks in interaction with policy. A final section concludes.

2 Nature of macroeconomic tail risk expectations

How do firms assess the subjective probability of a macro tail event occurring? In this section, I introduce the firm survey and document the nature of firms' macro tail risk expectations over time. In addition, I analyze how macro tail risk expectations are associated with firms' expectations about their own business. Lastly, I examine firms' beliefs about their exposure to macro tail events.

2.1 ifo Business Survey

To study the nature of firms' macro tail risk expectations, I add new questions to the ifo Business Survey (IBS). Since 1949, the ifo Institute has conducted the IBS, a monthly survey of about 9,000 German firms that was first used for research by Theil (1955).[9] The survey is used to provide business sentiment indicators in Germany, such as the renowned ifo Business Climate Index, which is among the top 20 macro news events moving global asset prices (Kerssenfischer and Schmeling, 2024) and one of Bloomberg's "12 Global Economic Indicators to Watch." Answers to the regular questions of the survey are reported for the EU Harmonized Business Survey. The ifo Institute incentivizes participation in the survey by automatically providing participants with the survey results free of charge as a thank you.

[9]Other papers that use the IBS include, for example, Bachmann and Elstner (2015), Bachmann et al. (2025), Bachmann, Elstner and Sims (2013), Buchheim et al. (2022), Buchheim, Link and Möhrle (2024), Enders, Hünnekes and Müller (2022), Link et al. (2023).

To further encourage participation in the IBS, this report contains more detailed information, such as more disaggregated sectoral data, than the publicly available results.

The panel dimension of the survey has a low attrition rate, making it well-suited for studying the expectations and behavior of firms over time. For more details and a comparison to other firm surveys, see Born et al. (2022). The IBS is representative of the German economy (Hiersemenzel, Sauer and Wohlrabe, 2022), enabling statements about macroeconomic effects. Crucially for analyzing the effects of expectations on decision-making, the survey is typically answered by the CEO or owner of the firm (Hennrich, Sauer and Wohlrabe, 2023). The high quality of the survey is also reflected in comparatively little dispersion in macroeconomic point forecasts across firms and their close alignment with professional forecasters, as documented by Link et al. (2023).

Subjective expectations and uncertainty The survey contains a wide range of both qualitative and quantitative questions on firms' expectations and uncertainty about their own business. In this paper, I focus on the quantitative questions.

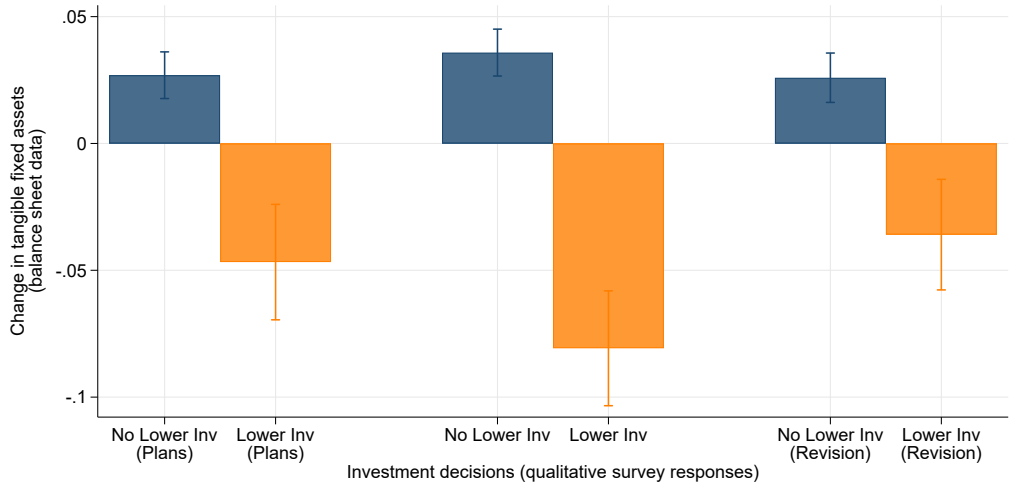
In the main part of the survey, firms report subjective expectations regarding their own business over the next six months with a slider on a visual analog scale from 0 to 100, where 50 means no change. Similarly, firms report subjective uncertainty about their own business over the same period also with a slider on a visual analog scale from 0 to 100, where 50 means average uncertainty.

A subset of firms participates in the "uncertainty module" initiated by Bachmann et al. (2025). Here, firms report their sales growth expectations in % for different horizons—one quarter ahead, one year ahead, and average annual growth two to four years ahead—in the worst, average, and best case. I use the average-case sales growth expectations as an alternative measure for business expectations and the range between best- and worst-case sales growth expectations as an alternative measure of business uncertainty. Appendix A provides the wording of all survey questions used, translated into English.

Firms' business decisions Importantly, the IBS also elicits information on business decisions. Most relevant for my subsequent analysis is the information on investment, which is collected twice a year in the survey. The questions are qualitative in nature and are framed in terms of changes compared to the previous year, see Appendix A for the wording of the questions. My focus is on the November survey waves, in which firms report their investment plans for the next year as well as their investment in the current year.

Do the qualitative survey responses on investment decisions map into actual changes in the capital stock? For a subset of firms, I can link the survey data to annual balance sheet

Figure 1: Survey responses on investment and change in tangible fixed assets



Notes: The figure shows how survey responses on investment (indicators) predict changes in the tangible fixed assets (balance sheet data). The bars represent the point estimates of three separate regressions based on Equation (1). The blue bars show the estimate of the constant α. The orange bars show the estimate of $\alpha+\beta$. Sample: 2016–2019.

data provided by Orbis. While I cannot use the balance sheet data directly in my analysis due to the smaller sample size and missing data for 2021 to 2024, I can examine how a survey response about changes in investment generally translates into changes in the stock of tangible fixed assets (a major component of the capital stock) on the balance sheet between 2016 and 2019. To do this, I run the following regression:

$$\Delta log(Capital_{i,t}) = \alpha + \beta \mathbb{1}\{\Delta Investment_{i,t} < 0\} + \gamma_{t,s} + \delta_i + \varepsilon_{i,t}. \tag{1}$$

For the survey responses on investment, I use (i) an indicator for a planned decrease in investment in the next year, (ii) an indicator for a realized decrease in investment in the current year, and (iii) an indicator for a downward revision of investment compared to previous plans. I exploit only the variation within firms at a given point in time within industries by including firm fixed effects δ_i and year$\times$two-digit NACE industry fixed effects $\gamma_{t,s}$. Figure 1 shows the estimated average year-over-year change in tangible fixed assets $\Delta log(Capital_{i,t})$ when the respective indicator is zero (in blue) or one (in orange).

The results show that the survey responses on investment predict large and significant changes in the capital stock. For example, when firms in the November wave of the survey report that they plan to reduce investment in the next year, tangible fixed assets actually fall by almost 5% on average in that following year. When firms do not plan to reduce

investment, the capital stock increases by more than 2% on average. Hence, the qualitative survey responses predict very large movements in investment.

2.2 Firms' macroeconomic tail risk expectations

In October 2022, I supplemented the regular IBS with a set of questions eliciting firms' subjective probability of the occurrence of four specific macro tail events, which reads as follows:

What do you think:

What is the probability that the following events will occur in the next 5 years?

[Your answers can each be in a range between 0 and 100%, where 0 means absolutely unlikely and 100% means absolutely certain.]

1. *A drop in annual GDP in the magnitude of at least 5%: __*
2. *A financial crisis (with a magnitude similar to the 2008/2009 financial crisis): __*
3. *A pandemic (with a magnitude similar to the COVID-19 pandemic): __*
4. *An escalation of geopolitical conflicts (direct war involvement of NATO): __*

I chose these four scenarios because a large drop in GDP serves as a reduced-form measure of macro tail events, while the other three scenarios capture the typical reasons why the economy ends up in a macro tail event (Barro and Ursúa, 2012, Nakamura et al., 2013). I have added a short explanation to the events, where the references to recent crises should help participants to get an idea of the magnitude. The geopolitical scenario is framed as general as possible in order to capture overall geopolitical tensions. The range of five years is chosen to overcome potential issues with stating small probabilities. In the paper, I mainly focus on the scenario of a drop in annual GDP of at least 5%. Results for the other, more specific scenarios are mostly presented in the Appendix and point in the same direction.

It is important to note that there is no 'correct answer' to these questions, as such events are notoriously difficult to predict. Even when relying solely on the frequency of past occurrences, the small number of events can result in drastically different conclusions. Over the past 100 years, there have been four macroeconomic tail events in Germany: (i) the COVID-19 pandemic, (ii) the Great Recession, (iii) World War II, and (iv) the Great Depression. Thus, a reference to the last 100 years—20 five-year windows—implies a frequency of 20% in a five-year window. Considering only the post-WWII period leads to a lower probability, while looking at the last 20 years implies a probability of 50%.

I repeated the questions about macro tail beliefs in the following years in October 2023, 2024, and 2025. The panel dimension of the survey enables me to study changes in beliefs

within firms over time. Panel (a) of Figure 2 shows the cross-sectional distribution of firms' subjective probability of a large drop in GDP over the four survey waves, while Panel (b) depicts the firm-level revisions of the subjective probability from year to year.

Observations from October 2022 reveal notably elevated expectations on average: the median firm, marked with crosses, expects a large decline in GDP ($\geq 5\%$) with 50% probability, a financial crisis with 40%, a pandemic with 10%, and a geopolitical escalation with 30% probability over the next five years. In the subsequent years, the subjective probability of a significant decline in GDP fell but remained elevated at 20 percentage points (pp). The median subjective probability of a financial crisis declined to 20 pp and then edged up again in 2025, while median probabilities for the pandemic and geopolitical escalation scenarios stayed broadly unchanged.[10] The particularly high subjective probabilities in October 2022 are consistent with the fears discussed in the media at that time of a major recession caused by a cut in energy supplies from Russia (Bachmann et al., 2022, Moll, Schularick and Zachmann, 2023).

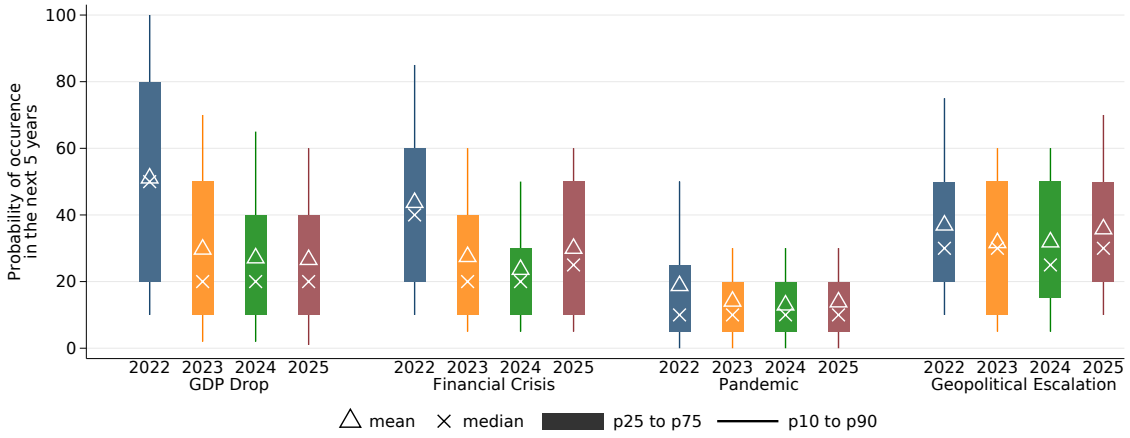
We also observe a large cross-sectional dispersion across firms. For example, the interquartile range spans from 20 to 80 percent for the GDP drop scenario, 20 to 60 percent for the financial crisis, 5 to 25 percent for the pandemic, and 20 to 50 percent for the geopolitical escalation scenario in October 2022. In Appendix D, I analyze the drivers of the level differences across firms. The results suggest an important role for experience in shaping firms' macro tail risk expectations.

Firms strongly revise the subjective probability of a macro tail event from year to year. The panel dimension of the IBS allows me to study, how macro tail risk beliefs are updated over time at the firm level. Panel (b) of Figure 2 shows year-to-year revision of these subjective probabilities. From 2022 to 2023, most firms strongly revise downward their subjective probability of a large drop in GDP, but some firms also revise upward: at the 10th percentile, firms increase their subjective probability by 15 pp. While on average macro tail risk beliefs remain relatively stable over the next years, p10-to-p90 revisions span from -40 to $+30$ from 2023 to 2024 and from -30 to $+30$ from 2024 to 2025. This implies substantial within-firm updating over time, in both directions. I exploit this large variation in within-firm revisions later to identify the relationship with firms' investment decisions. Also for the three more specific macro tail events, firms substantially revise their subjective probabilities over time. However, the magnitude of these changes is somewhat smaller.

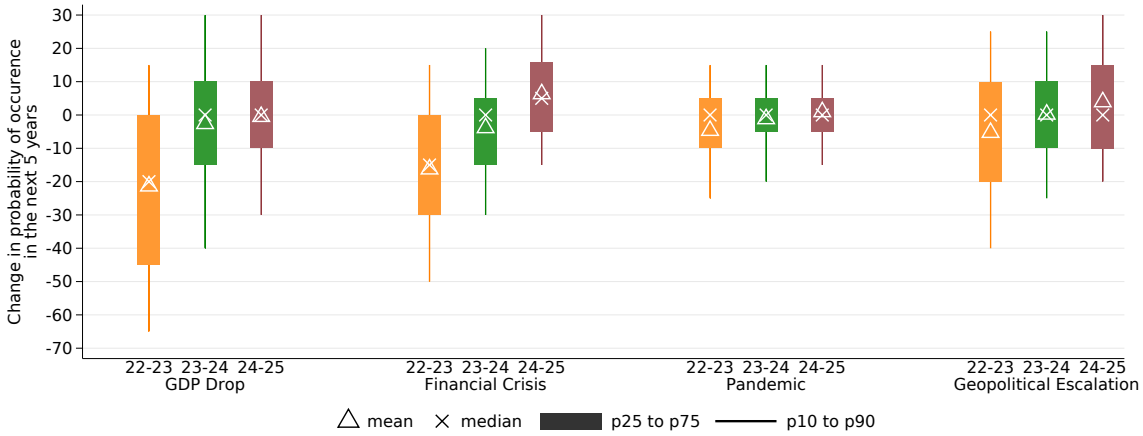
[10]The strong fluctuations in macro tail risk expectations are consistent with Orlik and Veldkamp (2022), who provide a framework in which new data can lead to large revisions in tail probabilities.

Figure 2: Distribution of firms' macroeconomic tail risk expectations over time

(a) Distribution of subjective probabilities



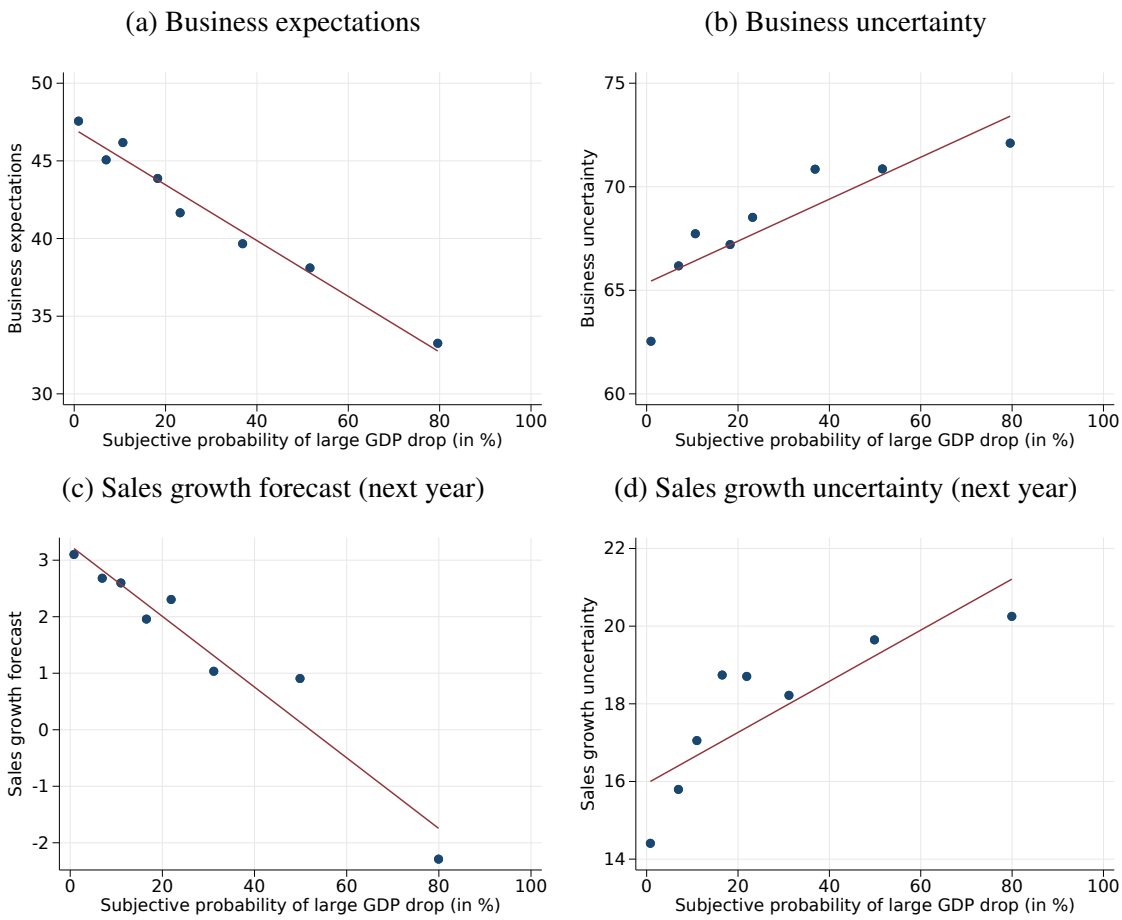
(b) Distribution of year-to-year revisions of subjective probabilities



Notes: Panel (a) shows the cross-sectional distribution of firms' subjective probability of four macro tail events over the next five years in October 2022, 2023, 2024, and 2025 (balanced panel). Panel (b) shows the cross-sectional distribution of firm-level revisions of firms' subjective probability of four macro tail events from 2022 to 2023, 2023 to 2024, and 2024 to 2025. The triangles indicate means, and the crosses indicate medians. The boxes correspond to the interquartile ranges. The lines correspond to the p10-p90 ranges. The question on the respective macro tail event is shown in the text.

Relation to subjective expectations and uncertainty Are macro tail risk expectations associated with firms' business outlooks? It is conceivable that firms might not incorporate macro tail risk expectations into their own business outlooks, particularly if they exhibit overconfidence (Malmendier and Tate, 2015) or focus on business or industry-specific news when forming expectations (Andrade et al., 2022, Born et al., 2024). However, if they do so, all else equal, a rise in the subjective probability of transitioning to a macroeconomic tail

Figure 3: Relation of macro tail risk expectations and business outlooks



Notes: This figure displays binned scatter plots between the subjective probability of the occurrence of a large decline in annual GDP ($\geq$5%) in the next five years and firms' business outlooks. In Panels (a) and (b), business expectations and uncertainty are measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In Panel (c), the alternative first moment measure is sales growth expectations for the next year in %. In Panel (d), the alternative second moment measure is sales growth uncertainty, constructed as the span between best- and worst-case scenarios in percentage points. Appendix A provides the wording of the questions.

risk event in the future should lead to a reduction in firms' average business expectations (first moment) and a rise in their business uncertainty (second moment).

Higher macro tail risk expectations strongly predict more negative business expectations and higher business uncertainty. Figure 3 shows binned scatter plots of the subjective probability of a GDP drop of at least 5% and firms' business expectations in Panel (a) and firms' business uncertainty in Panel (b). A one standard deviation increase in macro tail risk expectations (about 30 pp) is associated with 5 units lower business expectations and 3 units higher business uncertainty. For comparison, during the COVID-19 pandemic in 2020, business expectations declined by about 17 units and business uncertainty increased

by about 18 units from peak to trough, see Appendix Figure A1. Over 2019–2025, the time-series standard deviations of business expectations and business uncertainty are 5 and 7 units, respectively.

