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THE DEVIL IS IN THE TAIL: MACROECONOMIC TAIL RISK EXPECTATIONS OF FIRMS

Manuel Menkhoff*

April, 2025

Abstract

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. I consistently find across different empirical approaches 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

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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, Wachter, 2013), 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 variation, (ii) experimental variation, and (iii) time-series variation, 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). 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 focus on four specific macro tail events, as described above, asked at three different points in time. 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. Continuing with the example, the interquartile range (IQR) spans from a subjective probability of 20% to a subjective probability of 80%. This substantial cross-sectional dispersion contrasts with firms' point forecasts of GDP growth and the unemployment rate, which are more similar and closely aligned with those of professional forecasters (Link et al., 2023). For the financial crisis scenario, the median subjective probability is slightly lower and the IQR more narrow. Both subjective probabilities of the median firm decreased by 20 and 30 percentage points, respectively, by October 2023. The pandemic and geopolitical escalation scenarios are perceived to be less likely, but still show substantial dispersion. An increase in the subjective probability of macro tail events is closely associated with lower business expectations and higher business 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. Even conditional on average exposure, there is large heterogeneity in expected best- and worst-case exposures. I find that stronger past exposure to realized macro tail events, such as the Great Recession and COVID-19, significantly predicts a more negative expected worst-case exposure to future macro tail events, even after conditioning on expected average exposure. This finding is in line with the hypothesis by Kozlowski, Veldkamp and Venkateswaran (2020) of scarring effects after strong economic downturns. 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. The survey responses are manually coded into categories according to a codebook. 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 of uncertainty for firms. The first layer is the likelihood of occurrence of a macro tail event. The second layer is firm-specific exposure to macro tail events. 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).¹ 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 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 ("micro approach") exploits firm-level 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.² I find that a one standard deviation increase in the subjective probability of a drop in GDP of at least 5% predicts a 7.5 percentage points higher probability of reducing investment in the next year. 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 fixed firm characteristics on

¹Bachmann et al. (2020) document that Knightian uncertainty is pervasive among firms.

²To 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.

the results, I next use only within-firm variation. While this naturally reduces available variation and increases noise, 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.

In the second approach ("experimental approach"), I use experimental variation to establish causality and to test the proposed mechanism on ambiguity about firm exposure, as explained above. I conduct a survey experiment, where I confront firms with different hypothetical macroeconomic outlooks in a vignette using the ifo Management Survey. 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 first approach, firms are significantly less likely to invest when there is substantial macro tail risk. A main advantage of the experimental approach is that the first layer of macro tail risk expectations—the probability of a future macro tail event realization—is fixed by the outlooks and, therefore, can be separated from the role of firms' beliefs about exposure, which constitutes the second layer of macro tail risk expectations. 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.

The third approach ("macro approach") exploits time-series variation in macro tail risk to increase external validity. It combines the idea that firms' macro tail risk beliefs are formed through news consumption (Carroll, 2003, Chahrour, Nimark and Pitschner, 2021) with the fact that large language models have demonstrated an increasing ability to behave like humans (Aher, Arriaga and Kalai, 2023, Bybee, 2023, Horton, 2023). Specifically, I feed articles from Germany's largest business newspaper, *Handelsblatt*, between 1986 and 2023 into OpenAI's GPT-3.5 and ask the model to forecast macro tail risk based on each article. To disentangle macro tail risk—defined as a sharp decline in GDP ($\geq 5\%$)—from other moments of macro news, I also construct indices for average macro forecasts and upside risk macro expectations. The upside risk index isolates changes in macro tail risk from simultaneous movements in upside risk, thus capturing the second moment. Using local projections, I find that an interquartile range increase in the macro tail risk index, conditional on average and upside macro risk, foreshadows to a persistent decline in aggregate investment of about 7%.

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 the extent to which monetary and fiscal policy can stimulate investment after an increase in macro tail risk, comparing a world with and without ambiguous exposure to the macro tail event. I conduct counterfactual analyses involving credible policy rule changes in response to a realized macro tail event, which act as automatic stabilizers (Dolls, Fuest and Peichl, 2012, Edgerton, 2010). Counteracting monetary policy in the form of a interest rate cut in a macro tail event, motivated by the Taylor rule, significantly stimulates investment in both worlds, with and without ambiguous macro tail risk exposure. Regarding 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. The counterfactual analysis indicates that this policy mitigates the negative investment response to an increase in macro tail risk beliefs by 20–25% in a world with ambiguous exposure, while having little effect in a world without ambiguity. Intuitively, this counter-cyclical fiscal policy is particularly effective, as firms expecting significant losses in their worst-case exposure scenario to the macro tail event 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).³ 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. To complement this, I also generate a time series of macro tail risk beliefs based on newspaper articles following Bybee (2023). This connects to the extensive literature that creates various types of macro indices based on newspaper articles, such as the Economic Policy Uncertainty Index by Baker, Bloom and Davis (2016), the "recession" topic

³Roth 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.

by Bybee et al. (2024), or the Geopolitical Risk Index by Caldara and Iacoviello (2022). I extend this avenue by disentangling different moments of macro forecasts using large language models.

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 employ an IV strategy to estimate the causal effect on firms' decision-making. They also find a negative impact on investment. Bachmann, Elstner and Sims (2013) exploit time-series variation in firm-level uncertainty, measured in the ifo Business Survey, and document a negative effect on economic activity. 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. Evidence is more limited regarding the influence of firms' macro expectations on decision-making.⁴ An exception is Kumar, Gorodnichenko and Coibion (2023), who provide causal evidence for the negative effects of aggregate uncertainty on firm decisions. 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.⁵ 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

⁴For 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).

⁵Procyclical skewness is also documented for income risk (Busch et al., 2022, Guvenen, Ozkan and Song, 2014) and option-implied stock returns (Dew-Becker, 2024).

(2014) both explore how macro tail risk can be inferred from financial markets, with the former using option prices to estimate the probability of macro disasters and the latter proposing a firm-level approach based on the cross-section of returns.⁶ 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 strippeddown 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 and Schneider, 2018, Dimmock et al., 2016, Ilut and Schneider, 2014). 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. After fixing ideas theoretically in Section 3.1, I relate macro tail risk beliefs to firm decisions based on a micro approach (Section 3.2), an experimental approach (Section 3.3), and a macro approach (Section 3.4). 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 changes in macro tail risk expectations are associated with changes in firms' expectations about their own business. Lastly, I examine firms' beliefs about their exposure to macro tail events.

⁶This 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.

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).⁷ 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. 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).

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. (2024). 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.

⁷Other papers that use the IBS include, for example, Bachmann and Elstner (2015), Bachmann et al. (2024), Bachmann, Elstner and Sims (2013), Buchheim et al. (2022), Buchheim, Link and Möhrle (2024), Enders, Hünnekes and Müller (2022), Link et al. (2023).

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.

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 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:

$$\Delta log(Capital_{i,t}) = \alpha + \beta \mathbb{1} \{ \Delta Investment_{i,t} < 0 \} + \gamma_{t,s} + \delta_i + \varepsilon_{i,t}.$$
(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×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 an overall magnitude similar to the 2008/2009 financial crisis): ____
- 3. A pandemic (with an overall magnitude similar to the COVID-19 pandemic): ____
- 4. An escalation of geopolitical conflicts (direct war involvement of NATO countries): ____

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.

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



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

Notes: The figure shows the cross-sectional distribution of firms' subjective probability of four macro tail events over the next five years for October 2022, April 2023, and October 2023 (balanced panel). 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.

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 April 2023 and October 2023, enabling me to study changes in beliefs within firms over time.

Figure 2 shows the cross-sectional distribution of firms' subjective probability of the four macro tail events over the three survey waves. 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 April and October 2023, the subjective probability of a significant decline in GDP decreased sharply by 30 percentage points (p.p.), those for a financial crisis by 20 p.p., while the median subjective probability of pandemic and geopolitical escalation scenarios remained unchanged.⁸ 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).

The elevated macro tail risk expectations might question firms' general knowledge about macroeconomic developments. Appendix Figure A1 shows the relation between the subjective

⁸The 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.

probability of a large decline in GDP in the next five years (elicited in October 2022) and point forecasts of GDP growth in 2020 and 2021 (elicited in August 2020).⁹ While there is a slightly negative relationship, even firms that are very pessimistic about a large decline in GDP still have very reasonable point forecasts of GDP growth that are close to those of professional forecasters during this period.

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. A variance decomposition reveals that macro tail risk expectations are persistent at the firm level: 52% to 62% of the variation can be explained by firm fixed effects, while common time variation accounts for between 1% and 13%, depending on the specific macro tail risk scenario. 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.

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). I test the link between firms' macro tail risk expectations and business outlooks by regressing firms' business expectations (first moment) and business uncertainty (second moment) on their subjective probability of a macro tail event. 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. I add firm fixed effects to use only the variation in macro tail risk expectations within firms over time.

Table 1 presents the regression results for the four different macro tail events. An increase in macro tail risk expectations is significantly associated with a decline in business expectations (Columns 1–2) and an increase in business uncertainty (Columns 3–4); a relationship that persists even after controlling for business expectations (Column 5). In terms of magnitude, a one standard deviation increase in firms' subjective probability of a drop in GDP of at least 5% decreases their business expectations by 0.064–0.13 standard deviations and increases their business uncertainty by 0.053–0.097 standard deviations. The results are robust for the other three more specific macro tail events, where subjective expectations regarding the occurrence of a pandemic and a geopolitical escalation are more strongly associated with business uncertainty than business expectations. Appendix Table A1 replicates the analysis using firms' quantitative sales growth expectations and uncertainty. Although the results become noisier as the sample size is halved, we once again observe

⁹Dovern, Müller and Wohlrabe (2023) analyze these expectations of GDP growth in the IBS in more detail.

	Business Expectations		Business Uncertainty		
	(1)	(2)	(3)	(4)	(5)
Subj. Prob. GDP Drop $\geq 5\%$	-0.13*** (0.011)	-0.064*** (0.013)	0.097*** (0.013)	0.061*** (0.012)	0.053*** (0.012)
Business Expectations					-0.12*** (0.013)
Subj. Prob. Financial Crisis	-0.13*** (0.012)	-0.056*** (0.014)	0.10*** (0.013)	0.049*** (0.013)	0.042*** (0.013)
Business Expectations					-0.12*** (0.013)
Subj. Prob. Pandemic	-0.033*** (0.011)	-0.018 (0.012)	0.054*** (0.013)	0.035*** (0.011)	0.032*** (0.011)
Business Expectations					-0.12*** (0.013)
Subj. Prob. Geop. Escalation	-0.075*** (0.010)	-0.024* (0.014)	0.064*** (0.012)	0.042*** (0.011)	0.039*** (0.011)
Business Expectations					-0.12*** (0.013)
Observations	10715	10715	10715	10715	10715
Business Situation	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	Yes	Yes
Year X Industry FE	Yes	Yes	Yes	Yes	Yes

Table 1: Relation of macro tail risk expectations and business outlooks

Notes: The table presents the estimation results based on linear regressions of firms' subjective probability of a GDP drop of at least 5% / financial crisis / pandemic / geopolitical escalation in the next five years on firms' business expectations for the next six months (Columns 1-2) and firms' business uncertainty for the next six months (Columns 3-5). 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. All variables are normalized by their cross-sectional standard deviation. Standard errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01

a negative association with sales growth expectations and a positive association with sales growth uncertainty for the coming year. These results are consistent with the notion that macro tail risk expectations affect firms' business outlooks. Therefore, it seems natural that they may impact their 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.

Macro tail risk expectations also shift the mean of macro forecast distributions. Thus, it could be that macro tail risk expectations are mostly reflected in firms' macroeconomic point forecasts. Macro point forecasts are collected irregularly for a subset of firms in the IBS in the form of oneyear-ahead unemployment rate expectations.¹⁰ Figures A3 and A4 in the Appendix show binscatter plots of the subjective probability of a large decline in GDP in the next five years and unemployment rate expectations as well as uncertainty about it one year ahead.¹¹ Unemployment rate expectations are elicited in the last month of the quarter, so I can relate the macro tail risk expectations reported in October to the unemployment rate expectations elicited in the respective previous September and subsequent December wave. While there is indeed a positive relationship—higher subjective probabilities of a large decline in GDP are associated with higher unemployment rate expectations unemployment rate expectations are surprisingly similar across firms that strongly disagree on the probability of a macro tail event occurring. In fact, the relationship between the subjective probability of a large decline in GDP and the point forecast of the unemployment rate disappears when I use only within-firm variation. These results are consistent with Link et al. (2023), who find comparatively little variation in macro point forecasts across firms and close alignment with professional forecasters.¹² Firms' uncertainty about the unemployment rate one year ahead is also only weakly related to the subjective probability of a large decline in GDP and disappears when only within-firm variation is used. In sum, macro tail risk expectations represent a new dimension of heterogeneity that may influence firms' decision-making.