A similar picture emerges, when considering the alternative business outlook measures that directly elicit sales growth expectations in % for the next year, as visible in Panels (c) and (d). A standard deviation increase in macro tail risk expectations predict about 2 pp lower sales growth expectations and about 2 pp wider span and hence higher uncertainty about sales growth for the next year. Appendix Figure A2 shows that also the other three more specific macro tail events are associated with firms' business outlooks.

In Appendix Table A2, I test the link between firms' macro tail risk expectations and business outlooks more formally. Columns 1 and 4 report estimates using pooled variation. Columns 2 and 5 add time fixed effects, so identification comes from cross-sectional variation within each period; the results are very similar. In the next step, I only consider year-to-year revisions, exploiting within-firm variation. To mitigate potential reverse causality—specifically, using local information to forecast aggregate growth—I control for year×industry fixed effects and the current business situations of firms (Columns 3 and 6). Consistent across specifications, upward revisions in the subjective probability of a large GDP drop are associated with lower business expectations and higher uncertainty.

Ultimately, for decision-making, what matters is whether macro tail risk beliefs affect firms' assessment of their *own business* prospects. Nonetheless, for completeness, I also assess to what extent macro tail risk expectations are associated with firms' macroeconomic point forecasts. All else equal, an increase in macro tail risk should also lower the mean of firms' macroeconomic forecast distributions, since more probability mass is placed in the left tail. In November 2024, the IBS elicits firms' GDP growth expectations for 2025, allowing me to test this relationship in the cross section.

A higher subjective probability of a large GDP drop over the next five years significantly predicts lower one-year-ahead GDP growth point forecasts, see Appendix Figure A3. However, across the wide range of subjective tail risk probabilities, average expected GDP growth varies only within a relatively narrow range and remains close to the Bundesbank's professional forecast at the time. Thus, although macro tail risk is mechanically linked to the mean of the forecast distribution, cross-firm differences in perceived macro tail risk translate only weakly into differences in average GDP growth expectations. In sum, this section indicates that macro tail risk expectations represent a new dimension of heterogeneity that may influence firms' decision-making. In Section 3, I test whether macro tail risk expectations

affect firms' investment decisions, even after conditioning on their first and second moment expectations.

2.3 Firms' expected exposure to macro tail events

For firms, there is a second layer of macro tail risk expectations, which is their belief about what happens to the firm in the case of a macro tail event. To better understand these beliefs, I elicit the expected firm exposure to a hypothetical 5% decline in German GDP using both structured and open-ended survey questions.

Structured survey question To obtain quantitative exposure beliefs of firms, I elicit expected exposure to a 5% decline in German GDP in terms of real sales changes. Since firm exposure is notoriously difficult for managers to predict, I ask for potential exposure *scenarios* in the worst case, on average, and in the best case. Specifically, I added the following question to the IBS in October 2023:

Imagine a macroeconomic crisis in Germany (GDP collapses by ≈5% in a year). To what extent do you expect that your firm would be affected? Please give a rough estimate of the potential impact on your firm's real sales in percent.

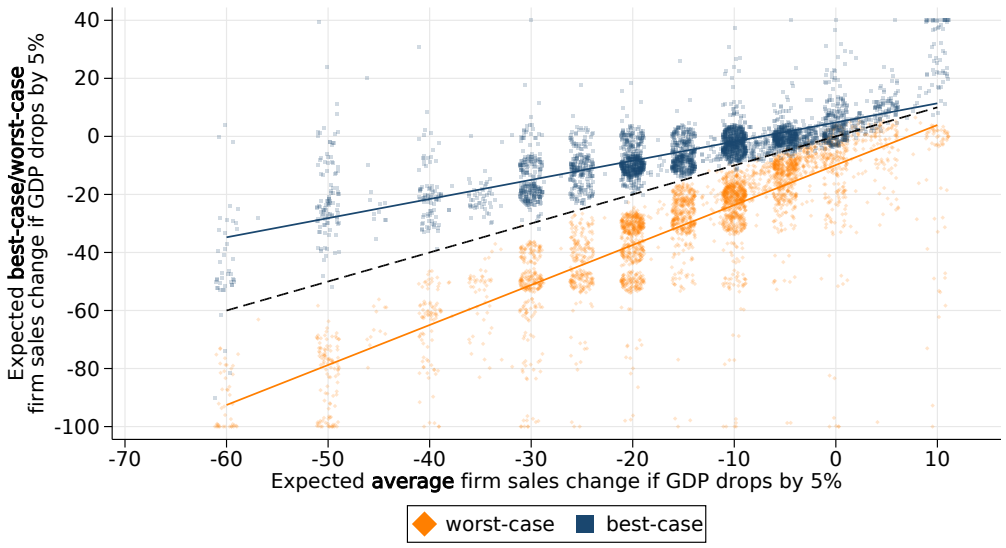
- *in the best case:* ___ %
- *on average:* ___ %
- *in the worst case:* ___ %

Firms' expected average exposure to a large drop in GDP is strongly heterogeneous. The median firm expects a 10% decline in real sales in the average scenario, while firms at the 10th percentile expect no change in sales and firms at the 90th percentile expect a 30% decline, see Appendix Table A3. Figure 4 shows, in a jittered scatter plot, how firms' expected average exposure (horizontal axis) relates to their expected best- and worst-case scenarios (vertical axis; shown in blue and orange, respectively). We observe that even conditional on expected average exposure, firms report very different best- and worst-case exposures. On average, the difference between the worst-case exposure and average exposure is larger than the difference between the best-case exposure and average exposure, indicating a left-skewed exposure distribution, consistent with the findings of Salgado, Guvenen and Bloom (2023).[11]

There is substantial exposure uncertainty, measured by the distance between best- and worst-case exposure scenarios. For the median firm, there is a 20 pp difference between

[11] Appendix Figure A4 shows that higher subjective exposure beliefs are slightly positively correlated with a higher subjective probability of the occurrence of a macro tail event, but not with changes in those subjective probabilities.

Figure 4: Expected firm exposure scenarios in case of a 5% decline in GDP



Notes: The figure shows how firms' expected average exposure scenario relates to their worst- and best-case scenarios in terms of real sales changes in case of a 5% decline in German GDP. The survey question was elicited in the October 2023 wave. Observations are excluded when expected worst-case sales growth exposure in the 5% GDP-drop scenario is $\geq 5\%$. For graphical presentation, values on the horizontal axis are winsorized below -60% and above 10%, and values on the vertical axis above 40%. The scatter plot is jittered—random noise is added to the scatter—to align with data-protection rules and avoid overplotting. The blue (orange) line shows the fitted linear regression of best-case (worst-case) exposure on average exposure. The black dashed line is the 45-degree line.

the expected best- and worst-case exposure. This uncertainty is systematically related to expected average exposure: while the best- and worst-case exposures are close to the dashed 45-degree line for expected average exposures around zero, the gap widens as the average exposure becomes more negative.[12]

Open-ended survey question To gain a deeper understanding of how managers think about what happens to their firm in the case of a macro tail event, I incorporated an open-ended question to the survey. The main advantage of the open-ended survey question format is that it prevents respondents from being influenced by predefined response categories, see Haaland et al. (2024) for a review on open-ended questions. In my setup, this approach allows firms to freely express their thoughts on exposure beliefs. Specifically, I posed the following question in the IBS in June 2024:

[12]In Appendix Table A1, I show that greater exposure to the Great Recession or COVID-19 predicts more negative worst-case expectations. This both validates the measure—subjective exposure beliefs track realized exposure—and is consistent with firm-level scarring effects, whereby severe shocks persistently shape expectations (Kozlowski, Veldkamp and Venkateswaran, 2020).

To what extent can you generally forecast the effects of such a potential macroeconomic crisis (GDP collapses by around 5% within a year) on your real sales? Please let us know your thoughts on this macroeconomic scenario here:

The responses are hand-coded into categories by a research assistant following a codebook provided in the Appendix Table A15. I received 2220 responses with an average length of 161 characters. The main takeaway from analyzing the exposure narratives of firms is that there is substantial uncertainty about potential exposure to macro tail events. In the following, I list the three main findings that lead to this conclusion. Appendix E provides a more detailed discussion of the open-ended text responses.

First, the most common response from firms directly expresses major difficulties in forecasting exposure to macro tail events. Among those who comment on assessability, 94% report that it is difficult or even (almost) impossible to assess their potential exposure to such events. Second, when firms share exposure in terms of quantitative sales changes, they tend to report scenarios that deviate from central tendencies. In fact, they are more likely to share exposure in terms of ranges or max/min scenarios rather than averages. Third, firms refer to their—sometimes heterogeneous—exposure to past macro tail events. This highlights that firms have to rely on a small set of experiences—typically mentioning the Great Recession and COVID-19—to gauge their exposure to future macro tail events.

3 Macroeconomic tail risk expectations and firm decisions

In this section, I analyze how macro tail risk expectations influence firms' decisions, focusing on investment. After presenting a stylized model, I empirically assess the role of macro tail risk expectations for investment decisions, using both observational and experimental variation.

3.1 Stylized model framework

Before diving into the empirical analysis, I illustrate with a stylized model, how a firms' macroeconomic tail risk expectations may affect the investment decision of the firm.

Model setup Consider a firm choice model with heterogeneous exposure to macro tail events. Firms, indexed by i, use capital, which fully depreciates each period, to produce output with a decreasing return to scale production function $A_i k^{\alpha}$, where A_i denotes the productivity of the firm.

Differences in productivity across firms arise only due to firm-specific exposure to aggregate productivity. Aggregate productivity A is stochastic and follows a two-state Markov

process, switching between a high (A^h) and low (A^l) productivity state. Here, A^l represents periods of severe economic downturns, i.e. macro tail events. For simplicity, all firms have the same exposure to the normal productivity state A^h. However, there is heterogeneous exposure β_i to the macro tail event A^l. Firms contemplate three different scenarios of β_i: a worst-case, average-case, and best-case scenario, such that $\beta_i \in \{\beta_{i,worst}, \beta_{i,average}, \beta_{i,best}\}$. Therefore, the expectation about future productivity for a given firm in a current high productivity state can be written as follows:

$$\mathbb{E}[A_{i,t+1}|A^h] = p_{h\to h}A^h + p_{h\to l}[A^h - \mathbb{E}[\beta_i](A^h - A^l)] \tag{2}$$

where $\mathbb{E}[A_{i,t+1}]$ denotes expected productivity of the firm and $\mathbb{E}[\beta_i]$ is the expected exposure.[13] For now, I assume that firms can confidently assess probabilities to the different exposure scenarios. This assumption will be subsequently relaxed by introducing ambiguous exposure. Intuitively, the exposure of the firm β_i scales the aggregate productivity change $(A^h - A^l)$, where for firms with $\mathbb{E}[\beta_i] = 1$ own productivity equals aggregate productivity in the macro tail event.

The decision to introduce these different exposure scenarios in the model is motivated by the fact that firms rarely experience macro tail events as well as evidence on scenario planning of firms by Graham (2022) and Bachmann et al. (2025). The imperfect knowledge about firms' exposure adds a second layer of uncertainty: There is uncertainty not only about future macroeconomic conditions, but also about firm-specific exposure in severe recessions, a situation of compound risk.

Investment decision Firms' objective is to maximize expected profits. Firms are risk neutral and discount the future with $1/(1+r)$, where r is the cost of capital. In this stylized setup, the optimal capital stock is:

$$k_i^* = \left(\frac{\alpha\mathbb{E}[A_{i,t+1}|A^h]}{1+r}\right)^{\frac{1}{1-\alpha}} \tag{3}$$

Higher expected productivity $\mathbb{E}[A_{i,t+1}|A^h]$ leads to a larger optimal capital stock, which is equal to investment in this simple model. For a given expected exposure $\mathbb{E}[\beta_i]$, we can state that an increase in the subjective probability of a macro tail event $p_{h\to l}$ has a first-moment effect on the optimal level of capital, as visualized in Figure 5 with the blue line. When a firm has a higher expected exposure $\mathbb{E}[\beta_i]$, this would imply a larger first-moment

[13] For simplicity, I assume that the average-case exposure scenario $\beta_{average}$ equals the firm's expected exposure.

effect on the optimal capital stock, operating through the expectation of productivity. Note that only the expectation of the next period's production matters for the choice of capital. Beliefs about higher order moments do not play a role in this setup. For instance, an increase in uncertainty through a mean-preserving spread of the aggregate productivity process or changes in worst-case and best-case firm-specific exposure scenarios have no effect on the optimal capital stock.

Ambiguity aversion How can macro tail risk expectations affect investment decisions beyond the first moment? In general, there are many potential sources of non-linearity in firms' policy functions that imply effects of changes in macro tail risk expectations on investment decisions beyond the first-moment effect. In the following, I focus on a novel mechanism that takes into account the empirically documented substantial uncertainty of firms about their exposure to macro tail events.

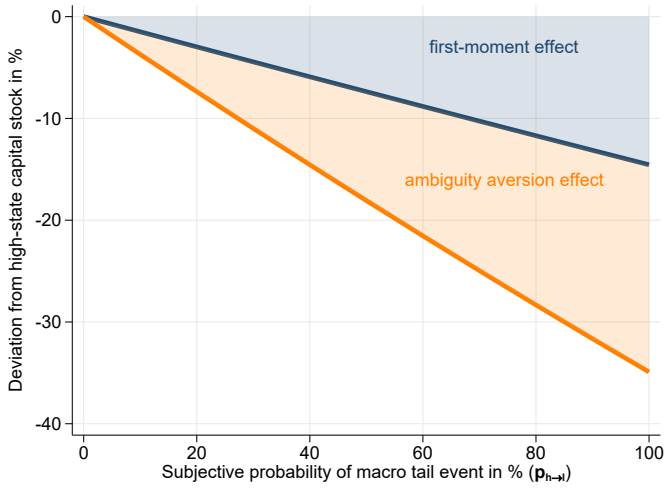
Specifically, I make the arguably reasonable assumption that firms are not confident enough to assign probabilities to the exposure scenarios. This is an instance of ambiguity, which refers to uncertainty when—distinct from risk—the odds are not known, see Ilut and Schneider (2022) for a review. In general, uncertainty about probability assessments can be described by the size of the belief set governing the distribution of the next period state, as conceptualized by Gilboa and Schmeidler (1989). In the context of ambiguous exposure to macro tail events, I parameterize the set of beliefs by a set of event realizations consisting of the firm-level exposure scenarios $\beta_i \in \{\beta_{i,worst}, \beta_{i,average}, \beta_{i,best}\}$.[14]

Agents prefer to know the odds of an event—they are ambiguity averse. Indeed, a large body of experimental work shows that ambiguity aversion is a widespread phenomenon, see Trautmann and Van De Kuilen (2015) for a review.[15] Following Gilboa and Schmeidler (1989), agents deal with ambiguity by choosing actions *as if* they were using the most pessimistic plan from the belief set. Through the lens of the model, firms act *as if* their worst-case exposure to the macro tail event, that minimizes expected future output, will be realized when the economy is in A^l. Thereby, the optimal capital stock decreases beyond the first-moment effect as the subjective probability of a macro tail event increases, as visualized in Figure 5 with the orange line. One key advantage of ambiguity is its source dependence, meaning that it does not influence decisions made under risk, where probabilities are known.

[14] Specifying the uncertainty about probability assessments by a set of event realizations is a standard approach in the literature. For example, Ilut and Schneider (2014) parameterize ambiguity about TFP growth by an unknown TFP component with an interval of means centered around zero.

[15] Interestingly, there are studies showing that ambiguity aversion especially arises in the context of compound risk (Abdellaoui, Klibanoff and Placido, 2015, Halevy, 2007).

Figure 5: Optimal capital stock and macro tail risk expectations



Notes: This figure shows the percentage deviation from the high productivity state ($A^h = 1$) optimal capital stock due to changes in the expected probability of transitioning to the low productivity state ($A^l = 0.9$) in the next period. The first-moment effect is visualized in blue and arises from the fact that the subjective probability of a macro tail event influences expected productivity. The ambiguity aversion effect is visualized in orange and is determined by firms' expected worst-case exposure to the low productivity state. The interest rate is set to $r = 0.02$ and output elasticity $\alpha = 0.33$. The calibration of the exposure to macro tail events is based on the median firm in the survey, see Table A3. Average exposure is $\beta_{average} = 1$ and worst-case exposure is $\beta_{worst} = 2.5$.

Thus, when the subjective probability of a macro tail event is very low, the model converges to a standard firm choice problem.

Note that while for actions—such as investment—there is an observationally equivalent model with pessimistic beliefs, this equivalence breaks down when we ask people about their forecast, such as firms' sales forecasts. To further illustrate this point, consider the classic Ellsberg paradox involving a choice between two urns, urn A with a known distribution of red and black balls (50/50 ratio) and urn B with an unknown distribution (Ellsberg, 1961). Although participants are indifferent between betting on a particular color from urn B with an unknown distribution—implying an expected 50/50 ratio—they show a clear preference for urn A with a known distribution over urn B. This behavior indicates that while their forecasts (e.g., the expected ratio of red to black balls) remain neutral, their actions—preferring the known risk of urn A over the ambiguity of the unknown in urn B—reveal an underlying aversion to ambiguity. This analogy underscores that firms' cautious behavior in the face of uncertainty does not imply pessimistic forecasts in surveys.

In Appendix F, I examine two alternative mechanisms: risk-averse shareholders in a Bayesian setting and bankruptcy risk. While both generate negative investment effects, matching the magnitudes implied by the ambiguity model requires implausibly high levels

of risk aversion or default risk. Moreover, unlike ambiguity, idiosyncratic risk diversifies away and therefore does not directly link investment to firms' worst-case exposure beliefs. Empirical tests in the next section further suggest that these alternatives are not the main drivers of the results.

3.2 Observational variation

To test empirically whether macro tail risk expectations shape investment decisions, I start by exploiting substantial firm-level variation in managers' subjective probabilities of a macro tail event. I elicit these probabilities in October 2022, 2023, 2024, and 2025, while investment plans for the next year are elicited one month later, in the November survey wave. I consider an indicator for a planned decrease in investment in the next year relative to the current year (see the previous section, which documents a strong relationship between investment plans and changes in firms' capital stock). I first study the predictive power of the subjective probability of a macro tail event for firms' investment plans in the cross-section. In a second step, I exploit the panel dimension of the survey and study within-firm revisions of macro tail risk beliefs over time.

3.2.1 Cross-sectional relationship

Higher macro tail risk expectations strongly predict lower investment plans. Panel (a) of Figure 6 shows the relationship between the subjective probability of a macro tail event in % and the probability of planning an investment cut in the next year in %, using a binned scatter plot and controlling for time fixed effects. Firms that assign a higher probability to a macro tail event over the next five years are substantially more likely to plan an investment cut in the subsequent year.

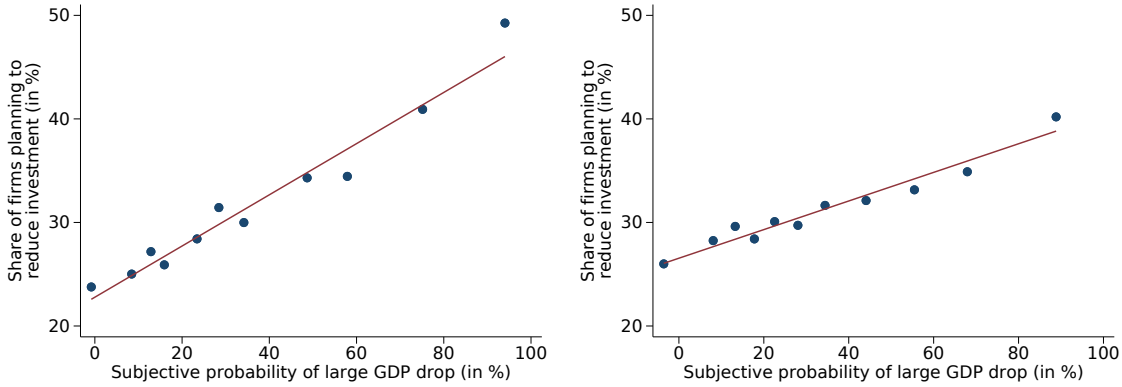
Table 1 reports the cross-sectional relationship between the subjective probability of a macro tail event in % and the probability of planning an investment cut in % for each year in Columns 1–4. For example, in 2022, a one standard deviation (30 pp) increase in the subjective probability of a macro tail event predicts an increase in the probability of decreasing investment by 6 pp. Given an unconditional probability of 21% to decrease investment, this corresponds to a 25% increase relative to the unconditional mean. The relationship is of similar magnitude in all four years, suggesting that it is a robust feature of the data. Column 5 corresponds to the pooled sample estimate with time fixed effects, as in Panel (a) of Figure 6.

Macro tail risk expectations remain strongly correlated with firms' investment plans, even after conditioning on subjective first and second moment expectations. Panel (b) of

Figure 6: Firms' macro tail risk expectations and investment plans

(a) Raw relation in the cross-section (no controls)

(b) Conditioned on business expectations and uncertainty



Notes: This figure shows binned scatterplots. The variable on the vertical axis is an indicator of a planned decrease in investment in the next year compared to the previous year, elicited in the November waves 2022–2025. The variable on the horizontal axis is the subjective probability of the occurrence of a large decline in annual GDP (≥5%) in the next five years, elicited in the October waves 2022–2025. Time fixed effects are absorbed. In Panel (b), it is controlled for firms' business expectations for the next six months and firms' business uncertainty for the next six months. Both are measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Appendix A provides the wording of the questions. Columns 5 and 6 of Table 1 display the corresponding point estimates. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 6, again, plots the subjective probability of a macro tail event against the probability of planning an investment cut. As a first check to what extent macro tail risk expectations matter in its own right for investment, I control for firms' business expectations and subjective uncertainty, as introduced in the previous section. While the slope flattens relative to the raw relationship, it remains economically meaningful significant.

Mirroring existing results in the literature, business expectations (first moment expectations) are negatively correlated with the probability of reducing investment in the next year and subjective uncertainty (second moment expectations) is positively correlated with the probability to reduce investment in the next year (Column 6). The coefficient on the subjective probability of a macro tail event shrinks substantially, indicating that part of the effect of macro tail risk beliefs operates through changes in first and second moments. However, the coefficient declines by less than half, suggesting that macro tail risk beliefs retain explanatory power for firms' investment plans beyond first and second moments.

As alternative measures of subjective first and second moments, I use quantitative sales growth forecasts, as introduced in the previous section. Macro tail risk beliefs again remain strongly predictive of firms' investment plans (Column 7). Notably, the quantitative sales growth measures attenuate the relationship between macro tail risk beliefs and investment

Table 1: Macroeconomic tail risk expectations and investment decisions

	Indicator for a Decline in Investment						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	2022	2023	2024	2025	2022–2025		
Subj. Prob. Macro Tail Event	0.21***	0.25***	0.30***	0.24***	0.24***	0.14***	0.18***
	(0.025)	(0.032)	(0.033)	(0.031)	(0.016)	(0.016)	(0.018)
Business expectations						-0.60***	
						(0.029)	
Business uncertainty						0.075***	
						(0.021)	
Sales growth forecast							-0.68***
							(0.057)
Sales growth uncertainty							0.11***
							(0.035)
Constant	20.8***	22.6***	25.2***	23.2***	22.9***	45.7***	23.3***
	(1.59)	(1.28)	(1.34)	(1.31)	(0.91)	(2.23)	(1.17)
N	3148	3099	3212	3815	13274	13274	7451
R^2	0.020	0.021	0.026	0.019	0.022	0.084	0.051

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025 (in %). The main explanatory variable is the firm's subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October waves 2022–2025. Time fixed effects are included in all specifications. Column (6) controls for firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Column (7) controls for firms' sales growth expectations and uncertainty for the next year. Sales growth uncertainty is measured as the span between best- and worst-case scenarios. Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

plans less than the reduced-form measures in Column 6. One potential reason is that they capture only expected revenue growth and uncertainty about revenue changes, whereas the reduced-form measures reflect a broader set of expectations. In fact, firms' business expectations may contain information beyond the first moment.

Also, for the other three more specific macro tail events—a financial crisis, a pandemic, and a geopolitical escalation—an increase in the subjective probability of occurrence strongly predicts lower investment, even when controlling for subjective first and second moments, see Appendix Table A4. The relationship is particularly strong for the financial crisis scenario and about half as strong for the pandemic and geopolitical escalation scenarios.

In 2024, I also observe firms' GDP growth expectations for the next year, elicited in November. When controlling for GDP growth expectations, the subjective probability of a large GDP drop has slightly stronger predictive power for investment plans than when controlling for business expectations (see Appendix Table A5). This suggests that controlling for firms' own business outlooks is more conservative than controlling for their average

macro outlook. One reason is that macro conditions matter to firms to different degrees: expectations about the firm's own business already incorporate heterogeneity in exposure, whereas GDP growth expectations reflect a common aggregate outlook. Through the lens of the stylized model, GDP growth expectations map to $\mathbb{E}[A_{t+1}]$, while business expectations capture $\mathbb{E}[\beta_i \times A_{t+1}]$.

3.2.2 Firm-level revisions

To move closer to a causal interpretation of the link between macro tail risk expectations and firms' investment decisions, I next exploit the panel dimension of the survey. Specifically, I construct firm-level revisions in macro tail risk beliefs, defined as the change in the subjective probability of a macro tail event in year t relative to year $t-1$: $\Delta\mathbb{P}_{i,t}(MacroTail) = \mathbb{P}_{i,t}(MacroTail) - \mathbb{P}_{i,t-1}(MacroTail)$. By taking first differences, I rely only on within-firm variation and thereby mitigate concerns that time-invariant firm characteristics may be correlated with both macro tail risk beliefs and investment decisions. As documented in the previous section, there is substantial within-firm variation in macro tail risk beliefs over the four-year panel, with firms frequently revising their beliefs both upward and downward.

In the empirical specification, I regress an indicator for a planned decrease in investment in year $t+1$ relative to year t, $\mathbb{1}\{\Delta Inv_{i,t+1} < 0\}$, on the revision in firm i's subjective probability that a macro tail event occurs within the next five years $\Delta\mathbb{P}_{i,t}(MacroTailEvent)$. To account for the mean-reverting nature of macro tail risk beliefs, I also control for the lagged level $\mathbb{P}_{i,t-1}(MacroTailEvent)$, since firms with higher tail risk beliefs in $t-1$ are more likely to revise them downward in t. In addition, I control for the firm's current and lagged business situation and include an indicator for whether the firm reduced investment from $t-1$ to t. In further specifications, I augment the regression with levels and revisions of subjective first and second moments at the firm level by including current and lagged business expectations and business uncertainty. Time fixed effects α_t flexibly absorb macroeconomic conditions. Standard errors are clustered at the 2-digit NACE industry level to allow for arbitrary correlation of the error term within industries across firms and over time:

$$\mathbb{1}\{\Delta Inv_{i,t+1} < 0\} = \alpha_t + \beta\Delta\mathbb{P}_{i,t}(MacroTail) + \theta\mathbb{P}_{i,t-1}(MacroTail) + \gamma X_{i,t} + \varepsilon_{i,t}. \quad (4)$$

An upward revision in the subjective probability of a macro tail event from the past to the current year significantly predicts that firms plan to cut investment. Table 2 reports

Table 2: Revisions in macroeconomic tail risk expectations and investment decisions

	Indicator for a Decline in Investment			
	(1)	(2)	(3)	(4)
Panel (a): Baseline controls (visual analog sliders)				
Δ Subj. Prob. Macro Tail Event	0.098***	0.067***		
	(0.024)	(0.025)		
× Low worst-case exposure			-0.0056	0.00090
			(0.044)	(0.066)
× High worst-case exposure			0.094***	0.096***
			(0.033)	(0.032)
N	7518	7518	5781	3910
R^2	0.13	0.15	0.14	0.15
Panel (b): Alternative controls (quant. sales expectations)				
Δ Subj. Prob. Macro Tail Event	0.14***	0.10***		
	(0.033)	(0.035)		
× Low worst-case exposure			0.070	0.057
			(0.064)	(0.097)
× High worst-case exposure			0.16***	0.17***
			(0.041)	(0.043)
N	3382	3382	2787	1830
R^2	0.10	0.13	0.13	0.14
First and second moment expectations controls	No	Yes	Yes	Yes
High average exposure sample	No	No	No	Yes

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025. The main explanatory variable is the firm's year-over-year revision in the subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October waves 2022–2025. Time fixed effects and an indicator for whether firms reduced investment in the current year are included in all specifications. To control for business conditions: Panel (a) controls for the current and lagged business situation (measured on a visual analog scale from 0 (negative situation) to 100 (positive situation)); Panel (b) controls for realized sales growth in the previous quarter. Columns 2–4 additionally control for firms' first and second moment expectations. In Panel (a), these are firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In Panel (b), these are sales growth expectations and uncertainty for the next year. Sales growth uncertainty is measured as the span between best- and worst-case scenarios. Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

regressions based on Equation 4 across different specifications. A one standard deviation upward revision in the subjective probability of a GDP drop of at least 5% over the next five years (30 pp) makes firms about 3 pp more likely to cut investment in the next year (Column 1). Given an unconditional probability of 30% of cutting investment, this corresponds to a 10% increase.

Even after controlling for the current and lagged subjective first and second moments, firm-level revisions in macro tail risk beliefs significantly predict lower investment plans.

The effect size decreases by less than half, suggesting that macro tail risk beliefs are of first-order importance for firms' investment decisions beyond adjustments in first and second moments, see Column 2.[16]

In the next step, I analyze heterogeneity with respect to firms' exposure to a macro tail event realization. The theoretical framework in Section 3.1 predicts particularly strong effects beyond the first-moment effect when firms are highly exposed in the expected worst case. Consistent with this prediction, Column 3 shows substantially larger effects for firms with high worst-case exposure (above median), which are significantly different from the effects for firms with below-median worst-case exposure.

The effect on investment beyond adjustments in first and second moments is present only among high worst-case exposure firms, even when restricting the sample to firms with above-median average-case exposure, see Column 4. This suggests that worst-case exposure beliefs are key, and that the results are not driven solely by high exposure on average.

In Panel (b) of Table 2, I repeat the analysis using alternative measures of first- and second-moment expectations. Reassuringly, the results are very similar when controlling for one year ahead quantitative sales growth expectations. If anything, the effect on the probability of planning an investment cut is larger. The results also hold when restricting identification to within-industry variation over time by adding 2-digit NACE industry $\times$ time fixed effects, see Appendix Table A7.

One potential caveat of the analysis is that the controls for the business expectations and uncertainty cover only the next six months, while the macro tail risk expectations are elicited over a five-year horizon to circumvent problems with eliciting small probabilities. The alternative specification in Panel (b) with quantitative one year ahead sales growth expectations discussed above, already partly addresses this issue. Moreover, the quantitative sales growth expectations and uncertainty question is available over various horizons, up to four years into the future (although answered by fewer firms). I re-run the main specification for short-, medium-, and long-term sales growth expectations and find very similar effect sizes, see Appendix Table A8. Hence, the results are robust to the horizon at which first and second moments are measured.

[16] In Appendix Table A6, I examine firm-level revisions for the three more specific macro tail events. The point estimates consistently move in the same direction across scenarios. While the effects are strongly significant for the financial crisis scenario, they are not statistically significant for the pandemic scenario and only partially significant for the geopolitical escalation scenario. This pattern is likely driven by the more limited variation available for these latter scenarios.

The main takeaways from the analysis so far are threefold. First, higher macro tail risk expectations have a strong negative effect on investment. Second, the effect remains significant and sizable even after controlling for proxies of first- and second-moment expectations. Third, the negative effect is particularly pronounced for firms that expect to be heavily exposed in worst-case scenarios. This provides suggestive evidence that firms act on their worst-case exposure as predicted by the stylized model in Section 3.1. In the experimental approach in Section 3.3.2, I test this mechanism more formally.

Do investment plans induced by changes in subjective macro tail risk expectations translate into realized investment? While the effect of macro tail risk beliefs on quantitative investment realizations is of clear interest, it is empirically more challenging to establish. Macro tail risk expectations fluctuate substantially over time, and investment is implemented with heterogeneous lags across firms. The IBS elicits realized investment volumes (in euros) in the March wave for the previous calendar year. Due to data availability, I can only study one belief revision episode—from 2022 to 2023—as realized investment data for more recent years are not yet available. I estimate regressions of next year's log investment on the year-to-year revision in the subjective probability of a macro tail event, controlling for the previous year's subjective probability and previous year's log investment.

An upward revision in firms' macro tail risk expectations predicts a statistically significant reduction in realized investment volumes, and the magnitude is economically large. A one standard deviation upward revision (30 pp) is associated with a decline in realized investment of about 10.8% (Column 1 of Appendix Table A9). The relationship is stable when controlling for current and lagged business situation, business expectations, and business uncertainty (Column 2). Consistent with the evidence on investment plans, this suggests that macro tail risk beliefs matter for investment decisions over and above firms' first and second moment expectations. In Columns 3 and 4, I instrument the indicator for a planned investment cut with the subjective probability of a macro tail event and study effects on realized log investment. While the IV estimates are noisier, they imply very large declines in realized investment. The point estimates are 1.63 and 2.57 log points, corresponding to investment reductions of about 80% and 92%, respectively. Economically, this is consistent with a near-complete investment freeze among firms whose plans to cut investment are driven by upward revisions in macro tail risk expectations.

Heterogeneity I now study heterogeneity in the effect sizes across a number of firm characteristics. This allows me to test for further mechanisms. I consider (i) the raw relationship between firms' plan to cut investment in the next year and the subjective

probability of a macro tail event and (ii) the full year-to-year revision specification as in Equation 4. In both cases, I interact firm characteristic indicators with all explanatory variables. To ensure that the results are not driven by the exposure to macro tail events, I restrict the analysis to firms with above-median worst-case exposure (corresponding to the high worst-case exposure group in Table 2, Column 3).

Figure A5 presents the results. First, the effect sizes are similar for small and large firms, suggesting that changes in macro tail risk also have sizable aggregate effects on investment dynamics. Second, we observe larger effect sizes for family-owned firms, which could be due to several factors. One is that there are typically fewer decision-makers in family firms, see Bertrand and Schoar (2006) for an overview of the characteristics of family firms. Thus, idiosyncratic expectations of the owner are likely to have a stronger impact on the firm's decision making. Moreover, larger effect sizes for family-owned firms support the idea that the owners' primary goal is the long-term success of the firm. In contrast, managers in non-family firms are more likely to ignore tail risks due to limited liability, as formalized by Maćkowiak and Wiederholt (2018). Third, I examine heterogeneity by managerial risk-taking. While one mechanism behind effects beyond the first moment could be risk aversion, the estimates are similar for firms with more and less risk-taking managers, labeled as "risk taker" in Figure A5. Finally, I examine leverage. Effect sizes are similar for firms with high and low equity ratios, suggesting that financial frictions, including bankruptcy risk, are unlikely to be the dominant driver. If anything, effects are slightly larger for firms with a high equity ratio.

3.3 Experimental variation

In the following, I corroborate the finding of the strong negative relationship of macro tail risk expectations and investment—also beyond first and second moments—from the observational variation with two complementary approaches using experimental variation to establish causality. First, I generate exogenous variation in macro tail risk beliefs by conducting a randomized control trial with information treatments, which also reveals how firms update macro tail risk beliefs when new information arrives. Second, I confront firms with hypothetical macro outlooks to probe the underlying mechanism more directly.

3.3.1 Randomized control trial with information treatments

In the first experimental approach, I generate exogenous variation in the subjective probability of a macro tail event through an information intervention. Shifting firms' macroeconomic beliefs in reality is challenging, as managers are typically better informed than the average

household. As a result, they hold strong prior beliefs and tend not to update in response to public news, as shown by Link et al. (2023) for German firms and formalized by Mackowiak and Wiederholt (2025). When it comes to macroeconomic tail risk beliefs, there is no "correct" forecast for the probability of macroeconomic tail events. While this feature makes those beliefs particularly intriguing and useful for the observational approach, it complicates the use of information provision experiments to shift firms' beliefs about the probability of macroeconomic tail events.

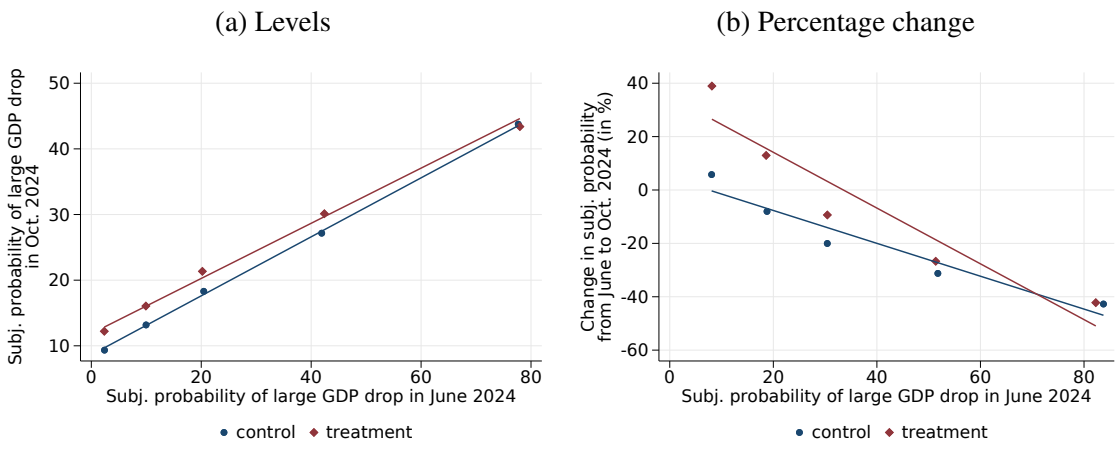
Treatment design To increase the likelihood of shifting firms' beliefs, I use unpublished survey results from an earlier wave as the basis for the information treatment. In the October 2024 wave, a randomly assigned half of the firms are informed about the average elicited probability of a GDP drop of at least 5% over the next five years, based on responses from the June 2024 wave, when macroeconomic tail risk beliefs were last elicited. The other half receives no information. The treatment text reads as follows:
In June 2024, firms were last asked how likely they considered a decline in annual GDP of at least 5% within the next five years. At that time, ***firms participating in the ifo survey estimated*** *the probability at an average of* ***28%****.*

Prior beliefs correspond in this setting to firms‘ macro tail risk beliefs in June 2024 and posterior beliefs to firms‘ macro tail risk beliefs in October 2024. I focus on firms that are familiar with the question, i.e., those that have previously reported macro tail risk beliefs in the survey. To systematically downweight outliers and reduce noise, I follow the literature and estimate Huber-type robust regressions in the first stage.

The main outcome—just as in the observational approach—is an indicator for planning to reduce investment in the next year, elicited in November. This creates a one-month post-treatment gap, reducing experimenter demand concerns and captures a medium-run effect. Using June 2024 priors and eliciting macro tail risk beliefs only once in the October 2024 wave after treatment further limits first-stage demand effects. Although investment plans are not a third-party realized measure, they strongly predict realized changes in firms' capital stock (see Section 2), making them informative for causal identification.

Posterior beliefs The information treatment successfully shifts firms‘ subjective probability of a macro tail event. Figure 7 plots prior against posterior beliefs by treatment group: Panel (a) plots levels on the vertical axis; Panel (b) plots percentage changes relative to the prior. Appendix Table A10 shows the corresponding regression output. The control group (blue dots) shows a strong positive relationship between macro tail risk beliefs at the firm level over time from June 2024 to October 2024. This supports using June 2024 beliefs as

Figure 7: Effect of information treatment on macro tail risk beliefs



Notes: This figure shows binned scatterplots for posterior (measured immediately after the treatment) and prior beliefs (measured four months before the treatment in June 2024) about the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years by treatment group. In the left panel, the vertical axis plots the level of posterior beliefs. In the right panel, the vertical axis plots the percentage change of posterior beliefs relative to prior beliefs. This change is undefined for firms with 0% prior beliefs.

priors, although the slope is below one, reflecting that firms updated their macro tail risk expectations due to other information during this period. The negative relationship between June-to-October percentage changes and June levels in Panel (b) suggests some degree of mean reversion in firms' macro tail risk beliefs.