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:

¹⁰GDP growth expectations are collected even less regularly, as mentioned in the text above.

¹¹This information comes from a quarterly voluntary module in the IBS, see Link et al. (2023) and Link et al. (2024).

¹²Note that point forecasts in surveys provide a central tendency of beliefs, although it is not clear whether firms report means, medians, or modes, see Manski (2018). The weak link between the subjective probability of a macro tail event and firms' macro point forecasts suggests that firms may be more likely to report the median or mode.

Imagine a macroeconomic crisis in Germany (GDP collapses by $\approx 5\%$ 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 A2. Figure 3 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).¹³

There is substantial exposure uncertainty, measured by the distance between best- and worst-case exposure scenarios. For the median firm, there is a 20 percentage points difference between 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. Since the expected worst-case exposure is at the center of the proposed mechanism in the next section, I analyze it in more detail.

Motivated by Kozlowski, Veldkamp and Venkateswaran (2020), one hypothesis is that firms' expected exposure scenarios are shaped by experienced exposure to realized macro tail events in the past. The idea is that firms have imperfect knowledge about exposure and view the realized exposure in a macro tail event as a draw from their firm-specific distribution. I test this potential mechanism by relating firms' expected worst-case exposure, elicited in 2023, to their realized exposure in the Great Recession and the COVID-19 pandemic, leveraging the panel dimension of the survey. I proxy firm-specific exposure to the Great Recession with the share of months in which firms report negative business conditions in 2008 and 2009. I utilize a more direct proxy for exposure to the COVID-19 pandemic, as firms were asked in the survey about the impact of COVID-19

¹³Appendix Figure A2 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 3: Expected firm exposure scenarios in case of a 5% decline in GDP

Notes: The figure shows how firms' expected average exposure scenario relate to their worst- and best-case scenarios in terms of real sales changes in case of a 5% decline in German GDP. 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 average exposure on best-case (worst-case) exposure. The black dashed line is the 45-degree line.

on their business on a seven-point Likert scale from -3 (negative) to +3 (positive). I construct an indicator of a strong negative impact from COVID-19, defined as firms reporting an average COVID-19 impact score of less than -1, following Balleer et al. (2024). Table 2 presents the regression results. Indeed, higher exposure to realized macro tail events in the past is significantly associated with a more negative expected worst-case exposure in 2023. Although the magnitude of this relationship is diminished, it remains significant when controlling for average and best case exposure and is also robust to the inclusion of industry fixed effects. First, these results act as a validation exercise, confirming that firms' subjective exposure beliefs are meaningfully correlated with realized exposure during past macro tail events. Second, the results align with the idea of scarring effects at the firm level, where strong negative experiences in a macro tail event persistently shape firms' expectations.

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

	Expected worst-case firm sales change if GDP drops by 5%					
	(1)	(2)	(3)	(4)	(5)	(6)
Neg. Business State (08/09)	-13.3*** (2.26)	-2.71** (1.19)	-2.86** (1.23)			
Strong COVID-19 impact				-6.41*** (0.77)	-0.89** (0.42)	-1.19*** (0.45)
Average exposure		1.73*** (0.069)	1.72*** (0.070)		1.83*** (0.039)	1.78*** (0.038)
Best-case exposure		-0.63*** (0.10)	-0.61*** (0.10)		-0.75*** (0.056)	-0.68*** (0.054)
Constant	-24.6*** (0.68)	-5.85*** (0.56)	-5.88*** (0.58)	-27.1*** (0.52)	-6.33*** (0.38)	-6.63*** (0.41)
Observations Industry FE	1252	1252	1252 √	3167	3167	3167 √

Table 2: Expected worst-case exposure and realized exposure to the Great Recession and the COVID-19 Pandemic

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 relate 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

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:

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 A10. 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 take a threefold approach to empirically assess the role of macro tail risk expectations. First, I employ a "micro approach" that utilizes observed variation in firms' macro tail risk expectations in the cross-section and over time. Second, I implement an "experimental approach," where I confront firms in vignettes with macroeconomic outlooks, varying only the skewness, and elicit the corresponding investment decisions. Third, in a "macro approach," I construct a time series of macro tail risk expectations and other subjective macro moments based on newspaper articles, and then analyze the relation with future aggregate investment dynamics.

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:

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

where $\mathbb{E}[A_{i,t+1}]$ denotes expected productivity of the firm and $\mathbb{E}[\beta_i]$ is the expected exposure.¹⁴ 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. (2024). 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:

$$k_i^* = \left(\frac{\alpha \mathbb{E}[A_{i,t+1}|A^h]}{1+r}\right)^{\frac{1}{1-\alpha}}$$
(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 4 with the blue line. When a firm has a higher expected exposure $\mathbb{E}[\beta_i]$, this would imply a larger first-moment 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

¹⁴For simplicity, I assume that the average-case exposure scenario $\beta_{average}$ equals the firm's expected exposure.

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 $\beta_i \in {\beta_{i,worst}, \beta_{i,average}, \beta_{i,best}}$.¹⁵

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.¹⁶ 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 4 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. 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

¹⁵Specifying 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.

¹⁶Interestingly, there are studies showing that ambiguity aversion especially arises in the context of compound risk (Abdellaoui, Klibanoff and Placido, 2015, Halevy, 2007).



Figure 4: 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 A2. Average exposure is $\beta_{average} = 1$ and worst-case exposure is $\beta_{worst} = 2.5$.

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 explore two other mechanisms that can also generate negative effects on investment beyond the first-moment effect. First, I consider shareholder maximization with risk averse investors in a Bayesian world, where probabilities can be assigned to each state. Second, I introduce bankruptcy risk. I show that these alternatives generate quantitatively rather small effects beyond the first-moment effect. It would require an extremely high degree of risk aversion (CRRA parameter $\eta = 20$) or bankruptcy risk to obtain similar magnitudes as in the model with ambiguity aversion in this stylized setup. In addition, since idiosyncratic risk diversifies away—in contrast to ambiguity (see Appendix F for details)—the investment decisions are not directly associated with firms' worst-case exposure beliefs.¹⁷ I also empirically test both alternative mechanisms in the next section, and the findings suggest that they are not the main drivers of the results.

¹⁷In an entrepreneur-type model, where the entrepreneur's only source of income is the output of her own firm, there is a direct relationship with firm's worst-case exposure beliefs. Again, however, the risk aversion parameter must be extremely high ($\eta \approx 10$) to obtain similar magnitudes as in the model with ambiguity aversion, see Appendix F for details.