Firms respond asymmetrically to the news in the information treatment. Managers who believe that a large GDP drop is rather unlikely significantly update their beliefs after the treatment (red diamonds): they become more pessimistic after negative news. In contrast, firms that were very pessimistic prior to the treatment do not become more optimistic—they do not respond to the positive news. This asymmetry is consistent with conservative belief updating, which seems reasonable here since the average of other managers' subjective beliefs about an event that is almost impossible to forecast is a rather intangible signal. For instance, the asymmetric response is in line with models of updating with ambiguous signals, in which negative (positive) news is treated as if signal precision is higher (lower), see Epstein and Schneider (2008).

The magnitude of updating is rather small in levels, but large relative to firms' prior beliefs. Panel (a) of Figure 7 visualizes level changes. While the treatment significantly increases firms' subjective probability of a macro tail event, posterior beliefs in the treatment group remain relatively close to priors (100% updating would imply a horizontal line at 28%). This is consistent with the information treatment not providing perfect information about the probability of a macro tail event, and thus not being expected to generate very

large level shifts. Panel (b) of Figure 7 shows that changes relative to prior beliefs are economically large. For example, firms that reported a 10% probability of a macro tail event over the next five years update by about 4 pp. Relative to the prior, this corresponds to an increase of 40%. Relative changes are smaller at higher prior levels, both because absolute updating is more limited and because priors are already relatively high.

In the following, I focus on those firms with low prior macro tail risk beliefs, i.e. those that respond strongly to the treatment. Specifically, I consider firms that in June 2024 assigned less than 20% probability to an annual GDP drop of at least 5% over the next five years (below the cross-sectional median). This yields a simple treatment indicator, which allows for an intuitive interpretation of the treatment effects and a straightforward conversion of first-stage and reduced-form estimates into the second-stage estimate. To increase precision, I control for prior macro tail risk beliefs, sector dummies, firms' business situation, and an indicator for whether the firm reduced investment in the current year.

For firms that expected a GDP drop with less than 20 percent probability in the next five years in June 2024, the information treatment—based on other managers' tail risk beliefs—significantly increases their own macro tail risk beliefs. Specifically, the subjective probability of a macro tail event increases by 2.8 pp (Column 1 of Table X). Column 2 shows that the estimate declines only marginally when controlling for firms' business expectations and uncertainty. Relative to average prior beliefs in this group of firms of 6.7% in June 2024, this implies an increase in macro tail risk beliefs of about 40%. In the next step, I analyze whether this shift in beliefs also affects firms' investment plans.

Effects on firms' investment For firms starting with low macro tail risk beliefs, receiving the treatment significantly reduces planned investment for the next year. The likelihood of planning an investment cut rises by 8.2 pp in the reduced-form estimation (Column 3). The effect is sizable: relative to the control group mean of 22%, this implies a 37% increase.

Next, I run a mediation analysis controlling for firms' business expectations (first moment) and uncertainty (second moment) to test whether macro tail risk beliefs matter in their own right. Overall, the treatment effect attenuates only modestly, to 7.6 pp (Column 4). This aligns with the findings from the observational variation in the previous section: macro tail risk beliefs affect investment plans beyond changes in subjective first and second moments. Business expectations become slightly more pessimistic, while business uncertainty is not significantly affected by the treatment (see Appendix Table A12).

A one percentage point increase in macro tail risk beliefs leads to a 3 pp higher probability of planning an investment reduction in the next year. The second stage can be directly

Table 3: Treatment effects: Firms with low prior macro tail risk expectations

	$\mathbb{P}(MacroTail)$		$\mathbb{1}\{\Delta Investment < 0\}$			
	First stage		Reduced form		Second stage	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	2.77***	2.70***	8.22***	7.56***		
	(0.51)	(0.51)	(2.80)	(2.78)		
Subj. Prob. GDP Drop $\geq 5\%$					2.97***	2.80**
					(1.14)	(1.16)
Observations	955	955	955	955	955	955
F-stat					29.7	28.2

Notes: This table displays regression results of the information treatment among firms with below-median prior beliefs ($< 20\%$) about the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years (measured four months before the treatment in June 2024). Columns 1 and 2 present first stage results on posterior beliefs (measured immediately after the treatment in October 2024), Columns 3 and 4 present reduced form results on the probability to plan a decrease in investment in the next year relative to the current year (in %), elicited in November 2024. Columns 5 and 6 present second stage results, where the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years is instrumented using the treatment indicator. In all specifications, it is controlled for prior macro tail risk beliefs, sector dummies, firms' business situation, and an indicator for whether the firm reduced investment in the current year. In even-numbered columns, it is additionally controlled for subjective first and second moments (business expectations and uncertainty), measured immediately after the treatment in October 2024 on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

obtained by dividing the reduced-form estimates by the first stage. Columns 5 and 6 report the results. The first stage is sufficiently strong, with an F-statistic of 28–30. The coefficient again becomes only slightly smaller when controlling for subjective first and second moments. Overall, this shows that the changes in investment plans operate through treatment-induced updating in macro tail risk beliefs.

Reassuringly, when I focus on firms with even lower prior macro tail risk beliefs—those that assigned less than 10% probability to a large GDP drop in the next five years—the treatment effects remain present and become larger. For this group, the treatment increases macro tail risk beliefs by 2.5 pp, roughly doubling the prior mean of 2.6%, see Appendix Table A11. The probability of planning an investment decrease rises by 12 pp for the treatment group. The second stage estimate suggests that a one percentage point increase in macro tail risk beliefs raises the probability of planning an investment reduction in the next year by almost 5 pp.

The effect size is an order of magnitude larger than in the observational approach. This is a common finding in the literature and likely reflects, among other factors, lower measurement error and tighter timing between belief updates and subsequent investment decisions. Macro tail risk beliefs fluctuate substantially within firms over time and the treatment induced variation is generated just one month before firms report their investment

plans for the next year, whereas the observational approach relies on year-to-year changes in beliefs.

As in the observational approach, the treatment effects are particularly pronounced for firms with high worst-case exposure to macro tail events, as visible in Appendix Table A13. Both above- and below-median exposure firms with low prior macro tail risk beliefs significantly update their subjective probability of a macro tail event after receiving the information treatment. The first-stage effects are slightly stronger for firms with high worst-case exposure, potentially reflecting greater attention during the survey. The probability of planning an investment decrease rises significantly by 10.5 pp for firms with high worst-case exposure following the treatment, while it is not significantly different from zero for firms with low worst-case exposure. A potential limitation of the heterogeneity analysis is that attention to this topic may differ across the two groups, both within and outside the survey, and the treatment may also prompt firms to reassess their exposure to macro tail events. Moreover, the number of observations does not allow for a more granular analysis.

3.3.2 Hypothetical vignettes of macroeconomic outlooks

In the second approach, I employ experimental methods to identify the causal effect of macroeconomic tail risk expectations on investment.[17] To isolate the effect of macroeconomic tail risk expectations on investment decisions beyond first- and second-moment effects, I design hypothetical vignettes on macroeconomic outlooks, in which I vary only the higher-order moments. Specifically, I present managers two simple macroeconomic outlooks that have different skewness and kurtosis but identical mean and variance. They are then asked to rank the outlooks based on which one they are more likely to make large investments in or whether they are indifferent. The baseline vignette reads as follows:

Outlook A:

*The German economy (measured by the **GDP**) will either **decline by -1% with 50% probability or grow by 5% with 50% probability** in the next year.*

Outlook B:

*The German economy (measured by the **GDP**) will either **decline by -7% with 10% probability or grow by 3% with 90% probability** in the next year.*

(In both outlooks, the GDP level returns back to the current level in the subsequent year.)

[17] See Haaland, Roth and Wohlfart (2023) for a review of hypothetical vignettes. Recent examples of studies employing vignettes in a macroeconomic context are Roth, Wiederholt and Wohlfart (2023), who improve the understanding of how monetary policy affects household consumption and Gödl-Hanisch and Menkhoff (2023), who study price pass-through dynamics at the firm level.

Under which outlook would your firm be more likely to make major investments?

Outlook A	*O*
No difference	*O*
Outlook B	*O*

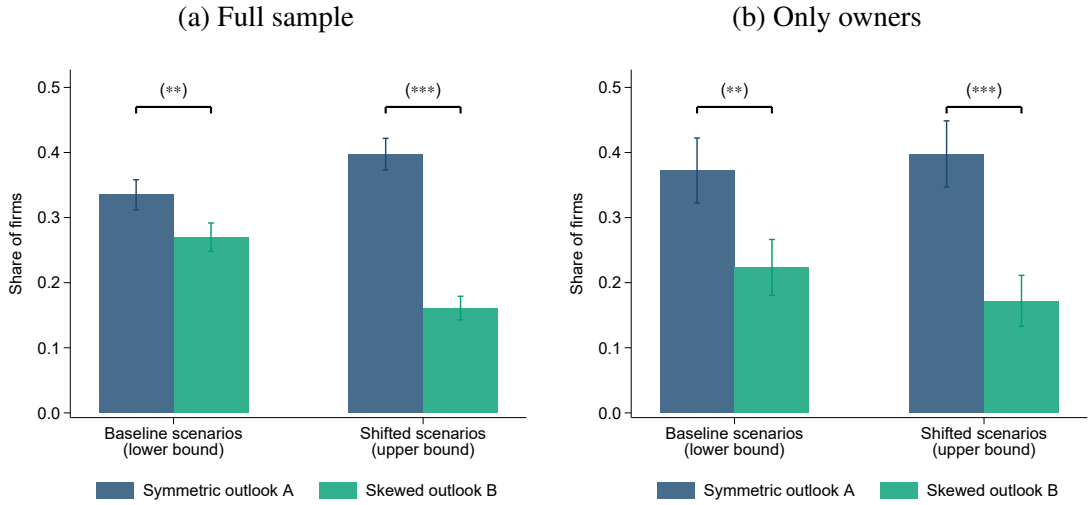
The hypothesis is that firms are less likely to invest in Outlook B, where considerable macro tail risk is present due to the negative skewness and higher kurtosis.[18] To circumvent different expectations of subsequent economic dynamics that could affect the response, I add the information that the GDP level returns to the previous level in the subsequent year in both outlooks. To convey the outlooks as clearly as possible, I also provide a visualization as shown in Panel (a) Figure A6 and chose outlooks where the growth rates and probabilities have no decimal places.

A potential limitation of the approach is that the results may depend too much on the specific values chosen in the simplified outlooks. A specific concern is potential loss aversion or recession aversion, which implies a central role for the sign of GDP growth rates. To address this concern, both outlooks include a scenario with positive and negative growth. Under loss aversion, firms would invest less in Outlook A, because there is a higher probability of a recession in the next year. Thus, the baseline vignette can be interpreted as a rather conservative approach and a lower bound for testing the hypothesis. Therefore, for those firms that actually chose to invest more in Outlook B with negative skewness, I present a second vignette, in which all growth rates are shifted upward by two percentage points, see Panel (b) of Figure A6. Now, the mean is at 4% and the other moments are the same as before. Firms again choose which outlook they would invest more in. Since Outlook A now contains only positive scenarios, the results can be interpreted more as an upper bound to test the hypothesis.

I conducted the experiment in the ifo Management Survey during July and August 2023. The survey asks decision-makers in German firms about current economic policy issues and changes in the macroeconomic environment (Sauer, Schasching and Wohlrabe 2023). The survey covers about 350 firms across all sectors of the economy. The majority of respondents are the owner or CEO of their respective firm. I also elicit firms' expected exposure scenarios in the worst, average, and best cases in terms of real sales changes conditional on a GDP drop of 5% in exactly the same way as in the ifo Business Survey to

[18] In Outlook A and B, the mean (1. moment) is 2 and the variance (2. moment) is 9. The skewness (3. moment) is 0 in Outlook A and -2.$\bar{6}$ in Outlook B. The kurtosis (4. moment) is 1 in Outlook A and 8.$\bar{1}$ in Outlook B.

Figure 8: Firms' investment choice in the hypothetical macro outlooks



Notes: The figure shows the share of firms choosing the symmetric outlook A (blue) and skewed outlook B (green) in the baseline scenario and shifted scenario. Panel (a) is based on the full sample, while Panel (b) focuses solely on firms where the respondent is known to be at least a partial owner. The whiskers reflect the standard errors of the means. The asterisks indicate the significance levels testing the rejection of the equivalence between the proportion of firms choosing the symmetric outlook A and those choosing the skewed outlook B. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

formally analyze whether firms' exposure scenarios predict their investment decisions in the vignettes.

Hypothetical vignette results In the baseline scenario, significantly more firms would invest more in symmetric Outlook A than in Outlook B, which has a 10% probability of exposing firms to a macro tail event in the next year (a 7% drop in GDP), as visualized in Figure 8. This is despite the fact that the symmetric Outlook A has a higher probability of a recession. When we also consider the shifted scenarios, we observe an even stronger preference for the symmetric scenario. About 40% of firms would invest more in Outlook A, more than twice as many as in Outlook B.[19] The results are similar when considering only firms where the survey respondent is known to own at least part of the firm, see Panel (b) of Figure 8.

A crucial advantage of the hypothetical vignette is that it fixes the probability of a macro tail event occurring—the first layer of macro tail risk for firms. We can now analyze the extent to which the decisions of the firms in the vignette are related to their exposure beliefs—the second layer of macro tail risk for firms—in the case of a 5% drop in GDP. Specifically, I run a regression with the firm's chosen outlook as dependent variable and

[19]Note that this result includes the responses to the baseline scenario of firms that would invest more in the symmetric Outlook A or that were indifferent between the outlooks.

Table 4: Investment choice and firm exposure to a macro tail event

	Base scenarios		Shifted scenarios	
	Invest more in ...			
	(1)	(2)	(3)	(4)
	1: **sym**; 0: no diff -1: **skew**	1: **sym** 0: no diff 0: **skew**	1: **sym** 0: no diff -1: **skew**	1: **sym** 0: no diff 0: **skew**
$\beta_{i,worst}$ (exposure to GDP↓ 5%)	-0.018**	-0.010**	-0.021***	-0.014***
	(0.008)	(0.005)	(0.006)	(0.004)
Observations	327	327	327	327
Average & best-case exposure ctrls	Yes	Yes	Yes	Yes

Notes: The table shows the estimation results of a linear regression. The dependent variable is the firms' decision in the hypothetical vignette, coded differently across columns. Columns 1 and 2 are based on firms' responses in the baseline scenario, while Columns 3 and 4 also consider the shifted scenarios. The explanatory variables are firms' beliefs on exposure scenarios (worst-case, average, and best-case) in terms of changes in real sales, when GDP drops by 5%, elicited after the vignette in the ifo Management Survey. In Section 2, I introduce the question. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the firms' expected best-case, average, and worst-case exposure scenarios as explanatory variables. Through the lens of the mechanism proposed in Section 3.1, one would expect that firms with a highly negative worst-case scenario would be less likely to invest in Outlook B, which contains negative skewness and therefore high macro tail risk.

Table 4 shows the regression results for different codings of the choice in the vignette. Indeed, a more negative expected worst-case exposure significantly predicts the choice to invest more in the symmetric outlook, while controlling for average and best-case exposure. This holds for both, the baseline and the shifted scenarios. The slightly stronger effects in the shifted scenarios in Columns (3) and (4) may be due to the fact that some firms interpret the -1% growth scenario already as a macro tail event. The magnitude is economically meaningful: expecting a 10 p.p. stronger decline in real sales in the worst-case exposure scenario increases the probability of choosing the symmetric scenario by 10 to 14 p.p. based on Columns (2) and (4).

4 Quantitative heterogeneous firm model

In this section, I extend the stylized model in Section 3.1 to a quantitative heterogeneous firm model to simulate macro tail risk news shocks and study policy counterfactuals. The model builds on a standard heterogeneous firm framework (Cooper and Haltiwanger, 2006) used in richer RBC models (e.g., Bloom et al. 2018). Guided by my empirical findings, I introduce ambiguous firm-specific exposure to the low aggregate productivity state (the

macro tail event). I, thereby, propose a new framework that characterizes the stochastic environment for firms.

4.1 Model setup

The model augments the stylized model in Section 3.1 with (i) stochastic idiosyncratic productivity, (ii) partial capital depreciation, and (iii) three capital adjustment costs.

Technology and productivity Firms, indexed by i, produce output with a decreasing returns to scale production function. Their productivity is the product of idiosyncratic productivity z and aggregate productivity A. The log of idiosyncratic productivity follows an AR(1) process. Aggregate productivity varies over time according to a three-state Markov chain: (i) a high productivity state A^h with low macro tail risk, (ii) a high productivity state A^h with high macro tail risk, and (iii) a low productivity state A^l corresponding to the macro tail event.[20] The stochastic process of aggregate productivity is not symmetric, but rather characterized by infrequent significant plunges in productivity, consistent with the view of economic fluctuations as described by the plucking model (Friedman, 1964, 1993).

Importantly, firms differ in exposure to the low aggregate productivity state. The productivity decline is scaled by a firm-specific parameter β_i:

$$A_i^l = A^h - \beta_i (A^h - A^l). \tag{5}$$

Due to the parameter β_i, there is an increase in cross-sectional dispersion of productivity in a macro tail event. The increase in dispersion in a recession is a prominent feature of business cycle models with time-varying volatility (Bloom et al., 2018) or skewness (Salgado, Guvenen and Bloom, 2023) of idiosyncratic risk. In contrast to these papers, the increase in dispersion in my model is tied to firm exposure to the macro tail event. Importantly, firms have ex-ante heterogeneous beliefs about this exposure, which has significant policy implications, as discussed below.

Firms consider a set of exposure scenarios $\beta_i \in \{\beta_{worst}, \beta_{average}, \beta_{best}\}$, but they are unable to assign probabilities to these scenarios, making the firm-specific exposure ambiguous, which is an instance of Knightian uncertainty (Keynes, 1921, Knight, 1921). There are three key advantages of this modelling assumption. First, it provides a parsimonious approach to generate large effects of macro tail risk on firms' investment decisions operating beyond the first-moment effect, as discussed in Section 3.1. Second, it accounts for the empirical

[20] Modeling the macro tail event as a fall in aggregate productivity is a reduced-form device that captures rare, severe downturns in a parsimonious way without taking a stand on their underlying structural sources.

evidence of substantial uncertainty about firm exposure, documented in Section 2.3. Third, the Knightian uncertainty is state dependent. Hence, when macro tail risk is very low, such as in the aggregate state (i), we converge back to a standard firm model.

Capital adjustment costs Firms face convex and non-convex capital adjustment costs. Investment is given by

$$I_{i,t} = k_{i,t+1} - (1-\delta)k_{i,t} \tag{6}$$

Capital depreciates with δ every period. Capital adjustment costs consist of (i) fixed disruption cost ϕ_1 for non-zero investment, (ii) quadratic adjustment cost ϕ_2, and (iii) resale cost ϕ_3 for net disinvestment, as capital is partially irreversible.

$$\psi(k_{t+1}, k_t) = \phi_1 \mathbb{I}_{I_{i,t}\neq 0} + \frac{\phi_2}{2}\left(\frac{I_{i,t}}{k_{i,t}}\right)^2 + (1-\phi_3)|I_{i,t}|\mathbb{I}_{I_{i,t}<0} \tag{7}$$

Corporate income tax and additional costs To study fiscal policy implications, I introduce a corporate income tax τ on profits. As it is typically the case in advanced economies, I assume that the tax rate is asymmetric: firms pay taxes on profits but receive no refund when profits are negative, see Fuest and Neumeier (2023). To match profit margins, I add fixed production costs γ_0 to capture overhead costs as well as production costs that are linear in capital γ_1 as a reduced-form proxy for labor costs.

Firm problem Firms are risk neutral and ambiguity averse, i.e. they prefer to know the probability of future events. Their dynamic problem consists of choosing the capital stock for the next period to maximize the present discounted value of future profits.

When evaluating different investment plans, firms draw the exposure to macro tail events from the set of firm-specific exposure scenarios that minimizes expected continuation utility.[21] Hence, the dynamic problem of the firm is governed by the firm's worst-case exposure $\beta_{i,worst}$, reflecting firms' cautious behavior in the presence of Knightian uncertainty:

$$V(k,z,\beta,A) = \max_{k'} \left\{ \begin{array}{c} (1-\tau)(Azk^{\alpha} - \delta k - \psi(k',k) - \gamma_0 - \gamma_1 k) \\ -k' + k + \frac{1}{1+r} \min\limits_{\beta\in\{\beta_{worst},\beta_{average},\beta_{best}\}} \mathbb{E}[V(k',z',\beta,A')] \end{array} \right\} \tag{8}$$

[21] Epstein and Schneider (2003*b*) axiomatize the recursive version of behavior under ambiguity.