3.2 Micro approach

3.2.1 Empirical strategy

The goal is to establish a causal link between macro tail risk expectations and firms' investment decisions. In an ideal world, one would compare two completely identical economies, shock one of them with higher macro tail risk expectations and then compare the investment dynamics. I employ this approach in a model simulation exercise in Section 4. Since this is not empirically feasible, the main idea of the micro approach is to exploit the substantial variation in the subjective probability of a macro tail event occurring at the firm level. Macro tail risk expectations are elicited in October 2022 and 2023, while investment plans for the next year are elicited one month later, see Figure 5.

Figure 5: Timing of questions in the ifo Business Survey



I regress an indicator for a planned decrease in investment $\mathbb{1}\{\Delta Investment_{i,t+1} < 0\}$ in the next year on the subjective probability of a macro tail event occurring within the next five years $\mathbb{P}_{i,t}(MacroTailEvent)$ of firm *i*:

$$\mathbb{1}\{\Delta Investment_{i,t+1} < 0\} = \alpha_t + \beta \mathbb{P}_{i,t}(MacroTailEvent) + \gamma X_{i,t} + \delta_i + \varepsilon_{i,t}.$$
(4)

Here, time fixed effects α_t flexibly absorb macroeconomic circumstances. In addition, I control for subjective first and second moments at the firm level by including business expectations and business uncertainty in the regression. I also control for current business conditions. These three variables are based on a visual analog scale ranging from 0 to 100, as introduced in the previous section. I conduct several robustness checks by varying the set of control variables $X_{i,t}$. By including firm fixed effects δ_i , I use only within-firm variation.

While this first analysis is rather descriptive, four aspects speak against major bias. First, firms are forecasting the probability of a single macro outcome at the same point in time, namely a macro tail event. Therefore, the estimation is unlikely to be prone to reverse causality in the sense that firms' investment plans will mechanically influence managers to be more pessimistic about macro tail events, see Gennaioli, Ma and Shleifer (2016) for a similar argument. Second, investment plans are elicited in the subsequent wave after the macro tail risk expectations. This minimizes

potential response bias due to general sentiment at the time of the survey. Third, by controlling for business conditions, business expectations, and business uncertainty, I account for many other potentially confounding factors. For example, if a firm is simply more pessimistic in general or extrapolates from their own business situation. Fourth, I additionally estimate specifications that rely only on within-firm variation between October/November 2022 and 2023 by controlling for firm fixed effects. This addresses the concern that certain firm characteristics may be correlated with both, macro tail risk beliefs and investment decisions.

3.2.2 Results

I start by mapping macro tail risk expectations to the decision to reduce investment in the following year using the pooled data. Figure 6 visualizes the relation in a binned scatterplot. The raw relation in Panel (a), which includes only time fixed effects, reveals a strong and significant positive association between the subjective probability of a large decline in GDP and the decision to reduce investment in the next year. In terms of magnitude, a standard deviation increase in macro tail risk expectations is associated with a 7.5 percentage point increase in the share of lower investment plans. Importantly, Panel (b) demonstrates that the positive association remains intact when we control for the current business situation as well as for the subjective first and second moments, namely business expectations and uncertainty over the next six months. Consistent with the model predictions in the previous section, the point estimate shrinks as the subjective probability of a macro tail event also moves business expectations and uncertainty. However, more than half of the total effect size remains even after accounting for the subjective first and second moments. Appendix Figure A5 also displays the regression results based on the expectations of the occurrence of the other three more specific macro tail events: financial crisis, pandemic, and geopolitical escalation. In all cases, I estimate a strongly negative effect on investment.

I now add firm fixed effects and thereby exploit only variation within firms over time. Naturally, I lose a large amount of variation in macro tail risk beliefs (up to 62%, see Section 2) and attenuation bias due to measurement error is potentially larger. While the point estimate is indeed somewhat smaller and estimated less precisely, the significant positive relation is still there, see Panel (c) in Figure 6. The effects also remain significant for the financial crisis and pandemic scenarios, but become insignificant for the geopolitical escalation scenario, see Appendix Figure A5.

In the next step, I analyze heterogeneity with respect to firms' expected worst-case exposure to a large GDP drop. 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. Indeed, the results in Panel (d) of Figure 6 show particularly strong effects for firms with above-median worst-case exposure, which are significantly different from those of firms with below-median worst-



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

Notes: This figure shows binned scatterplot based on Equation (4). Table A3 displays the corresponding point estimates. The dependent variable is an indicator of a planned decrease in investment in the next year compared to the previous year, elicited in the November waves 2022 and 2023. The macro tail risk variable is the subjective probability of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years, elicited in the October 2022 and 2023 waves. In Panel (d), all explanatory variables are interacted with an indicator for above median worst-case exposure to a macro tail event. Standard errors are clustered at the firm level.

case exposure.¹⁸ The results are similar when flexibly controlling for industry-specific time trends with year \times industry fixed effects instead of year fixed effects, see Appendix Table A3. For a subset of firms, the survey includes information on quantitative sales growth expectations and uncertainty

¹⁸Further, as explained in Section 3.1, ambiguity aversion does not imply that firms make their forecasts based on their worst-case exposure. Indeed, I find that the change in business expectations associated with changes in macro tail risk expectations does not significantly differ between firms with above- and below-median worst-case exposure, see Appendix Figure A7.

introduced in the previous section. In Panel (b) of Appendix Table A3, I repeat the analysis using quantitative year-on-year sales growth expectations as controls and obtain very similar results.

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. When using average exposure instead of worst-case exposure, the observed differences are not as strong, see Appendix Figure A6. In the experimental approach in Section 3.3, I test this mechanism more formally.

Additional robustness One potential caveat of the baseline 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 Appendix Table A3 with quantitative year-on-year 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, although the estimates are less precise due to the smaller sample size, see Appendix Figure A8. For an even smaller subset of firms, I also observe unemployment rate expectations and the associated uncertainty in the last month of a given quarter. Using the September and December unemployment rate expectations as controls to absorb macro expectations and uncertainty leads to very similar results, see Appendix Figure A9.

Other outcome variables Instead of planned investment, I also examine investment revisions by constructing an indicator of whether firms invested less than planned in 2023 and relating this to the change in macro tail risk expectations from 2022 to 2023. For all four subjective probabilities of macro tail events, I find a strong negative effect on investment revisions, consistent with the baseline results, see Appendix Table A4. In addition, I use information on quantitative realized investment, collected in the survey for 2021, 2022, and 2023. Although the timing is not as closely aligned with the question of the macro tail risk expectations, I still find that a higher subjective probability of a macro tail event in October 2022 predicts a strong decline in investment from 2021 to 2022, while April and October 2023 macro tail risk expectations show no relationship. This changes when analyzing the dynamics of investment from 2021 to 2023, where a higher subjective probability of a macro tail event in April 2023 now predicts a strong decline, see Appendix Table A5. In terms



Figure 7: Heterogeneity across firm characteristics

Notes: This figure shows the estimates of a one percentage point increase in macro tail risk expectations on the likelihood of reducing investment in the next year based on Equation (4), where all explanatory variables are interacted with indicators that split the sample by firm characteristics. The dependent variable is an indicator of a planned decrease in investment in the next year compared to the previous year, elicited in the November waves 2022 and 2023. The macro tail risk variable is the subjective probability of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years, elicited in the October 2022 and 2023 waves. 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 \geq 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 firm level.

of magnitude, a one standard deviation increase in the subjective probability of a macro tail event leads to a decline in investment of about 8.4% to 9.6% (based on Columns 6 and 7).

Heterogeneity I now study heterogeneity in the effect sizes across a number of firm characteristics. This allows me to test for further mechanisms. I use the baseline regression setup with and without firm fixed effects and 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 orange group in Figure 6 Panel (d)).

Figure 7 presents the results. First, the effect sizes are similar for small and large firms. If anything, the effects are greater for larger firms, implying that changes in macro tail risk also

have strong 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 analyze heterogeneity with respect to the degree of risk-taking of the managers. Theoretically, the mechanism driving the strong effects beyond the first moment could be due to risk-averse managers. However, if anything, the heterogeneity results indicate rather stronger effects for firms with *more* risk-taking managers, labeled as "risk taker" in Figure 7. One reason for this could be that the firms with more risk-averse managers are better prepared and diversified for a macro tail event. Lastly, I examine the role of firms' leverage. The effect sizes are similar for firms with high and low equity ratios, suggesting that financial frictions, including bankruptcy risk, do not seem to be a dominant factor.

3.3 Experimental approach

3.3.1 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.¹⁹ 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:

¹⁹See 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.

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.)

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

Outlook AONo differenceOOutlook BO

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.²⁰ 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 Figure A10 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 Figure A11. 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 formally analyze whether firms' exposure scenarios predict their investment decisions in the vignettes.

²⁰In 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 $-2.\overline{6}$ in Outlook B. The kurtosis (4. moment) is 1 in Outlook A and $8.\overline{1}$ in Outlook B.



Figure 8: Firms' investment choice in the hypothetical macro outlooks (a) Full sample (b) Only owners

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

3.3.2 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.²¹ 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 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

²¹Note 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.

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

Table 3: Investment choice and firm exposure to a macro tail event

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

would be less likely to invest in Outlook B, which contains negative skewness and therefore high macro tail risk.

Table 3 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).

3.4 Macro approach

How do firms' macro tail risk expectations evolve over time and how do they relate to future aggregate investment dynamics? In the third approach, I exploit recent advances in artificial general intelligence research, where state-of-the-art models exhibit increasingly human-like behavior. I generate beliefs about macro tail risk with a large language model (LLM) based on articles of the largest business newspaper in Germany. The underlying premise is that managers' macroeconomic outlooks are shaped by the information provided by daily newspapers. First, I explain the belief generation process using the GPT API. Second, I present and examine the macro tail risk expec-

tations index as well as an index of average macro forecasts and macro upside risk expectations to control for other moments of macro news. Then, I run local projections to analyze the relation between changes in macro tail risk beliefs and future aggregate investment dynamics.

3.4.1 Generating beliefs with a large language model

How can macroeconomic beliefs be generated using LLMs, and why is this approach feasible? There has been significant progress in the field of LLMs. A milestone was the invention of the "transformer architecture", which is also used in the GPT family. The GPT models generate output by predicting the next word in a sequence based on the words that have come before. They accomplish this by focusing on the importance of specific words in the input and using that information to make predictions. This process is repeated for each word, resulting in the generation of coherent and contextually appropriate text (Vaswani et al., 2017). Horton (2023) demonstrates that these models can be used as "simulated economic agents" by showing similar behavior as humans in classic experiments from the behavioral economics literature. Bybee (2023) is the first using LLMs to generate beliefs about macroeconomic outlooks and finds similar biases as in the previous literature based on surveys. I also refer to Bybee (2023) for a more detailed methodological discussion. To date, the economic literature has primarily relied on more traditional natural language processing tools, such as dictionary approaches or topic modeling. While the clear advantage of these approaches is the simplicity and transparency of the index construction, they lack the capacity to generate human-like beliefs, especially to distinguish between different moments of a forecast distribution.

As newspaper data source, I use the *Handelsblatt*, which is the largest business newspaper in Germany. I have access to all articles from 1986 to 2023. The Handelsblatt has been a standard daily newspaper source for managers for decades and is therefore a suitable newspaper for generating firm beliefs. I include all front-page articles in my analysis, along with 300 articles randomly sampled each month from the remaining articles. To generate beliefs, I use the API of OpenAI's GPT-3.5 model (Brown et al., 2020), a state-of-the-art large language model that also powered the well-known chatbot "ChatGPT". I feed the Handelsblatt articles as part of a prompt to the API, which has the following structure: First, I tell the model to take on the role of a manager predicting the future of the German economy based on the information in the article. Then, I provide the title and textbody of the article. Afterwards, I ask for three forecasts, given the information of the article:

1. Assessment of strong recession:

Does the likelihood of a strong recession (Gross Domestic Product declines of at least 5%) in Germany over the next 12 months increase or decrease? [increase, decrease, neutral]

2. Assessment of strong upturn:

Does the likelihood of a strong upturn (Gross Domestic Product increases by at least 3%) in Germany over the next 12 months increase or decrease? [increase, decrease, neutral]

3. Assessment on average:

In the most likely scenario, how will the economic development in Germany evolve in the next 12 months? [negative, positive, neutral]

Then, I provide a structured format in which way GPT should generate the response. I classify decrease/negative as -1, increase/positive as +1, and neutral as 0; implying that the article contains no clear signal for the forecast at hand. Additionally, I ask for the confidence in the answer and a short explanation for each forecast to reduce the likelihood of hallucination. Appendix I provides the exact wording of the prompt.