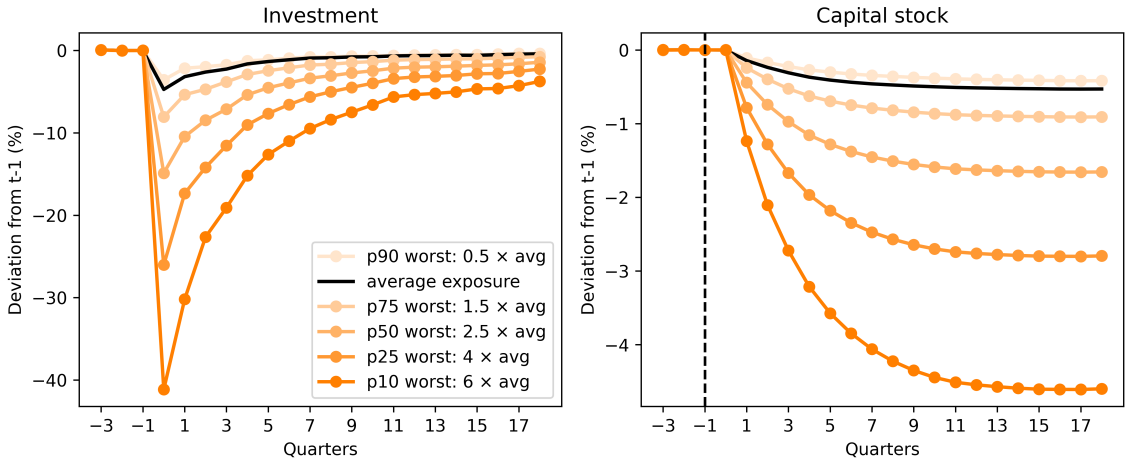
4.2 Model results

Calibration I solve the firm problem numerically by value function iteration. I discipline ambiguity using the elicited worst-case exposures from the ifo Business Survey and solve the model for firms at the 10th, 25th, 50th, 75th, and 90th percentile of the cross-sectional exposure distribution, as well as for $\beta = 1$. I parameterize the transition probabilities to the low aggregate productivity state guided by firms' subjective macro tail risk expectations from the survey. In the high productivity state with low macro tail risk, the quarterly probability of transitioning to the low productivity state is 1%, and in the one with the high macro tail risk it is 4%, equivalent to an 18% and 56% probability, respectively, over a five-year window. Hence, the change in the likelihood from the low to high macro tail risk state is slightly larger than the change in the average subjective probability reported in the ifo Business Survey between October 2022 and April 2023, see Section 2. Productivity of the median firm decreases by 7.5% in the realized macro tail risk state, which lasts for five quarters on average (length of the Great Recession in Germany). Remaining parameters follow standard quarterly calibrations, see Appendix G, where I also analyze the sensitivity of the results to parameter values.

Simulation of macro tail risk news shock Next, I simulate a macro tail risk news shock. For 60 quarters the economies are in the high productivity, low macro tail risk state. Then, there is a macro tail risk news shock: the economies are still in the high productivity state, but now face a higher probability of transitioning to the low productivity state in the future. From the next period on, economies switch back to the low macro tail risk state with a certain probability, but simulations where the macro tail event is realized are excluded.

Figure 9 plots the dynamics of investment and capital following the macro tail risk news shock. I plot the investment responses depending on firms' expected worst-case exposure. As macro tail risk increases, firms reduce investment sharply—higher macro tail risk expectations induce a recession. There is significant dispersion in the investment response across varying worst-case exposure beliefs. Given the left-skewness of the worst-case exposure distribution, the resulting cross-sectional changes following the macro tail risk news shock exhibit a fat left tail. Firms with below-median expected worst-case exposure (25th percentile of the exposure distribution) reduce investment by approximately 8% on impact, while those anticipating disproportionate impacts in the worst-case scenario (75th percentile) cut investment by over 25% on impact. The average decline in investment over the first four quarters after the shock is about 10% for the median firm, broadly in line with the empirically estimated effects based on observational variation.

Figure 9: Baseline simulation of a macro tail risk news shock



Notes: The figure shows the average simulation results over 1000 economies, each populated with 4000 firms, for a given worst-case exposure to the low productivity state. For 60 quarters, the economies are in the high productivity, low macro tail risk state. At time 0, there is a macro tail risk news shock: the economies are now in the high productivity state (same productivity as before) with a higher probability of transitioning to the low productivity state in the future. Thereafter, the aggregate productivity process evolves naturally, but excludes the simulations in which the macro tail event is actually realized. Deviations of investment and capital stock from the high productivity state with low macro tail risk are shown in percentages. The different lines correspond to different expected worst-case exposures to the macro tail event state. For example "p75 worst: 4 × avg" represents the 75th percentile of the exposure distribution, where the expected decline in sales in the worst-case exposure scenario is 4 times larger than in the average exposure scenario of the median firm.

4.3 Policy implications

I examine the extent to which counteracting monetary and fiscal policy can stimulate investment following an increase in macro tail risk, and whether this differs between a world with and without ambiguous exposure. To this end, I conduct counterfactual analyses in which I introduce credible rule-based changes in monetary and fiscal policy in the case of a realized macro tail event. I repeat the simulations of macro tail risk news shock to analyze the effectiveness of the policies in stimulating aggregate investment. Note that the respective policy does not change in this case, since only the probability of transitioning to the macro tail event increases without a realization of it. Importantly, I assume that the policy changes are credible, since only then firms' worst-case scenario in a macro tail event is improved.[22]

To study monetary policy, I consider a counterfactual in which the interest rate is rule-based and declines in a realized macro tail event.[23] Firms incorporate this state-contingent

[22]Both policies considered, the lower interest rate and the switch to symmetric corporate income taxation, also lead to level shifts of the capital stock in the low macro tail risk state. I abstract from these level shifts and focus only on the relative change in the capital stock following an increase in macro tail risk.

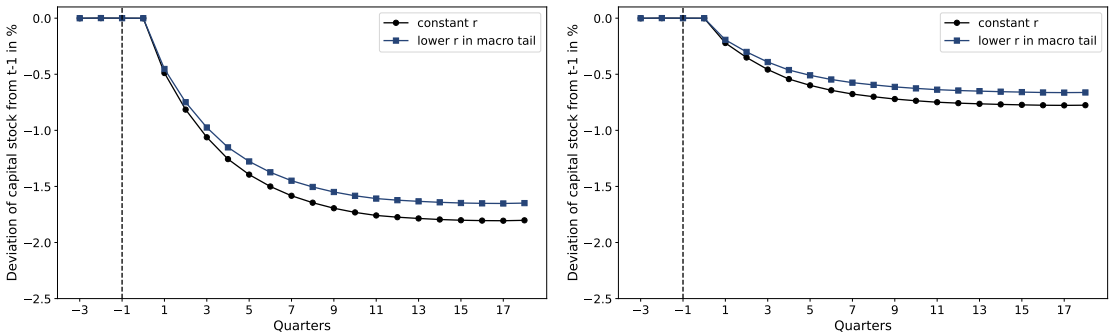
[23]Motivated by a Taylor-rule type response, I assume the cut in nominal rates is large enough that the real rate also falls.

Figure 10: Macro tail risk news shocks and rule-based policy counterfactuals: Dynamics of the aggregate capital stock

Monetary policy counterfactual

(a) World with ambiguous exposure

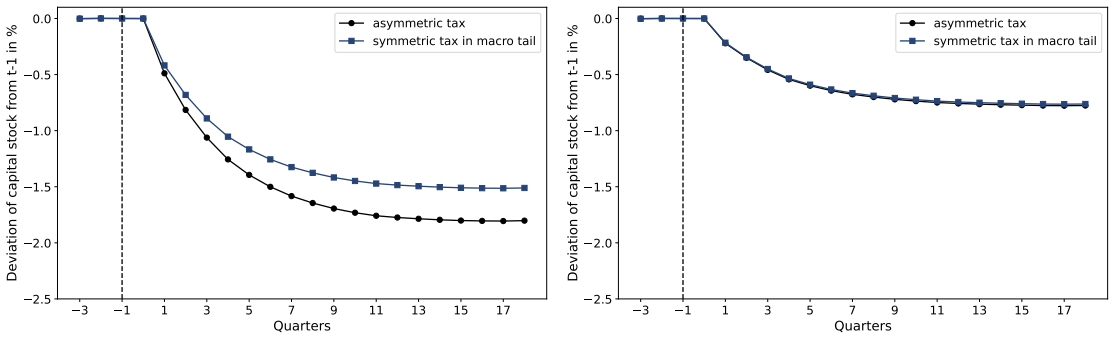
(b) World without ambiguous exposure



Fiscal policy counterfactual

(c) World with ambiguous exposure

(d) World without ambiguous exposure



Notes: The figures show the aggregate change in capital after a macro tail risk news shock. Note that only macro tail risk increases without a realization of the macro tail event. The left (right) panels are based on a world with (without) ambiguous exposure to macro tail events. The upper panels consider a monetary policy counterfactual (blue lines with square markers) in which the interest rate decreases in a realized macro tail event from 2% to 1%. The bottom panels consider a fiscal policy counterfactual (blue lines with square markers) in which corporate taxation becomes symmetric in a realized macro tail event.

rate cut into their optimization problem. I simulate a one percentage point cut in the annual interest rate, from 2% to 1%, in the macro tail event. The upper left panel of Figure 10 shows that the decline in the aggregate capital stock is mitigated by about 9–11%. The stimulus operates through a lower expected user cost of capital in the tail state, implying a higher optimal capital stock. The effect is similar in the worlds with and without ambiguous exposure. Importantly, this depends on the assumption that the user cost of capital is independent of firms' expected worst-case exposure to the macro tail event.

To study fiscal policy, I consider a credible switch from asymmetric to symmetric corporate income taxation in the macro tail event, so that firms receive refunds when losses

occur. Since refunds scale with losses, the policy partially insures firms, akin to generous loss carrybacks.[24]

I simulate this counterfactual following a macro tail risk news shock. In the presence of ambiguous exposure (lower left panel of Figure 10), the decline in aggregate capital is mitigated by about 20%, whereas the effect is small without ambiguity (lower right panel). The difference arises because the gains from symmetric taxation scale with worst-case losses and therefore matter primarily when firms evaluate decisions under worst-case exposure. Without ambiguity, only the average exposure scenario is relevant, implying smaller losses in the tail state and limited insurance benefits.

In a realized macro tail event, exposure corresponds to the average rather than the worst-case scenario. While I do not conduct an optimal policy analysis, the results suggest that a state-contingent switch to symmetric taxation is relatively inexpensive ex post yet stimulates investment ex ante, and is therefore more efficient than in a setting without ambiguity aversion. Universal symmetric taxation, however, would mainly benefit low-productivity firms in normal times, lowering average productivity and raising fiscal costs.

5 Conclusion

This paper provides a comprehensive analysis of firms' macroeconomic tail risk expectations. I show that firms perceive macro tail events as likely to occur and that these expectations are highly dispersed across firms and strongly co-moving with firms' expectations about their own business. Based on three complementary empirical approaches, I consistently find that higher macro tail risk expectations have a strong negative impact on investment beyond first- and second-moment expectations. Ambiguity aversion regarding firm-specific exposure to macro tail events can rationalize the findings: the effects are strongest for firms that expect to be highly exposed to the macro tail event in the worst-case scenario.

I conduct policy counterfactuals in a quantitative heterogeneous firm model and show that fiscal policy is particularly effective in stimulating investment during periods of elevated macro tail risk. Crucially, policies must be credibly announced such that firms' expected worst-case scenario in a macro tail event is mitigated. Therefore, automatic stabilizers such as loss carrybacks are suitable policy measures, while uncertain payouts of subsidies in a macro tail event would not stimulate investment.

[24] This comparison applies if firms paid taxes prior to the tail event.

Further investigation into the origins of macro tail risk expectations and their role in various economic decisions made by different economic agents presents fertile ground for future research. Additionally, examining the efficiency of policies that can mitigate the negative effects of macro tail risk expectations, along with the evaluation of the importance of rule-based announcements, seems promising for future analysis.

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Online Appendix

A ifo Business Survey: Survey questions (translated)

Business expectation (monthly)

Expectations about the next six months: our expected business state in economic terms: [continuous slider from 0 (rather worse) over 50 (the same) to 100 (rather better)]

Business uncertainty (monthly)

We estimate the uncertainty regarding our business expectations in the next six months as: [continuous slider from 0 (low) over 50 (average) to 100 (high)]

Business state (monthly)

We assess our current business state as: [continuous slider from 0 (bad) over 50 (satisfactory) to 100 (good)]

Investment plans (November wave)

In the next year (t+1 compared to t) our investments will likely ...
increase o not change o decrease o

Sales expectations (October wave): short run

By how much in percentage terms will your sales change in the fourth quarter of 2023 compared to the third quarter of 2023?

- In the best possible case:
- In the worst possible case:
- Taking into account all contingencies and risks, I expect for the fourth quarter of 2023 all in all a change of:

Sales expectations (October wave): medium run

By how much in percentage terms will your sales change in 2024 compared to 2023?

- In the best possible case:
- In the worst possible case:
- Taking into account all contingencies and risks, I expect for 2024 all in all a change of:

Sales expectations (October wave): long run

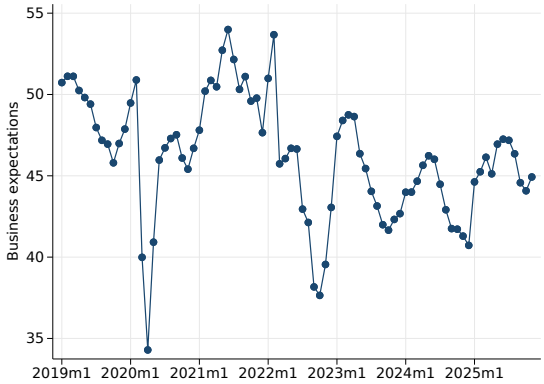
By how much in percentage terms will your sales change on average in the three years 2025 to 2027? (average annual rate of change)

- In the best possible case:
- In the worst possible case:
- Taking into account all contingencies and risks, I expect for the three years 2025 to 2027 all in all an overall average annual change of:

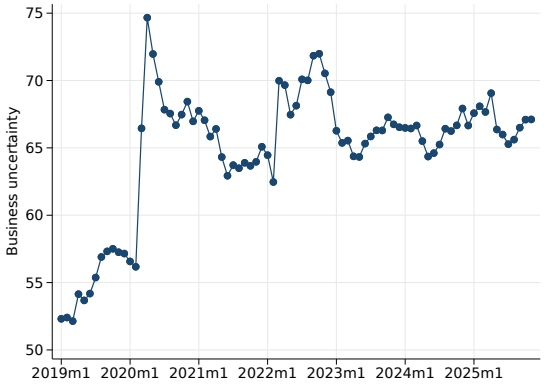
B Additional Figures

Figure A1: Time series of business expectations and business uncertainty

(a) Business expectations

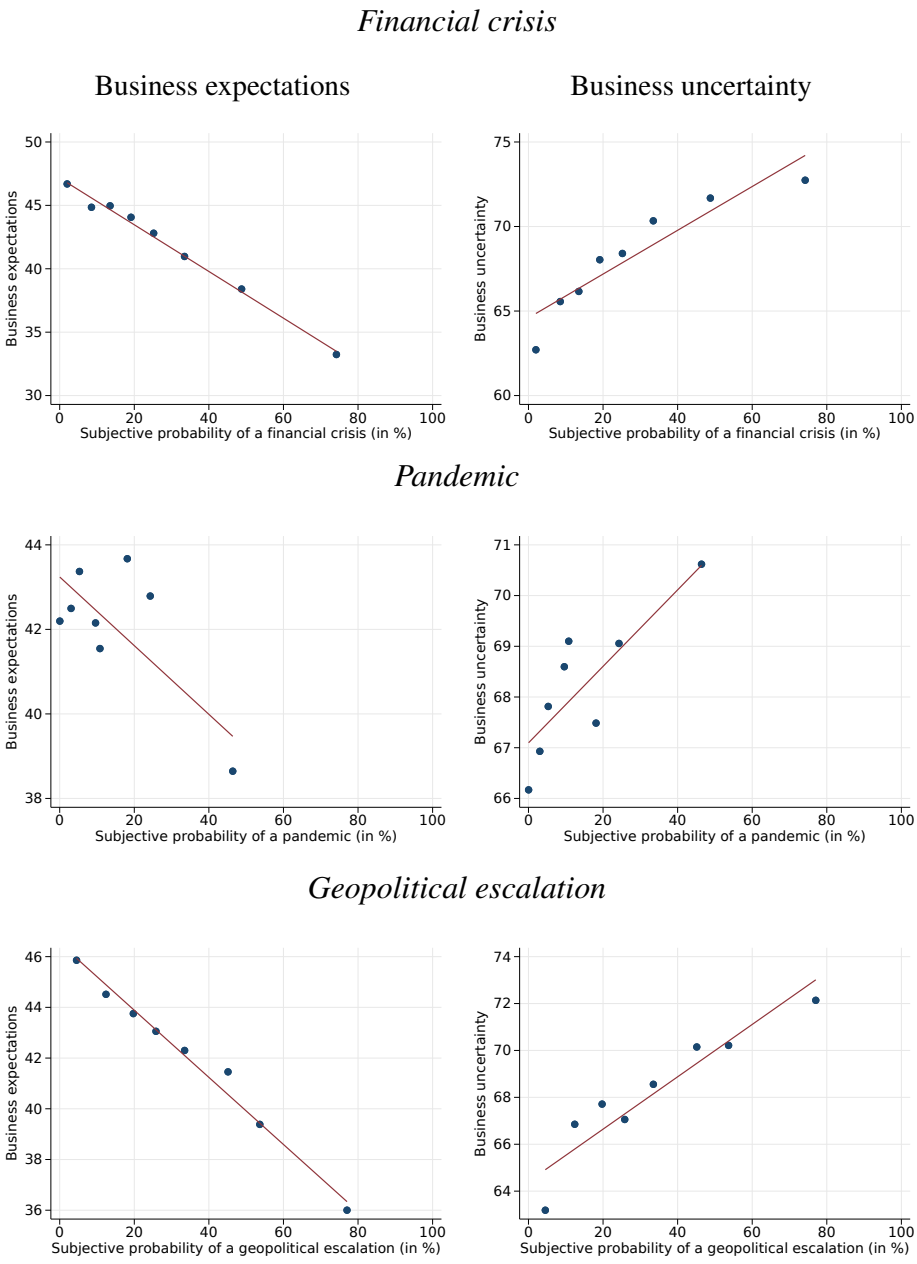


(b) Business uncertainty



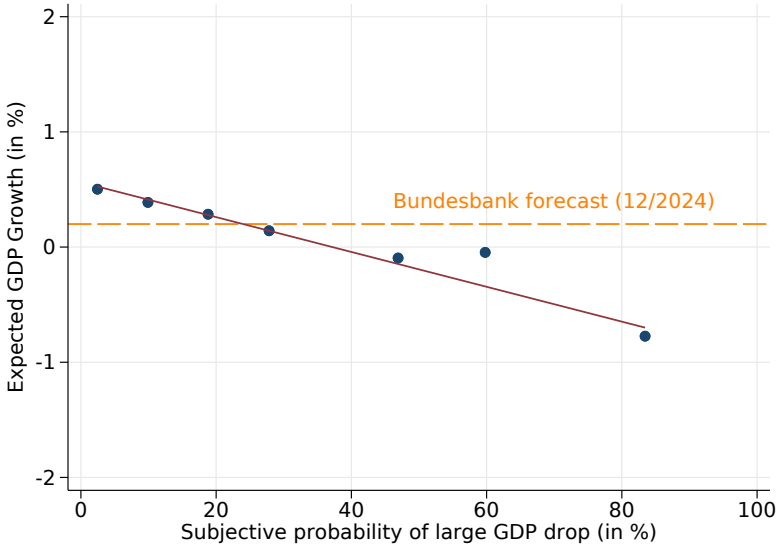
Notes: This figure displays cross-sectional averages of firms' business expectations and business uncertainty over time.