The design of the macro tail risk elicitation ("assessment of strong recession") aligns with the question I formulated for the ifo Business Survey, focusing on the probability of a substantial recession characterized by a decline in GDP of at least 5%. The upturn scenario ("assessment of strong upturn") is designed in a similar fashion, capturing potential strong growth opportunities. However, I selected 3% instead of 5% growth to reflect a more realistic upside scenario, given that 5% GDP growth has only been achieved during the reunification in 1990/1991. The third macro scenario ("assessment on average") is formulated in the same style as qualitative expectations are elicited in surveys, e.g. business expectations in the ifo Business Survey. To obtain a robust measure, the mode forecast ("most likely scenario") is asked for a given article. After averaging over many articles, the resulting index provides a qualitative measure of the average macro forecast.

Finally, I derive three indices by averaging the article-level classifications at the monthly level for each of the three macro forecasts. Following Bybee (2023), I weight each article equally. To ensure replicability, I re-ran the classifications a second time. The correlation between the first and second run at the monthly level exceeds 0.97 for all three indices. For the subsequent analysis, I use the average of the two runs.

3.4.2 Macro tail risk expectations index

Figure 9 shows the macro tail risk expectations index (*MacroTail* index), the average macro forecast index (*MacroAvg* index), and the macro upside risk expectations index (*MacroUp* index) on a monthly basis over time. The shaded areas indicate recession periods defined by the German Council of Economic Experts. We observe a strong co-movement of the three indices over time, see Appendix Table A6 for the correlation coefficients. In recessions, macro tail risk expectations are high, while average macro forecasts and macro upside risk expectations are low. This highlights the


Figure 9: Macroeconomic beliefs over time based on newspaper data

Notes: The figure shows macroeconomic belief indices based on articles from the *Handelsblatt* over the time period 1986-2023. The beliefs are generated by prompting forecasts with the large language model GPT 3.5, see Appendix I for the wording of the prompt. The light blue lines indicate the respective raw monthly index and the bold dark blue lines a moving average over the last three months. The shaded areas show recessions as defined by the German Council of Economic Experts. The dashed lines indicate the three months during which I elicit the subjective probability of a macro tail event from firms in the survey. Panel (a) presents the macro tail risk expectations index (*MacroTail* index), panel (b) presents the average macro forecast index (*MacroAvg* index), and panel (c) presents the macro upside risk expectations index (*MacroUp* index).

importance of disentangling macro tail risk expectations from other moments of the macro forecast distribution. The *MacroTail* index shows a slight upward trend: following the Great Recession, the index did not return to pre-2008 levels and has remained particularly elevated in recent years. The dashed lines indicate the three months during which I elicit macro tail risk expectations from firms in the survey. Consistent with the survey results, macro tail risk expectations are higher in October 2022 than in April and October 2023.

How do the indices correlate with conventional uncertainty measures? Appendix Table A6 shows a positive correlation with the VIX for Germany (0.29) and the European Economic Policy Uncertainty Index (0.56). There is also positive correlation with the US VIX (0.36) and a US skewness index (0.11), both based on S&P 500 returns. I conclude that while the *MacroTail* index shows—reassuringly—correlations in the expected direction with other uncertainty proxies, the relatively low correlation coefficients suggest that the index captures unique variation in macro tail risk.

To gain an intuition about GPT's classifications, I analyze which type of articles have the greatest impact on changes in macro expectations. Using a dictionary-based approach, I group articles into the following topics: news about the aggregate economy, idiosyncratic news about firms, financial news, news about national politics, and news about international politics. News that affect macro tail risk expectations are mostly about the aggregate economy and financial topics, while idiosyncratic news are relatively more important for average macro forecasts, see Appendix Table A7.

A potential concern is that GPT's expectations may reflect future event knowledge that could bias the responses due to the strong overlap between GPT's training period, which lasts until 2021, and my sample. However, two aspects speak against major biases. First, Bybee (2023) evaluate out-of-sample macro expectations and finds no significant difference in predictive power compared to in-sample results. Second, I explicitly include in the prompt that GPT should only consider the information from the article. An example demonstrating that this approach seems effective is an article from 2001 about the relationship between Putin and George W. Bush, including Putin saying, "The differences weighed far less than what unites us", see for more details in Appendix I.1. GPT classifies this article as reducing macro tail risk expectations while having no impact on average forecasts and upside risk expectations, despite NATO's eastward expansion in later years (this possibility is even mentioned in the article) and Russia's invasion and annexation of Crimea during the training period.

3.4.3 Dynamics of macro tail risk expectations and aggregate investment

The literature measuring various types of macro indices based on newspaper articles typically employs parsimonious time series models to analyze how changes in these indices predict macroe-conomic dynamics (e.g., Baker, Bloom and Davis, 2016, Bybee et al., 2024, Caldara and Iacoviello, 2022). I use local projections (Jordà, 2005) to estimate the link between changes in macro tail risk expectations and subsequent macroeconomic dynamics, focusing on investment. To disentangle macro tail risk expectations from other macro moment expectations, I explicitly include the two additional indices for average macro forecasts and upside risk macro expectations. I estimate the following equation on a monthly level over a horizon of up to four years:



Figure 10: Investment dynamics after an increase in macro tail risk expectations (MacroTail)

Notes: This figure shows local projections of investment good production in response to an interquartile-range increase in the macro tail risk expectations index (*MacroTail* index) based on Equation 5. In Panel (a), it is controlled for the average macro forecast index (*MacroAvg* index) and two lags of the outcome variable, *MacroTail* index, and *MacroAvg* index. In Panel (b), it is additionally controlled for the macro upside risk expectations index (*MacroUp* index) and two lags of it. Confidence bands are shown at the 68% and 90% level based on lag augmented standard errors (Montiel Olea and Plagborg-Møller, 2021).

$$y_{t+h} = \alpha_h + \beta_{1,h} MacroTail_t + \beta_{2,h} MacroAvg_t + \beta_{3,h} MacroUp_t + \Gamma X_t + \varepsilon_t,$$
(5)

where X_t contains two lags of the outcome variable, the *MacroTail* index, *MacroAvg* index and *MacroUp* index. The main outcome variable is the monthly log of the seasonally adjusted production of investment goods index in Germany, which serves as a high-frequency proxy for aggregate investment developments.²²

Figure 10 shows the estimation results for an interquartile-range increase in the macro tail risk expectations index. The left panel presents the results from local projections controlling for the average macro forecast index, while the right panel includes additional controls for the macro upside risk expectations index. In both cases, an increase in macro tail risk expectations foreshadows a large decline in investment. The impact accumulates gradually over time and persistently depresses investment by up to 7%. An increase in the average macro forecast index predicts a positive short-lived increase in investment, while changes in upside risk macro expectations show no significant relation to subsequent investment dynamics, see Appendix Figure A12.

To test the robustness of the results, I estimate several alternative specifications, as summarized in Appendix Figure A13. I find that the results are robust to changing the number of lags, taking

²²The results remain robust when controlling for 12 or 24 lags of the outcome variable.



Figure 11: Impact of macro tail risk expectations (*MacroTail*) on investment: split by change in dispersion

Notes: In the left panel, the change in macro tail risk index $MacroTail_t - MacroTail_{t-1}$ is related to the change in the macro upside risk index $MacroUp_t - MacroUp_{t-1}$ in a scatter plot. The right panel show the local projection results following an increase in macro tail risk, split by co-movement with changes in the macro upside risk index based on Equation (6). Confidence bands are shown at the 68% and 90% level based on lag augmented standard errors (Montiel Olea and Plagborg-Møller, 2021).

out the Great Recession, including the European Economic Policy Uncertainty Index of Baker, Bloom and Davis (2016), and when controlling for the DAX and the VIX (proxied by the realized monthly volatility of daily stock market returns) as additional measures for first and second moment expectations.

Another way to isolate the impact of changes in macro tail risk from changes in the second moment (dispersion) is to differentiate changes in macro tail risk based on whether the macro upside risk index moves in the same direction, while still controlling for average macroeconomic forecasts. When an increase in macro tail risk is accompanied by an increase in the macro upside risk, both tails of the macroeconomic outlook widen, leading to an overall increase in the second moment. Conversely, if only the macro tail risk index rises without a corresponding increase in the macro upside risk, the impact is not confounded by concurrent changes in second moment expectations.

Panel (a) of Figure 11 shows a scatter plot of how month-to-month changes in macro tail risk are related to changes in macro upside risk. In most months, an increase in macro tail risk expectations does not coincide with an increase in macro upside risk expectations (orange shaded area, *SameDirection* = 0). However, there are also months in which both indices co-move (blue shaded area, *SameDirection* = 1). Panel (b) presents the investment changes following an increase in macro tail risk, differentiated by whether there is co-movement with changes in the macro upside

risk index:

$$y_{t+h} = \alpha_h + \beta_{1,h} MacroTail_t \times SameDirection_t + \beta_{2,h} MacroAvg_t + SameDirection_t + \Gamma X_t + \varepsilon_t$$
 (6)

First, we observe that an increase in macro tail risk expectations, even without a corresponding increase in macro upside risk expectations, has a negative effect on investment beyond the first moment (orange line). Second, when the increase in macro tail risk expectations is accompanied by an increase in macro upside risk expectations, the negative investment effect tends to be even larger. This is consistent with additional real option effects documented in the literature, e.g., Bloom (2009).

4 Quantitative heterogeneous firm model

In this section, I extend the stylized model from Section 3.1 into a quantitative heterogeneous firm model, simulate macro tail risk news shocks, and analyze policy counterfactuals. The model builds on a standard heterogeneous firm model (Cooper and Haltiwanger, 2006), which also forms the core of more elaborate RBC models that contain a heterogeneous firm model block (e.g., Bloom et al. 2018). I abstract from labor as a factor of production and general equilibrium effects, while introducing 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 is an augmented version of the stylized model in Section 3.1 with more realistic dynamics. The main additional features are (i) idiosyncratic productivity, (ii) capital only partially depreciates in a given period, and (iii) there are three types of 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. 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 are differentially exposed to the low aggregate productivity state. The decline in aggregate productivity from the high to the low productivity state is multiplied by a firm-specific exposure parameter β_i , resulting in productivity

$$A_i^l = A^h - \beta_i (A^h - A^l). \tag{7}$$

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 fist-moment effect, as discussed in Section 3.1. Second, it accounts for the empirical 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

$$I_{i,t} = k_{i,t+1} - (1 - \delta)k_{i,t}$$
(8)

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.

$$\Psi(k_{t+1},k_t) = \phi_1 \mathbb{I}_{I_{i,t} \neq 0} + \frac{\phi_2}{2} \left(\frac{I_{i,t}}{k_{i,t}}\right)^2 + (1-\phi_3)|I_{i,t}|\mathbb{I}_{I_{i,t} < 0}$$
(9)

Corporate income tax and additional costs To study fiscal policy implications, I introduce a corporate income tax τ on firms' profits. As it is typically the case in advanced economies, I assume that the tax rate is asymmetric: firms pay taxes on their profit but do not receive a transfer if they are making losses, see Fuest and Neumeier (2023) for a review on corporate income taxation. To achieve realistic profit margins in the cross-section and over time, 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 way to add 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.²³ Hence, the dynamic problem of the firm is based on the expected firm-specific worst-case exposure $\beta_{i,worst}$ to the macro tail event, reflecting firms' cautious behavior in the presence of Knightian uncertainty:

$$V(k,z,\beta,A) = \max_{k'} \left\{ \begin{array}{c} (1-\tau)(Azk^{\alpha} - \delta k - \psi(k',k) - \gamma_0 - \gamma_1 k) \\ -k' + k + \frac{1}{1+r} \min_{\beta \in \{\beta_{worst},\beta_{average},\beta_{best}\}} \mathbb{E}[V(k',z',\beta,A')] \end{array} \right\}$$
(10)

4.2 Model results

Calibration I solve the firm problem numerically using value function iteration. I discipline the degree of ambiguity aversion with 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 a firm with average exposure ($\beta = 1$). 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). The rest of the calibration assumes mostly standard parameters from

²³Epstein and Schneider (2003b) axiomatize the recursive version of behavior under ambiguity.





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: $4 \times avg$ " 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.

the literature on a quarterly level, 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 12 shows how investment and the capital stock evolve over time after the macro tail risk news shock at event time zero. 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 amounts to around 10% for the median firm. This is slightly larger but in the ballpark of the effect sizes estimated using the first empirical approach. Based on a back-of-the-envelope calculation—see Appendix H for details—my empirical estimates predict a decline between 6%–9% in investment.

4.3 Policy implications

To what extent can counteracting monetary and fiscal policy stimulate investment following an increase in macro tail risk? Is there a difference between a world with and without ambiguous exposure to macro tail events? To study these questions, 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.²⁴

Monetary policy counterfactual For studying monetary policy, I consider a counterfactual in which the interest rate is no longer fixed. Specifically, the interest rate is rule-based and decreases in the case of a realized macro tail event. This counterfactual is motivated by the Taylor rule, which predicts that the central bank cuts the nominal interest rate after a decline in output. Since I abstract from nominal rigidities, I assume that central banks would react disproportionately strongly to a potential decline in inflation, ensuring that the real interest rate also falls. Firms incorporate this interest rate cut in the case of a macro tail event into their optimization problem.