Figure A2: Relation of other macro tail risk expectations and business outlooks



Notes: This figure displays binned scatter plots between the subjective probability of the occurrence of a financial crisis / pandemic / geopolitical escalation in the next five years and firms' business outlooks. Business expectations and uncertainty are measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Appendix A provides the wording of the questions.

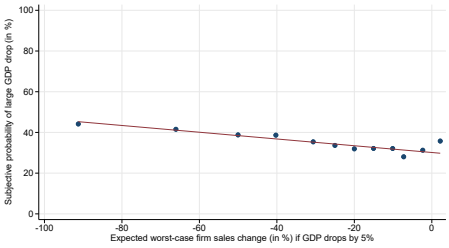
Figure A3: Firms' macroeconomic tail risk expectations and mean GDP growth expectations



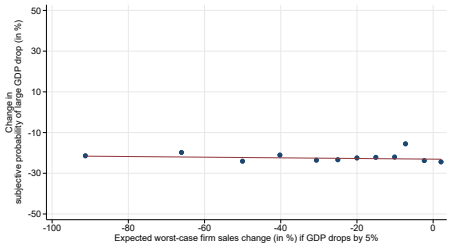
Notes: The figure shows a binned scatterplot of the subjective firm-level expectations of the occurrence of a large decline in annual GDP ($\geq$5%) in the next five years, elicited in October 2024, and the first moment GDP growth expectations, elicited in November 2024, for 2025. The dashed line shows the GDP forecast for 2025 in Germany of the Bundesbank from December 2024.

Figure A4: Relation of subjective probability of macro tail event occurrence and firm exposure beliefs

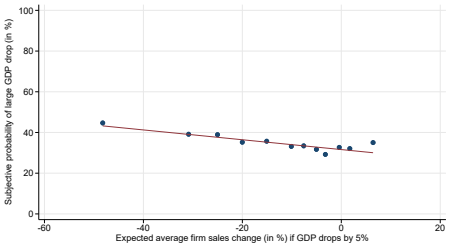
(a) worst-case exposure (raw relation)



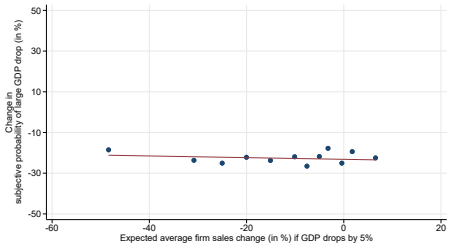
(b) worst-case exposure (within relation)



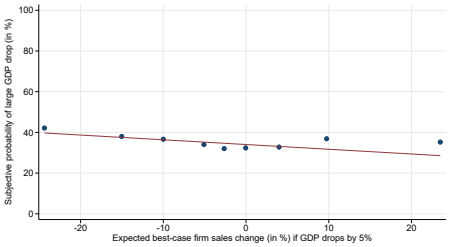
(c) average exposure (raw relation)



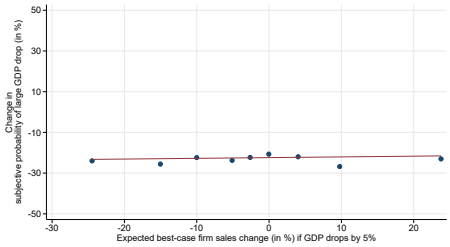
(d) average exposure (within relation)



(e) best-case exposure (raw relation)



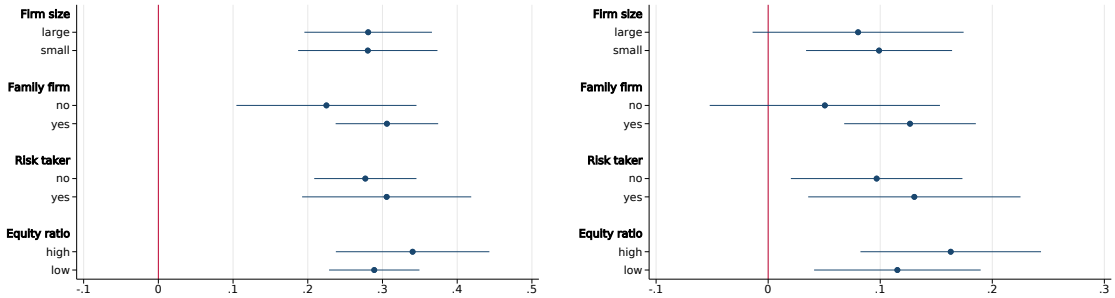
(f) best-case exposure (within relation)



Notes: This figure displays binned scatter plots between the subjective probability of the occurrence of a large decline in annual GDP ($\geq$5%) in the next five years and firm exposure expectations to a drop in GDP of 5% in terms of real sales changes. The figures in the first column relate subjective firm-level expectations of the occurrence of a large decline in annual GDP ($\geq$5%) in the next five years elicited in October 2022, April 2023, and October 2023 to firm exposure expectations to a drop in GDP of 5% in terms of real sales changes elicited in October 2023. The figures in the second column relate the change in subjective probability of the occurrence of a large decline in annual GDP ($\geq$5%) in the next five years from October 2022 to October 2023 to firm-specific exposure expectations to a drop in GDP of 5% in terms of real sales changes elicited in October 2023. The first row uses the expected worst-case exposure scenario, the second row the expected average exposure scenario, and the third row the expected best-case exposure scenario, see Section 2.3 for more details on firm exposure beliefs.

Figure A5: Heterogeneity across firm characteristics

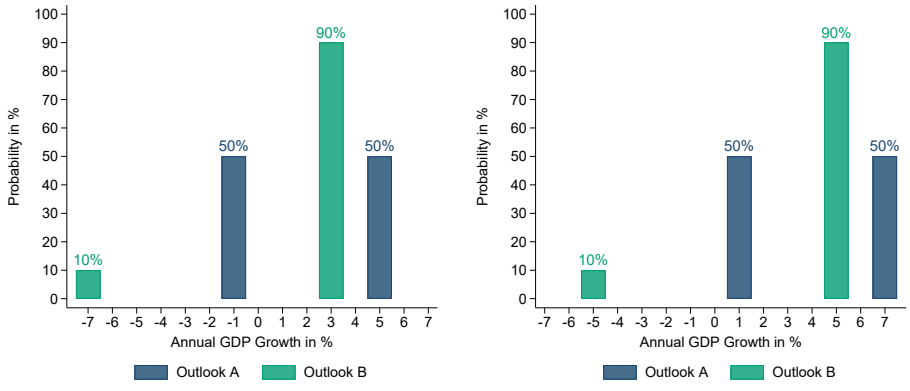
(a) Raw relationship (b) Full revision specification



Notes: This figure shows the estimates of a one percentage point increase in the subjective probability that annual GDP declines by at least 5% within the next five years on the likelihood of reducing investment in the next year. Panel (a): raw relationship, only adding time fixed effects; Panel (b): full revision specification based on Equation (4), where all explanatory variables are interacted with indicators that split the sample by firm characteristics. The sample is restricted to firms with above-median worst-case exposure. "Firm size" is an indicator that equals one if the number of employees is ≥ 50. "Family firm" is an indicator of whether the firm considers itself to be a family firm. "Risk taker" is an indicator that equals one if the manager selects a value > 6 (median) on a Likert scale from 0 (not at all willing to take risks) to 10 (very willing to take risks) when asked whether she considers herself a "risk taker" in general. "Equity ratio" is an indicator that is one if the equity ratio (self-reported in 2022) is above the median. 90% confidence intervals are depicted. Standard errors are clustered at the 2-digit industry level.

Figure A6: Vignettes

(a) Vignette: baseline outlooks (b) Vignette: shifted outlooks



Notes: This figure presents the vignettes. Panel (a) shows the baseline vignette. Both outlooks have the same mean (2) and variance (9), but different skewness (A: neutral skewness 0 ; B: negatively skewed $-2.\overline{6}$). Panel (b) shows the alternative, shifted vignette. Both outlooks have the same mean (4) and variance (9), but different skewness (A: neutral skewness 0 ; B: negatively skewed $-2.\overline{6}$). In Section 3.3.2, the corresponding wording of the question is displayed.

C Additional Tables

Table A1: Expected worst-case exposure and realized exposure to the Great Recession and the COVID-19 Pandemic

	Expected worst-case firm sales change if GDP drops by 5%					
	(1)	(2)	(3)	(4)	(5)	(6)
Neg. Business State (08/09)	-13.3***	-2.75**	-2.95**			
	(2.26)	(1.19)	(1.23)			
Strong COVID-19 impact				-6.41***	-0.90**	-1.21***
				(0.77)	(0.42)	(0.44)
Average exposure		1.72***	1.71***		1.80***	1.75***
		(0.074)	(0.075)		(0.039)	(0.038)
Best-case exposure		-0.60***	-0.58***		-0.67***	-0.60***
		(0.11)	(0.11)		(0.055)	(0.054)
Constant	-24.6***	-5.77***	-5.78***	-27.1***	-6.33***	-6.64***
	(0.68)	(0.59)	(0.61)	(0.52)	(0.39)	(0.41)
Observations	1252	1252	1252	3167	3167	3167
Industry FE	No	No	Yes	No	No	Yes

Notes: The table shows how firms' expected worst-case exposure in terms of real sales changes in case of a 5% decline in German GDP relates to firms' past realized exposure in macroeconomic crises. Columns 1-3 are based on the share of months in which a firm reports a negative business situation in 2008 and 2009 as a proxy for the exposure to the Great Recession 2008/2009. Columns 4-6 are based on the self-reported impact of COVID-19 on the business as a proxy for the exposure to the COVID-19 pandemic. "Strong COVID-19 impact" is an indicator based on a reported COVID-19 impact in the IBS on a 7-point Likert scale from -3 (negative) to +3 (positive). The indicator is one when firms report an average COVID-19 impact score of less than -1. Robust standard errors in parenthesis. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Relation of macro tail risk expectations and business outlooks

	Business expectations			Business uncertainty		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel (a): Baseline controls (visual analog sliders)						
Subj. Prob. Macro Tail Event	-0.17***	-0.17***		0.10***	0.10***	
	(0.0070)	(0.0071)		(0.014)	(0.014)	
Δ Subj. Prob. Macro Tail Event			-0.072***			0.018**
			(0.0076)			(0.0085)
L12.Subj. Prob. Macro Tail Event			-0.084***			0.011
			(0.0073)			(0.0091)
L12.Business expectations			0.35***			
			(0.013)			
Business situation			0.34***			-0.25***
			(0.013)			(0.021)
L12.Business situation			-0.085***			0.073***
			(0.012)			(0.018)
L12.Business uncertainty						0.58***
						(0.011)
N	9399	9399	9399	9399	9399	9399
R^2	0.057	0.059	0.43	0.013	0.013	0.46
Panel (b): Alternative measures (quant. sales expectations)						
	Sales growth forecast			Sales growth uncertainty		
Subj. Prob. Macro Tail Event	-0.063***	-0.063***		0.069***	0.066***	
	(0.0075)	(0.0074)		(0.011)	(0.011)	
Δ Subj. Prob. Macro Tail Event			-0.037***			0.040***
			(0.0081)			(0.0093)
L12.Subj. Prob. Macro Tail Event			-0.052***			0.034***
			(0.0076)			(0.010)
L12.Sales growth forecast			0.29***			
			(0.028)			
Realized growth			0.079***			-0.032*
			(0.016)			(0.017)
L12.Realized growth			-0.0096			0.0099
			(0.014)			(0.012)
L12.Sales growth uncertainty						0.47***
						(0.027)
N	4077	4077	4077	4077	4077	4077
R^2	0.021	0.021	0.21	0.015	0.029	0.35
Time FE	No	Yes	No	No	Yes	No
Time × Industry FE	No	No	Yes	No	No	Yes

Notes: The table presents the estimation results based on linear regressions of firms' business outlooks on firms' macroeconomic tail risk expectations. In Panel (a), results are shown for regressions of firms' business expectations for the next six months (Columns 1-3) and firms' business uncertainty for the next six months (Columns 3-6) on firms' subjective probability of a GDP drop of at least 5% in the next five years. Business expectations and uncertainty are measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In Columns 3 and 6, firm-level revisions of the subjective probability of a GDP drop of at least 5% in the next five years are considered as well as controlling for the business situation and lagged business expectations, uncertainty, and situation. Panel (b) considers one-year ahead sales growth expectations and uncertainty as alternative measures for firms' business outlooks. Appendix A provides the wording of the questions. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Distribution of firms' expected exposure to a 5% decline in GDP

	Change in real sales, when GDP drops by 5%		
	Worst-case scenario	Average-case scenario	Best-case scenario
p10	-5%	0%	5%
p25	-15%	-5%	0%
p50	-25%	-10%	-5%
p75	-40%	-20%	-10%
p90	-60%	-30%	-20%

Notes: This table presents the expected worst-case, average-case, and best-case exposure scenarios in case of a 5% decline in German GDP in terms of changes in real sales for firms across different percentiles of the exposure distribution. The survey question is shown in Section 2.

Table A4: Macroeconomic tail risk expectations and investment decisions

	Indicator for a Decline in Investment					
	(1)	(2)	(3)	(4)	(5)	(6)
Subj. Prob. Financial Crisis	0.30***			0.18***		
	(0.019)			(0.021)		
Subj. Prob. Pandemic		0.14***			0.076**	
		(0.026)			(0.029)	
Subj. Prob. Geop. Escalation			0.18***			0.097***
			(0.018)			(0.015)
Business expectations				-0.59***	-0.64***	-0.63***
				(0.028)	(0.027)	(0.027)
Business uncertainty				0.069***	0.080***	0.076***
				(0.021)	(0.022)	(0.021)
Constant	21.7***	29.0***	24.9***	45.0***	50.6***	48.2***
	(0.97)	(1.44)	(1.10)	(1.80)	(1.88)	(1.86)
N	13269	13267	13269	13269	13267	13269
R^2	0.025	0.0034	0.0091	0.086	0.079	0.080

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025 (in %). The main explanatory variable is the firm's subjective probability (in %) that there will be (i) a financial crisis (Columns 1 and 4), (ii) a pandemic (Columns 2 and 5), and (iii) a geopolitical escalation (Columns 3 and 6) in the next five years, elicited in the October waves 2022–2025. Time fixed effects are included in all specifications. Columns 3–6 control for firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Macro tail risk expectations, GDP growth expectations, and investment decisions

	(1)	(2)	(3)	(4)
Prob. GDP Drop $\geq 5\%$	0.30***	0.23***	0.17***	0.18***
	(0.034)	(0.036)	(0.036)	(0.035)
GDP Growth expectations (Nov)		-4.44***		
		(0.77)		
Business expectations (Oct)			-0.73***	
			(0.054)	
Business expectations (Nov)				-0.74***
				(0.053)
N	3085	3085	3085	3085
R^2	0.026	0.042	0.11	0.12

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November 2024 wave. The main explanatory variable is the firm's subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October 2024 wave. Column (2) additionally controls for firms' GDP growth expectations for 2025 (November 2024). Columns (3) / (4) additionally control for firms' business expectations, elicited in October 2024 / November 2024, respectively. Business expectations are measured on a visual analog scale from 0 (negative expectations) to 100 (positive expectations). Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Revisions in three specific macro tail risk expectations and investment decisions

	Indicator for a Decline in Investment					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Subj. Prob. Financial Crisis	0.11***	0.078***				
	(0.024)	(0.025)				
Δ Subj. Prob. Pandemic			0.061	0.051		
			(0.037)	(0.037)		
Δ Subj. Prob. Geopolitical Escalation					0.045**	0.021
					(0.021)	(0.022)
					(0.027)	(0.027)
N	7553	7514	7549	7510	7553	7514
R^2	0.13	0.15	0.12	0.15	0.13	0.15
First and second moment expectations ctrls	No	Yes	No	Yes	No	Yes

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025. The main explanatory variable is the firm's year-over-year revision in the subjective probability (in %) that there will be (i) a financial crisis (Columns 1 and 4), (ii) a pandemic (Columns 2 and 5), and (iii) a geopolitical escalation (Columns 3 and 6) in the next five years, elicited in the October waves 2022–2025. Time fixed effects and an indicator for whether firms reduced investment in the current year are included in all specifications. To control for business conditions, it is controlled for the current and lagged business situation. Columns 2, 4, and 6 additionally control for firms' first and second moment expectations: these are firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Revisions in macroeconomic tail risk expectations and investment decisions within industries

	(1)	(2)	(3)	(4)
Panel (a): Baseline controls (visual analog sliders)				
Δ Subj. Prob. Macro Tail Event	0.10***	0.070***		
	(0.024)	(0.024)		
× Low worst-case exposure			-0.010	-0.045
			(0.044)	(0.074)
× High worst-case exposure			0.10***	0.10***
			(0.033)	(0.032)
N	7503	7503	5733	3856
Δ Subj. Prob. Macro Tail Event	0.12***	0.084**		
	(0.033)	(0.035)		
× Low worst-case exposure			0.040	0.012
			(0.065)	(0.10)
× High worst-case exposure			0.16***	0.16***
			(0.041)	(0.042)
N	3365	3365	2737	1770
First and second moment expectations controls	No	Yes	Yes	Yes
High average exposure sample	No	No	No	Yes

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025. The main explanatory variable is the firm's year-over-year revision in the subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October waves 2022–2025. Time × 2-digit NACE industry fixed effects and an indicator for whether firms reduced investment in the current year are included in all specifications. To control for business conditions: Panel (a) controls for the current and lagged business situation, measured on a visual analog scale from 0 (negative situation) to 100 (positive situation); Panel (b) controls for realized sales growth in the previous quarter. Columns 2–4 additionally control for firms' first and second moment expectations. In Panel (a), these are firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In Panel (b), these are sales growth expectations and uncertainty for the next year. Sales growth uncertainty is measured as the span between best- and worst-case scenarios. Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Revisions in macroeconomic tail risk expectations and investment decisions: varying the horizon of first and second moment expectations

	(1)	(2)	(3)	(4)
Δ Subj. Prob. Macro Tail Event	0.12***	0.11**	0.12***	0.11***
	(0.037)	(0.040)	(0.039)	(0.038)
N	2464	2464	2464	2464
One quarter ahead first and second moment expectations	Yes	No	No	Yes
One year ahead first and second moment expectations	No	Yes	No	Yes
Two-four years ahead first and second moment expectations	No	No	Yes	Yes

Notes: This table reports regression results where the dependent variable is an indicator for a planned decrease in investment in the next year relative to the current year, elicited in the November waves 2022–2025. The main explanatory variable is the firm's year-over-year revision in the subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October waves 2022–2025. Time fixed effects, an indicator for whether firms reduced investment in the current year, and realized sales growth in the previous quarter are included in all specifications. All specifications control for current and lagged sales growth expectations and uncertainty at different forecast horizons. Column (1) controls for the sales growth forecast for the next quarter (Q4, elicited in October). Column (2) controls for the sales growth forecast for the next year (as in Panel (b) of Table 2). Column (3) controls for the sales growth forecast for the average annual sales growth two to four years ahead. Column (4) controls for forecasts at all horizons jointly. Sales growth uncertainty is measured as the span between best- and worst-case scenarios. Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A9: Revisions in macroeconomic tail risk expectations and realized investment volume

	(1)	(2)	(3)	(4)
Δ Subj. Prob. Macro Tail Event	-0.0036***	-0.0037**		
	(0.0013)	(0.0017)		
Instrumented indicator to plan inv cut			-1.63**	-2.57*
			(0.71)	(1.40)
Observations	1663	1587	1345	1290
First and second moment expectations controls	No	Yes	No	Yes

Notes: This table reports regression results where the dependent variable is log realized investment volumes (in euros) elicited in the March wave for the previous calendar year. The main explanatory variable is the firm's year-over-year revision in the subjective probability (in %) that annual GDP declines by at least 5% within the next five years, elicited in the October waves. In all specifications, it is controlled for the previous year's subjective probability and previous year's log investment. In Columns (2) and (4), it is controlled for firms' business expectations and uncertainty, measured on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In Columns (3) and (4), an indicator for a planned investment cut is instrumented with the firm's year-over-year revision in the subjective probability of a macro tail event. Appendix A provides the question wording. Standard errors are clustered at the 2-digit NACE industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A10: Treatment effects on macro tail risk beliefs (October 2024) in the full sample

	Levels	Percentage change
	(1)	(2)
Subj. Prob. GDP Drop $\geq$ 5% (June 2024)	0.45***	-0.62***
	(0.017)	(0.053)
Treatment $\times$ Subj. Prob. GDP Drop $\geq$ 5% (June 2024)	-0.029	-0.43***
	(0.024)	(0.078)
Treatment	3.23***	30.4***
	(0.65)	(4.29)
Constant	8.63***	4.65
	(0.46)	(2.90)
Observations	3231	2767
R^2	0.334	0.120

Notes: This table displays regression results of posterior beliefs (measured immediately after the treatment in October 2024) about the probability of a large decline in annual GDP ($\geq$ 5%) in the next five years on prior beliefs (measured four months before the treatment in June 2024), a treatment indicator, and an interaction term. In the first column, the dependent variable is the level of posterior beliefs. In the second column, the dependent variable is the percentage change of posterior beliefs relative to prior beliefs. This change is undefined for firms with 0% prior beliefs.

Table A11: Treatment effects: Firms with very low prior macro tail risk expectations

	$\mathbb{P}(MacroTail)$		$\mathbb{1}\{\Delta Investment < 0\}$			
	First stage		Reduced form		Second stage	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	2.47***	2.46***	12.3***	11.7***		
	(0.68)	(0.68)	(3.73)	(3.70)		
Subj. Prob. GDP Drop $\geq$ 5%					4.97**	4.76**
					(2.01)	(1.98)
Observations	481	481	481	481	481	481
Fstat					13	13

Notes: This table displays regression results of the information treatment among firms with very low prior beliefs ($<$ 10%) about the probability of a large decline in annual GDP ($\geq$ 5%) in the next five years (measured four months before the treatment in June 2024). Columns 1 and 2 present first stage results on posterior beliefs (measured immediately after the treatment in October 2024), Columns 3 and 4 present reduced form results on the probability to plan a decrease in investment in the next year relative to the current year (in %), elicited in November 2024. Columns 5 and 6 present second stage results, where the probability of a large decline in annual GDP ($\geq$ 5%) in the next five years is instrumented using the treatment indicator. In all specifications, it is controlled for prior macro tail risk beliefs, sector dummies, firms' business situation, and an indicator for whether the firm reduced investment in the current year. In even-numbered columns, it is additionally controlled for subjective first and second moments (business expectations and uncertainty), measured immediately after the treatment in October 2024 on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A12: Treatment effects on business expectations and uncertainty: Firms with low prior macro tail risk expectations

	Business expectations				Business uncertainty			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	-1.76*	-1.76*			1.18	1.20		
	(1.01)	(1.01)			(1.43)	(1.42)		
Subj. Prob. GDP Drop $\geq 5\%$			-0.64*	-0.63*			0.43	0.45
			(0.38)	(0.37)			(0.52)	(0.54)
Business uncertainty		0.0037		-0.0046				
		(0.028)		(0.029)				
Business expectations						0.0073		0.028
						(0.056)		(0.061)
Observations	955	955	955	955	955	955	955	955
F-stat			29.6	30			30	28

Notes: This table displays regression results of the information treatment among firms with below-median prior beliefs ($< 20\%$) about the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years (measured four months before the treatment in June 2024). In Columns 1–4, the outcome variable is business expectations and in Columns 5–8, the outcome variable is business uncertainty, measured immediately after the treatment in October 2024 on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). In all specifications, it is controlled for prior macro tail risk beliefs, sector dummies, firms' business situation, and an indicator for whether the firm reduced investment in the current year. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A13: Treatment effects by exposure: Firms with low prior macro tail risk expectations

	$\mathbb{P}(MacroTail)$		$\mathbb{1}\{\Delta Investment < 0\}$			
	First stage		Reduced form		Second stage	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	3.21***	1.92**	10.5**	4.13		
	(0.81)	(0.82)	(4.56)	(4.23)		
Subj. Prob. GDP Drop $\geq 5\%$					3.25**	2.14
					(1.64)	(2.33)
Observations	382	380	382	380	382	380
Worst-case exposure	high	low	high	low	high	low

Notes: This table displays regression results of the information treatment among firms with below-median prior beliefs ($< 20\%$) about the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years (measured four months before the treatment in June 2024). Odd-numbered columns focus on firms with high (above-median) expected worst-case sales growth exposure; even-numbered columns focus on firms with low (below-median) expected worst-case sales growth exposure. Columns 1 and 2 present first stage results on posterior beliefs (measured immediately after the treatment in October 2024), Columns 3 and 4 present reduced form results on the probability to plan a decrease in investment in the next year relative to the current year (in %), elicited in November 2024. Columns 5 and 6 present second stage results, where the probability of a large decline in annual GDP ($\geq 5\%$) in the next five years is instrumented using the treatment indicator. In all specifications, it is controlled for prior macro tail risk beliefs, sector dummies, firms' business situation, an indicator for whether the firm reduced investment in the current year, and subjective first and second moments (business expectations and uncertainty), measured immediately after the treatment in October 2024 on a visual analog scale from 0 (negative expectations / low uncertainty) to 100 (positive expectations / high uncertainty). Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

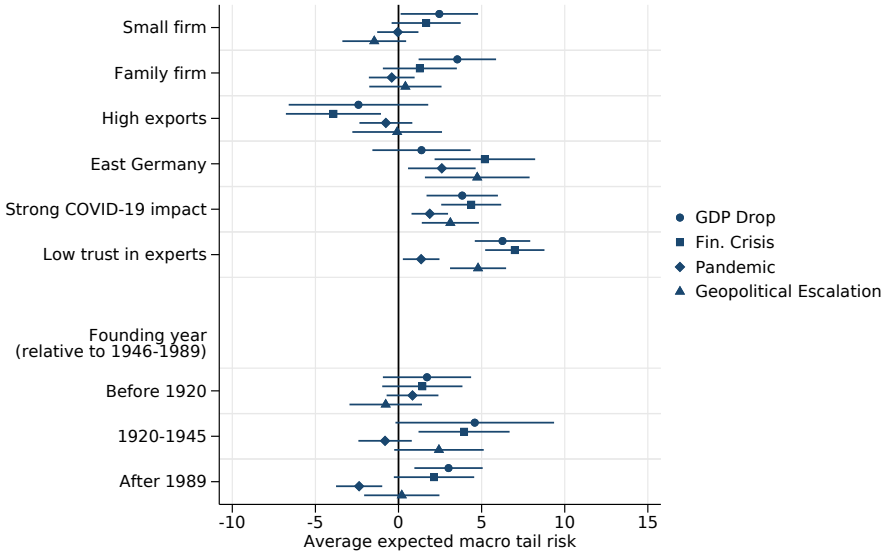
D Drivers of level differences between firms' macroeconomic tail risk expectations

What are the drivers of the average differences in macro tail risk expectations across firms? To answer this question, I regress firms' subjective probability of the four macro tail events on a set of firm characteristics and additionally control for 2-digit NACE industry fixed effects. Standard errors are clustered at the 2-digit NACE industry level. Figure A7 shows the respective point estimates and 95% confidence interval of the joint regression.

I find that standard firm characteristics such as firm size, whether the firm is family owned or not, and whether it has a large export share are not strongly correlated with average macro tail risk expectations. The subjective probability of a large GDP drop is slightly higher among small firms and family firms. Firms in former East Germany have, on average, slightly higher macro tail risk expectations, especially for the financial crisis scenario and the geopolitical escalation scenario. Being more affected by the COVID-19 pandemic is associated with higher macro tail risk expectations across the board. This is suggestive evidence of scarring effects: Experiencing a tail event leads to a particularly strong update of tail risk expectations. Low trust in experts advising policymakers is also positively associated with higher macro tail risk expectations. This is consistent with the idea that firms differ in their confidence that policymakers can avert a major crisis. In this context, it also makes sense that the pandemic scenario shows a lower correlation, as pandemics themselves are difficult to avoid.

Finally, the regression results show that firms that were founded during the turbulent period 1920-1945 (Hyperinflation/Great Depression/WW2) are significantly more likely to expect a financial crisis than firms founded between 1946-1989, a period without a realized macro tail event. This is suggestive evidence of institutional memory: While managers from 1920-1945 are no longer in the firms, the potentially turbulent founding histories are embedded in the firm's culture (Bouwman and Malmendier, 2015, Malmendier and Nagel, 2011). Younger firms, founded after 1989, tend to report a higher probability of a large GDP drop, consistent with having experienced two major downturns (the Great Recession and COVID-19) in their short operating history. In this light, it is surprising that young firms report lower probabilities despite having experienced COVID-19. Note that the within R^2 of this regression is still relatively low with 1.9–6.3% . This means that the level differences between firms are mostly due to other unobserved characteristics.

Figure A7: Drivers of level differences between firms' macroeconomic tail risk expectations



Notes: The figure shows the coefficients of a joint regression, relating firms' subjective macro tail risk expectations—elicited in October 2022, 2023, 2024, 2025—to firm characteristics. The question on the respective macro tail risk is shown in the text. It is controlled for 2-digit NACE industry fixed effects. Confidence intervals refer to the 95% level. Standard errors are clustered at the 2-digit NACE industry level.

E Firms' exposure beliefs: Evidence from an open-ended survey question

This section documents the results of an open-ended survey text question on firms' exposure beliefs to a 5% change in GDP in Germany. In Section 2.3, I introduce the survey question and present the main findings.

I received 2220 answers and read through all of them. Based on that, I created a codebook that classifies the responses into different categories. A research assistant then hand-coded all responses into the categories according to the codebook. I exclude firms that are categorized in the groups "politics", "general pessimism", or "other" because these managers mostly use the text box to complain about their current situation or to comment on something else unrelated to macro tail risk exposure.

Assessability There are 545 managers who directly report on the assessability of their exposure to a 5% drop in GDP. The vast majority of these responses (93%) report significant difficulties in predicting their exposure, with close to 40% of them even stating that it is

(almost) impossible to predict. This finding aligns with the concept of Knightian uncertainty, where firms are unable to quantify the firm-specific risk associated with a macro tail event.

Exposure in numbers A significant portion of firms also provided numerical estimates regarding expected sales changes in this macro tail event. More than half of these responses (54%) presented non-average exposure scenarios, such as ranges or max/min scenarios. Meanwhile, 29% provided a single number, and 17% offered a single number while explicitly noting the associated uncertainty. This further reflects the uncertainty surrounding the calculation of an average exposure.

Exposure strength (in words) A large share of firms express the estimated strength of their potential exposure. Among those firms, 14% expect close to zero exposure, 79% anticipate a negative impact, and 7% even foresee a positive impact. Within the negative impact group, the majority of firms expect a potentially disproportionally strong impact.

Reference to past events When firms are asked about sharing their thoughts on exposure, they often refer to their realized exposure in past macro tail events. The COVID-19 pandemic is referenced twice as much as the Great Recession, which is consistent with learning from experience and a higher weight of more recent experiences (Malmendier and Nagel, 2011, 2016). Additionally, 57 responses refer to other historical events, such as the 2001 downturn or more recent years.

Shock type What kind of shock do firms consider when asked about a 5% drop in GDP? The majority of responses identify different types of demand deficiencies, including general low demand, sectoral spillovers, and precautionary saving motives among customers. Nonetheless, there are also 67 responses that mention geopolitical escalations, typically a war between Taiwan and China, as an event that leads to a significant drop in GDP. Other supply-side factors are mentioned more indirectly through references to higher prices. Note that many of the demand channels mentioned could be the result of negative supply shocks, as discussed in Guerrieri et al. (2022).

Firm reactions to a macro tail event realization Many managers share in the open-ended text box their reactions to a macro tail event or generally how other firms might respond (the "(customers)" version). The most common response is reducing labor input, including the use of short-time work, which, however, seems insufficient in such a crisis. Additionally, managers suggest reducing investment, general business shrinkage, and overall cost reductions as reactions to a macro tail event. Firms also mention potential closures, and some discuss the possibility of switching production activities abroad.

Further responses There are also numerous responses (244) where managers indicate that they will be affected but do not provide further details. Many respondents also argue from an industry-wide perspective, consistent with the absence of firm-level exposure information. Some firms note that they are partially shielded from a significant GDP decline due to a diversified export structure. Others indicate that the impact on their business critically depends on government spending ('fiscal dependence'). Lastly, some firms explicitly refer to two different exposure scenarios, often describing a close-to-zero exposure scenario and a very strong exposure scenario.

Table A15: Codebook

Category	Explanation	Examples
Assessability		
Not assessable	Mentioning that it is impossible or almost impossible to assess exposure	"not possible to estimate" "An estimate is hardly possible. The past 2-3 years have shown that regional events can have a major impact on global contexts. [...]" "Cannot be estimated, as too many factors in this scenario are unpredictable."
Difficult to assess	Mentioning that it is difficult to assess	"Very difficult to assess " "It is difficult to estimate, but as we manufacture capital goods in the broadest sense, the effect is likely to be disproportionately high."
Assessable	Mentioning that it is possible to assess exposure	"The impact of a possible macroeconomic crisis in Germany on our real sales can be estimated to a certain extent [...]"
Easy to assess	Mentioning that it is easy to assess exposure	"The effects are easy to assess because we have precisely defined our customer base and can therefore estimate their behavior from past experience."
Expected sales changes (percent changes in numbers)		
One number	Change in sales in one number	"Sales down 25%"
One number and expressing uncertainty	Change in sales in one number, but expressing uncertainty	"Sales will slump by around 20%." "Turnover is likely to halve."
Range	Reporting expected sales change between two numbers	"Sales decline of between 25 and 40% possible."
Min exposure scenario number	Minimum sales change	"Impact 5% GDP on own sales > 20%."
Max exposure scenario number	Maximum sales change	"Difficult to estimate, sales losses of up to 30% conceivable"
Reference to past exposure		

Great Recession reference	Reference to the Great Recession / Financial Crisis (2008/2009)	"We already had this situation in the 2009 financial crisis. That would mean a 30% slump in sales."
COVID-19 reference	Reference to the COVID-19 pandemic	"Not assessable as it depends very much on which sectors are affected. Example: Corona crisis and booming construction industry." "Very difficult to estimate: Both the corona crisis (sharp drop in GDP) and the mild recession in 2023 (merely the absence of growth) have each led to double-digit percentage declines in sales. [...]"
Other historic reference	Reference to other experiences	"Past crises of this magnitude have shown that the automotive industry is also affected, but recovers relatively quickly. We anticipate a 15-25% loss of sales in the relevant annual period"
Exposure strength (in words)		
Positive impact	Positive impact on business	"In our sector, crises tend to boost our sales because certain consulting needs become necessary in order to reduce costs, optimize processes and increase sales. In principle, we always benefit."
(Almost) no impact	No or almost no impact on own business	"We have a broad base, so there are always sectors that work. We have not really been affected by slumps so far."
Disproportionately low impact	Minor negative impact on own business	"It is very difficult for us to assess the impact of such a crisis. As we operate in relatively resilient markets, as past crises have shown, we expect only minor, short-term declines in sales in such crises."
Proportional impact	1:1 impact of GDP on own business	"We will lose sales in proportion to the decline in GDP."
Disproportionately high impact	Particularly strong negative impact on own business	"Would have a catastrophic impact" "Significant drop in sales"
Shock type		
Demand shock (sector spillover)	Mentioning low demand from other sectors	"If GDP falls, this means that industry and commerce will suffer a sharp drop in sales and reduce their investments. This would have a direct impact on the success of our company."
Demand shock (precautionary customers)	Mentioning low demand because of low purchasing power / uncertainty	"A decline of 5% would be a dramatically large decline. The psychological impact on the economy would be more serious than the actual economic consequences. For the demand for my services, this could mean a drop in demand of up to 90%."
Demand shock other	Other demand factors, mentioning lower prices	"Market demand for cosmetics, which are otherwise quite crisis-proof, will then also decline significantly, with a drop in orders for us."
Supply shock (war / geopolitics)	Mentioning wars or international politics	"This is very difficult for us to assess. We assume that Ukraine will lose the war, climate catastrophes will become more frequent and China will probably dare to invade Taiwan. This will lead to a global economic crisis that will also hit our economy hard." "An escalation of the China Taiwan conflict would have a significant impact [...]" "
Supply shock other	Other supply factors, mentioning higher prices	"Competition would increase dramatically, and falling sales and rising unit costs would make things difficult."
Reaction to macro tail event		

Reduce labor	Decline in number of employees, fire employees	“"Slump in sales and layoffs of employees. [...]”
Reduce labor (customers / general)	Decline in employees of customers, general high unemployment	“The probable job losses will lead to a reduction in purchasing power and stand in the way of domestic demand. This will block purchases by citizens. [...]”
Short-time work	Use of short-time work	“Our order situation will deteriorate and we will consider short-time working”
Reduce investment	Reduction in investment	“[...] stop of investments.”
Reduce investment (customers / general)	Reduction in investment of customers, general lower investment	“The impact is very high. Less is being invested and that affects us directly.”
Shrink	Overall decline in activities	“Adjustment of capacities and personnel requirements”
Reduce costs	cutting costs	“Our sales would fall by double digits, but much less than 20%. In such a scenario, we would not be planning any layoffs at present, but would be aiming for significant cost reductions.”
Potential firm closure	Potential closure of firm / bankruptcy	“If the conditions get too bad, the company closes down and I become a privateer and sell spare parts on my own.” “endangers the company”
Potential firm closure (customers / general)	Potential firm closures of customers, general more exits	“[...] as some customers and suppliers would certainly not survive such a crisis.”
Go abroad	Move the business to other countries	“Crisis mode with job cuts and relocation of production abroad”
Other responses		
Exposed	Only stating that the firm would be affected	“Certainly an impact on our sales! ”
Industry	Relating to the exposure of the entire industry	“This would have a full impact because we are active in the leisure sector, where savings are always made first.”
Diversified	Diversified business	“Such a scenario cannot be predicted, but as a lesson from corona, we know how your own business model can be completely turned upside down within 7 days without even having made a mistake. Our lesson: diversification and innovation.”
High export	High export share	“The impact of a possible macroeconomic crisis in Germany on our real sales can be estimated to a certain extent, as we can control our foreign sales as a globally operating company”
Fiscal dependence	Dependent on fiscal response in the crisis	“We are heavily dependent on public sector investment. Macroeconomic crises that could lead to a decline in public investment would also have an impact on our sales.”
Two different scenarios	Discussion of two different explicit scenarios, range in words	“As a manufacturer of consumer goods, we are naturally affected by a macroeconomic crisis. On the other hand, there are strong market adjustments in our industry in such phases, which can even lead to an improvement in real sales despite declining macroeconomic figures.”

Politics	Frustration about politics	"If we had a government instead of the current missionaries, such a question would not arise. Honestly, Scholz and Co. are really weak and very clumsy."
General pessimism	Overall pessimism about low growth	"This macroeconomic crisis is already here. Turnover is falling. Entire industries are coming to a standstill or moving away. Sooner or later, we will probably have to relocate the rest abroad or close down in order to limit the damage."
Other	Other comments	"Demographic change will have a significant impact on the future."

Notes: This table provides the codebook which is used to classify the answers of firms to the open-ended question "*To what extent can you generally forecast the effects of such a potential macroeconomic crisis (GDP collapses by around 5% within a year) on your real sales? Please let us know your thoughts on this macroeconomic scenario here:*". The codebook provides an explanation of the categories, and example extracts from open-text responses.

F Model Appendix

Shareholder value maximization (risk aversion) This alternative model differs from the model in Section 3.1 in two ways. First, I introduce risk aversion as firms maximize shareholder value. They discount future cash flows using state prices, and those take into account investors' risk aversion in the form of risk neutral probabilities. Hence, there is risk aversion about aggregate developments. Second, the world is entirely Bayesian. This means that firms can assign probabilities to the respective firm-specific exposure scenarios in the low productivity state. I introduce risk aversion by using risk-neutral transition probabilities q. These can be derived by scaling the actual probability of the low productivity state by a stochastic discount factor m: $q_{h\to l} = m * p_{h\to l}$

In the following, I test whether this model also predicts a central role of the worst-case exposure for firms investment decisions. For simplicity, a firm has either productivity $A^l - s$ or $A^l + s$ in the case of a macro tail event, where $2 \times s$ defines the range of firm-specific exposure. The expected productivity depends on the risk-neutral probability of transitioning to the macro tail risk event q_l and the conditional probability $p_{w|l}$ of realizing the lowest

productivity $A^l - s$ in this case:

$$\mathbb{E}[A_{t+1}|A^h] = (1-q_l)A^h + q_l p_{w|l}(A^l - s) + q_l(1-p_{w|l})(A^l + s) \tag{9}$$

$$\frac{\partial}{\partial q_l} = -A^h + p_{w|l}\beta_w(A^l - s) + (1-p_{w|l})(A^l + s) \tag{10}$$

$$\frac{\partial}{\partial s \partial q_l} = 1 - 2p_{w|l} \tag{11}$$

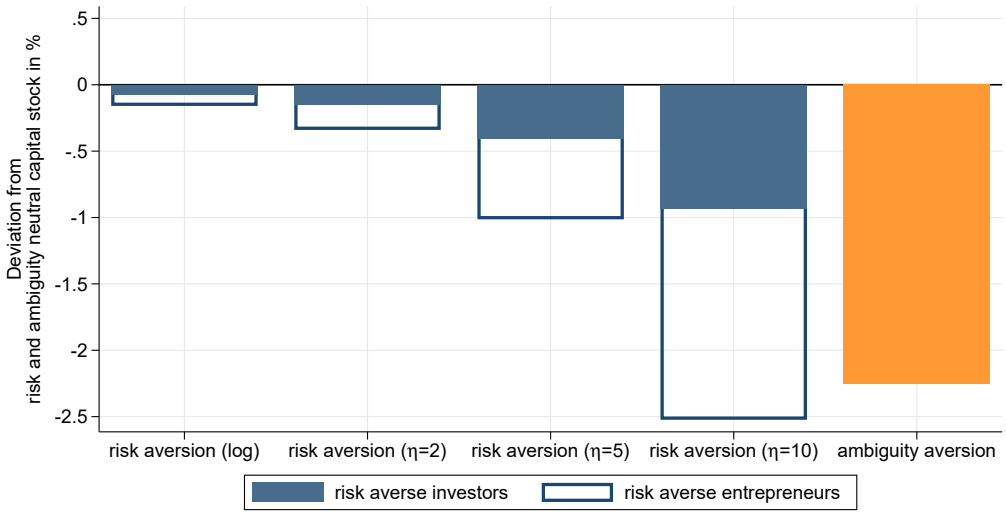
These equations show that as long as the distribution of exposure is symmetric ($p_{w|l} = 1/2$), changes in the severity of the worst-case scenario do not affect the optimal level of capital. This symmetry in exposure implies that for every firm facing its worst-case scenario, there is another experiencing its best-case scenario. Consequently, these idiosyncratic risks cancel each other out across firms, effectively diversifying away the impact on expected aggregate productivity. Note that this is not the case for ambiguity, where the law of large numbers does not hold. Intuitively, the investor faces independent sources of uncertainty, represented by a set of exposure scenarios, and therefore acts as if the mean productivity of each firm is lower. For further examples and a more detailed discussion, see Ilut and Saijo (2021) and **?**. A formal analysis of the law of large numbers for i.i.d. ambiguous random variables can be found in Epstein and Schneider (2003*a*).

I now examine the quantitative relevance of this alternative model with risk aversion relative to the baseline model with ambiguity aversion for firms' investment decisions beyond the first moment. To do so, I compute q_l for concrete examples. Investors' risk aversion can be thought of as a representative household that owns all firms and consumes firms' profits. Households maximize lifetime utility. For simplicity, I assume CRRA preferences $u(c) = \frac{c^{1-\eta}}{1-\eta}$. I back out the risk-neutral probability q_l, such that the utility of expected aggregate output based on q_l equals the utility of the certainty equivalent. For $\eta = 1$ (log utility), we have

$$\ln((1-q_l)h + q_l l) = (1-p_l)\ln(h) + p_l \ln(l)$$

$$q_l = \frac{h^{(1-p_l)}(h^{p_l} - l^{p_l})}{h-l}$$

Figure A8: Effect of different degrees of risk aversion on optimal capital stock



Notes: The figure shows the deviation from the risk and ambiguity neutral capital stock in % for different degrees of risk aversion (in blue) and the baseline model with ambiguity aversion about firm-specific exposure to macro tail risk events (in orange). The filled blue bars show results for the model with shareholder value maximization taking into account investors' risk aversion. The outlined bars show the results for an entrepreneur-type model. Both models are explained in the text. The parameterization follows Section 3.1: $A^h = 1$, $A^l = 0.9$, $\beta_{avg} = 1$, $\beta_{worst} = 2.5$, $\beta_{best} = 0.5$ and $p = 0.1$.

and for $\eta \neq 1$, we have

$$\frac{((1-q_l)h + q_l l)^{1-\eta}}{1-\eta} = (1-p_l)\frac{h^{1-\eta}}{1-\eta} + p_l \ln(l)$$

$$q = \frac{h - (-p_l h^{1-\eta} + h^{1-t} + p_l l^{1-\eta})^{1/(1-\eta)}}{h-l}.$$

h (l) refers to output units in the high (low) productivity state. Following the parameterization in Section 3.1, I set $A^h = 1$, $A^l = 0.9$, $\beta_{avg} = 1$, $\beta_{worst} = 2.5$, $\beta_{best} = 0.5$ and $p = 0.1$. Since aggregate productivity scales output linearly and preferences are CRRA, we simply set h and l so that the ratio $l/h = 0.9$. I consider different degrees of risk aversion ($\eta = 1, \eta = 2, \eta = 5, \eta = 10$). For instance, the implied risk-neutral probability with log utility is $q \approx 0.1048$.

How risk averse does the investor needs to be to achieve a similar decline in the optimal level of capital as in the model with ambiguity aversion? In Figure A8, I show the deviation from the risk and ambiguity neutral capital stock. The optimal level of capital hardly changes

(less than -0.1%) when I introduce shareholder maximization with a risk aversion parameter of $\eta = 1$ for investors. In contrast, ambiguity aversion about the firm-specific exposure to the macro tail risk event significantly reduces the optimal capital stock by 2.3%. A risk aversion parameter of $\eta = 2$ produces only a tenth of the effect compared to ambiguity aversion. Even with $\eta = 5$ or $\eta = 10$, the effect sizes are an order of magnitude smaller. To generate an effect size as large as with ambiguity aversion, we would have to assume extremely high risk aversion, with η close to 20.

Another extension of the model is an entrepreneur-type model in which an entrepreneurs' only source of income for consumption is her own firm's output. In this case, there is additional risk aversion about firm-specific output in the macro tail risk event. To analyze this possibility, I additionally introduce risk neutral probabilities for the conditional probabilities of realizing a high/low exposure to the macro tail risk event. I set the actual probabilities so that the average exposure scenario equals the expectation of worst-case and best-case scenarios.[1]

The outlined bars in Figure A8 show the additional effect on the optimal capital stock in the entrepreneur-type model. It is still the case that reasonable values of risk aversion do not generate strong negative effects on investment beyond the first moment. Only with η close to 10, an effect size similar to ambiguity aversion can be achieved. While this is a very stylized model, it demonstrates that introducing risk aversion in a Bayesian world instead of ambiguous exposure to macro tail risk events would have only small negative effects on investment beyond the first moment, given reasonable levels of risk aversion.

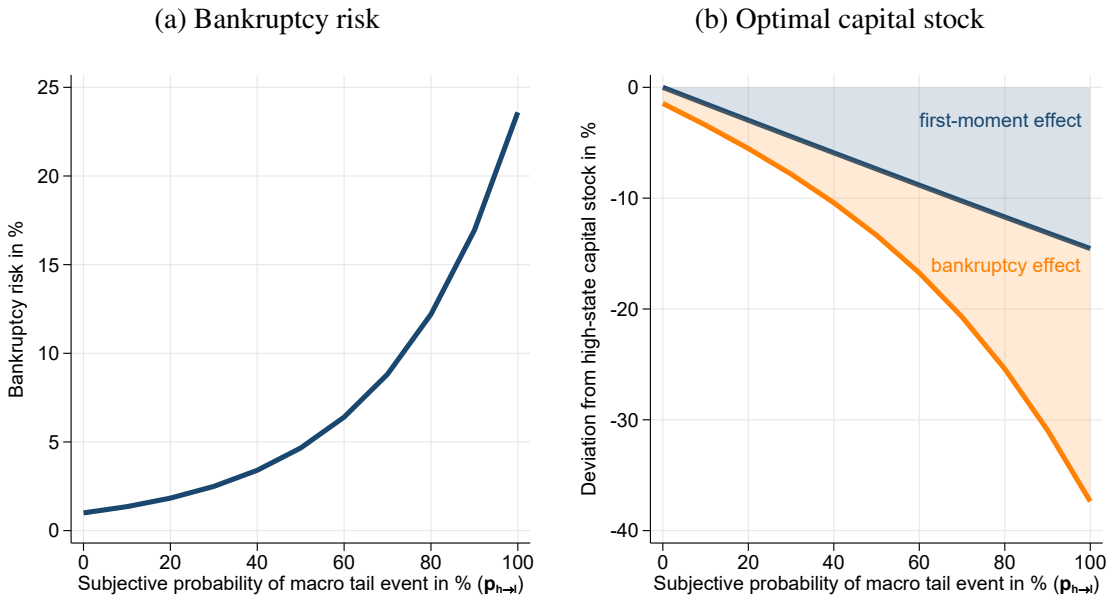
Bankruptcy risk This alternative model introduces bankruptcy risk to the firms' choice problem which increases exponentially with a decline in productivity. Upon bankruptcy, a firm incurs additional costs equating to its capital stock k. Hence, the following term is added in the optimization problem

$$\text{Potential bankruptcy costs:} \qquad \frac{k_{t+1}}{a \times \mathbb{E}[A_{t+1}]^b}, \tag{12}$$

where $a > 0$ and $b > 1$ translate the expected productivity in the next period into the probability of bankruptcy. In Panel (a) of Figure A9, the probability of bankruptcy is

[1] This entrepreneurial model with idiosyncratic risk aversion of the owner would predict a negative effect on investment beyond the first moment when the subjective probability of macro tail risk increases, driven by the firm's worst-case exposure. This is because the conditional risk-neutral probability of realizing the worst case $q_{w|l}$ is greater than $p_{w|l}$. However, I can rule out this possibility because I show empirically that the effects are not stronger for risk-averse managers, see Section 3.

Figure A9: Effect of bankruptcy risk in the stylized model



Notes: The figure shows the probability of bankruptcy (Panel (a)) and the effect of bankruptcy costs on the choice of optimal capital (Panel (b)) in relation to the subjective probability of a macro tail event.

plotted against the subjective probability of macro tail risk, where $a = 100$ and $b = 30$. The corresponding optimal capital stock is shown in Panel (b). Since the probability of bankruptcy increases exponentially with lower productivity, the optimal capital stock also falls in a concave manner with an increase in the subjective probability of macro tail risk. To obtain an economically significant effect of bankruptcy risk on the optimal capital stock that increases with macro tail risk, a relatively high probability of bankruptcy risk in a macro tail risk event is necessary, see Panel (a).

Table A14: Classifications

Categories	Number of responses
Accessibility	
Not assessable	189
Difficult to assess	292
Assessable	17
Easy to assess	22
Expected sales changes (percent changes in numbers)	
One number	92
One number and expressing uncertainty	53
Range	111
Min exposure scenario number	26
Max exposure scenario number	34
Reference to past exposure	
Great Recession reference	48
COVID-19 reference	90
Other historic reference	56
Exposure strength (in words)	
Positive impact	44
(Almost) no impact	84
Disproportionately low	160
Proportional impact	54
Disproportionately high impact	272
Shock type	
Demand shock (sector spillover)	103
Demand shock (precautionary customers)	145
Demand shock other	158
Supply shock (war / geopolitics)	68
Supply shock other	42
Reaction to macro tail event	
Reduce labor	81
Reduce labor (customers)	15
Short-time work	28
Reduce investment	27
Reduce investment (customers)	67
Shrink	32
Reduce costs	20
Potential firm closure	95
Potential firm closure (customers)	19
Go abroad	17
Other responses	
Exposed	244
Industry	116
Diversified	11
High export	73
Fiscal dependence	44
Two different scenarios	99

Notes: This table presents the classification results based on the answers of firms to the open-ended question "*To what extent can you generally forecast the effects of such a potential macroeconomic crisis (GDP collapses by around 5% within a year) on your real sales? Please let us know your thoughts on this macroeconomic scenario here:*". The classification is done by a research assistant following the Codebook, see Table A15.

G Additional quantitative model information

Numerical implementation I solve the problem of the firm using value function iteration over a discrete grid of points. I specify a 350-point capital grid with an upper bound that is large enough to be non-binding. The capital grid is constructed recursively to ensure that firms can always adjust their capital at no cost if they set investment equal to zero: $k_i = k_{i-1}/(1-\delta)$. Specifically, I generate two 175-point capital grids, where one is shifted by $\delta/2$ to create a more narrow grid. The aggregate productivity process is already discrete in the model and following a three-state Markov process. I discretize the autoregressive idiosyncratic productivity process following the standard method of Tauchen (1986) into a 13-state Markov process. I consider five firm-types with different worst-case exposures to the macro tail risk event. The model is solved separately for each type of firm.

Calibration details I parameterize the model based on standard parameters from the literature and informed by my empirical analysis at a quarterly level. In the baseline calibration, I set the annual real interest rate r to 2%. The decreasing return to capital is parameterized with $\alpha = 0.33$, with capital depreciating at 12% annually. Following other papers in the literature, I assume a high persistence of log idiosyncratic productivity shocks by setting $\rho = 0.95$. The standard deviation of the idiosyncratic innovations is 0.05 and thereby between the volatility of the high and low idiosyncratic uncertainty state in Bloom et al. (2018).

The corporate income tax rate is set to $\tau = 0.3$, which lies between the average statutory corporate income tax rate (slightly above) and the average effective corporate income tax rate in Germany (slightly below); see Fuest and Neumeier (2023). I calibrate the fixed production costs and linear production costs so that the majority of firms are profitable in normal times, but most will incur losses in a macro tail event. Panel (b) in Figure A10 shows that the overall investment response is very similar, regardless of how these parameters are calibrated. These additional parameters are only important for the fiscal policy counterfactuals that hinge on whether a firm is profitable.

The model features firm-specific exposure to macro tail risk events. In a world with ambiguous exposure, firms act based on the expected worst-case scenario. I calibrate the parameterization of the five firm types using the elicited worst-case exposures from survey data at the 10th, 25th, 50th, 75th, and 90th percentiles, see Table A3. For instance, the median firm in the survey expects a 2.5 times greater drop in sales in the worst-case scenario compared to the average-case scenario.

Table A16: Parameter calibration in the model (quarterly level)

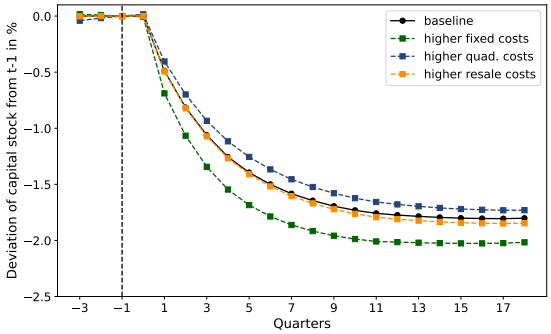
	Technology	
r	0.005	Annual interest rate of 2%
α	0.33	Decreasing return to scale
δ	0.03	Depreciation of capital stock
ρ_z	0.95	Persistence of idiosyncratic productivity
σ_z	5%	Standard deviation of innovations to idiosyncratic productivity
	Additional production costs	
γ_0	0.7	Fixed production costs
γ_1	0.12	Linear production costs
τ	0.3	Corporate income tax rate
	Macro tail risk exposure	
$\beta_{worst\,p10}$	0.5	0.5× avg. exposure of median firm (survey)
$\beta_{worst\,p25}$	1.5	1.5× avg. exposure of median firm (survey)
$\beta_{worst\,p50}$	2.5	2.5× avg. exposure of median firm (survey)
$\beta_{worst\,p75}$	4	4× avg. exposure of median firm (survey)
$\beta_{worst\,p90}$	6	6× avg. exposure of median firm (survey)
	Adjustment costs	
ϕ_1	0.1%	Fixed capital adjustment cost
ϕ_2	6	Quadratic capital adjustment cost
ϕ_3	97.5%	Resale capital adjustment cost
	Transition probabilities of macro productivity states	
$\pi_{lowA\|highA,low_risk}$	0.01	Probability of macro tail event in low macro risk state
$\pi_{lowA\|highA,high_risk}$	0.04	Probability of macro tail event in high macro risk state
$\pi_{lowA\|lowA}$	0.8	Probability of staying in macro tail event

Notes: The table provides the parameters relating to technology, additional production costs, macro tail risk exposure, adjustment costs, and aggregate transition probabilities. The transition probability from *lowA* to *highA*, *high_risk* is 0.1 and to *highA*, *low_risk* 0.1. The transition probability to stay in the current state is 0.95 for *highA*, *high_risk* and *highA*, *low_risk*. The probability to transition from *highA*, *low_risk* to *highA*, *high_risk* is 0.04 and 0.01 vice versa.

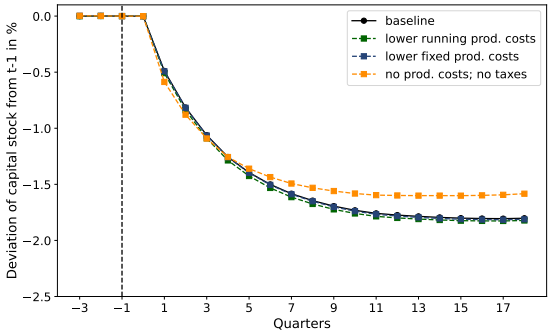
The model includes a series of capital adjustment costs. For quadratic adjustment costs, I follow Salgado, Guvenen and Bloom (2023) and set $\phi_2 = 6$. To achieve more dynamics in the change of firms that plan to decrease investment, which is my main outcome variable in Section 3.2, I set fixed and resale capital adjustment costs lower than Salgado, Guvenen and Bloom (2023) and set $\phi_1 = 0.001$ and $\phi_3 = 0.975$. Note that to generate sizable negative

Figure A10: Macro tail risk news shocks: Dynamics of the aggregate capital stock – sensitivity analysis

(a) Varying capital adjustment costs



(b) Varying additional production costs



Notes: The figures show the aggregate change in capital after a macro tail risk news shock. Note that only macro tail risk increases without a realization of the macro tail risk event. The left panel shows sensitivity analysis regarding the parameterization of the capital adjustment costs. The green dashed line is based on an alternative parameterization with higher fixed adjustment costs ($\phi_1 = 0.5\%$ instead of $\phi_1 = 0.1\%$). The blue dashed line is based on an alternative parameterization with higher quadratic adjustment costs ($\phi_2 = 8$ instead of $\phi_2 = 6$). The orange dashed line is based on an alternative parameterization with higher capital resale costs ($\phi_3 = 90\%$ instead of $\phi_3 = 97.5\%$). The right panel shows sensitivity analysis regarding the parameterization of the additional production costs and corporate tax rate. The green dashed line is based on an alternative parameterization with lower running costs ($\gamma_1 = 0.1$ instead of $\gamma_1 = 0.12$). The blue dashed line is based on an alternative parameterization with lower fixed costs ($\gamma_0 = 0.5$ instead of $\gamma_0 = 0.7$). The orange dashed line is based on an alternative parameterization without these additional production costs and corporate taxes ($\gamma_0 = \gamma_1 = \tau = 0$).

investment effects of volatility shocks through the "wait-and-see" mechanism these non-convex costs need to be high. In the present model, the mechanism does not hinge on these costs. Nonetheless, we observe in the sensitivity analysis in Figure A10 that higher fixed capital adjustment costs would further increase the negative effect of higher macro tail risk expectations on investment.

The macro productivity state in normal times is $A_h = 1$ and in the macro tail risk event $A_l = 0.925$, implying a 7.5% drop in productivity in the macro tail event for the median firm. I set the probability of remaining in the macro tail risk event to $\pi_{lowA|lowA} = 0.8$, implying an average length of a macro tail risk event of five quarters. This is equal to the length of the Great Recession 2008/2009 defined by the German Council of Economic Experts. The recession length of the COVID-19 recession was shorter, while the Great Depression and World War II were significantly longer.