To what extent does the anticipated decline in real interest rates change firms' investment behavior after an increase in macro tail risk? I simulate a monetary policy counterfactual in which the annual interest rate decreases from 2% to 1% in the case of a macro tail event. The upper left panel in Figure 13 shows that the decline in the aggregate capital stock is mitigated by about 9-11% due to the credible interest rate cut by one percentage point. The stimulus works through expected lower user cost of capital in case of a realization of the macro tail event, leading to a higher optimal

²⁴Both 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.

Figure 13: Macro tail risk news shocks and rule-based policy counterfactuals: Dynamics of the aggregate capital stock



Monetary policy counterfactual

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.

capital stock. The effect turns out to be similar in absolute terms in the world 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.

Fiscal policy counterfactual To study fiscal policy, I analyze a counterfactual in which there is a credible switch from asymmetric to symmetric corporate income taxation in case of a macro tail event. Intuitively, this means that firms receive money from the government when they incur losses. Importantly, the benefits of symmetric corporate taxes scale linearly with the size of the losses,

thereby partially insuring firms. In practice, this is similar to generous loss carrybacks, where losses can be deducted from previously payed taxes on profits.²⁵

How does the introduction of symmetric corporate income taxation in the macro tail event affect firms investment behavior after an increase in macro tail risk? Again, as with monetary policy, I simulate a fiscal policy counterfactual in which there is symmetric corporate income taxation in case of a macro tail event. In a world with ambiguous exposure (lower left panel in Figure 13), the decline in the aggregate capital stock is mitigated by about 20–25%, whereas there is no large effect of the fiscal policy counterfactual in the world without ambiguous exposure (lower right panel in Figure 13). Why is there such a large difference? In contrast to monetary policy, the benefit of symmetric corporate taxation is directly linked to firms' worst-case exposure: the larger the expected losses are in the worst-case exposure scenario in the macro tail event, the more funds do the firms receive from the government. In the world without ambiguous exposure, only the average exposure scenario matters, with significantly better firm performance in the macro tail event compared to the worst-case scenario.

Note that the exposure of firms in a realized macro tail event would ultimately be the average exposure scenario rather than the worst-case scenario. Thus, the announced switch to symmetric taxation in a macro tail event is less costly to the government yet still significantly stimulates investment, thereby enhancing the efficiency of the policy compared to a scenario without ambiguity aversion. Why not implement symmetric corporate taxation universally? Especially in normal times, firms with low idiosyncratic productivity would benefit most, implying lower average productivity and higher costs of the policy.

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.

²⁵Note that this comparison only holds if firms were profitable and paid taxes before a macro tail event.

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.

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.

References

- **Abdellaoui, Mohammed, Peter Klibanoff, and Lætitia Placido.** 2015. "Experiments on Compound Risk in Relation to Simple Risk and to Ambiguity." *Management Science*, 61(6): 1306–1322.
- Aher, Gati V., Rosa I. Arriaga, and Adam Tauman Kalai. 2023. "Using Large Language Models to Simulate Multiple Humans and Replicate Human Subject Studies." 337–371. PMLR.
- Alfaro, Iván, Nick Bloom, and Xiaoji Lin. 2023. "The Finance Uncertainty Multiplier." *Journal of Political Economy*, forthcoming.
- Andrade, Philippe, Olivier Coibion, Erwan Gautier, and Yuriy Gorodnichenko. 2022. "No Firm Is an Island? How Industry Conditions Shape Firms' Expectations." *Journal of Monetary Economics*, 125: 40–56.
- Ang, Andrew, Joseph Chen, and Yuhang Xing. 2006. "Downside Risk." *Review of Financial Studies*, 19(4): 1191–1239.
- **Bachmann, Rüdiger, and Christian Bayer.** 2014. "Investment Dispersion and the Business Cycle." *American Economic Review*, 104(4): 1392–1416.
- Bachmann, Rüdiger, and Steffen Elstner. 2015. "Firm Optimism and Pessimism." *European Economic Review*, 79: 297–325.
- Bachmann, Rüdiger, David Baqaee, Christian Bayer, Moritz Kuhn, Andreas Löschel, Benjamin Moll, Andreas Peichl, Karen Pittel, and Moritz Schularick. 2022. "What if? The Economic Effects for Germany of a Stop of Energy Imports from Russia." ECONtribute Policy Brief No. 028.
- **Bachmann, Rüdiger, Kai Carstensen, Stefan Lautenbacher, and Martin Schneider.** 2020. "Uncertainty is More Than Risk – Survey Evidence on Knightian and Bayesian Firms." Working Paper.
- Bachmann, Rüdiger, Kai Carstensen, Stefan Lautenbacher, Manuel Menkhoff, and Martin Schneider. 2024. "Uncertainty and Change: Survey Evidence of Firms' Subjective Beliefs." Working Paper.
- Bachmann, Rüdiger, Steffen Elstner, and Eric R Sims. 2013. "Uncertainty and Economic Activity: Evidence from Business Survey Data." *American Economic Journal: Macroeconomics*, 5(2): 217–49.
- **Backus, David, Mikhail Chernov, and Ian Martin.** 2011. "Disasters Implied by Equity Index Options." *Journal of Finance*, 66(6): 1969–2012.
- Baker, Scott R., Nicholas Bloom, and Steven J. Davis. 2016. "Measuring Economic Policy Uncertainty." *Quarterly Journal of Economics*, 131(4): 1593–1636.
- **Balleer, Almut, Sebastian Link, Manuel Menkhoff, and Peter Zorn.** 2024. "Demand or Supply? Price Adjustment Heterogeneity during the COVID-19 Pandemic." *International Journal of Central Banking*, 20(1): 93–158.

- **Barro, Robert J.** 2006. "Rare Disasters and Asset Markets in the Twentieth Century." *Quarterly Journal of Economics*, 121(3): 823–866.
- Barro, Robert J., and José F. Ursúa. 2012. "Rare Macroeconomic Disasters." Annual Review of *Economics*, 4(1): 83–109.
- Bertrand, Marianne, and Antoinette Schoar. 2006. "The Role of Family in Family Firms." *Journal of Economic Perspectives*, 20(2): 73–96.
- **Beutel, Johannes, and Valentin Stockerl.** 2023. "Tail Risk Neglect: A Reality Check." Working Paper.
- **Bianchi, Francesco, Cosmin Ilut, and Martin Schneider.** 2018. "Uncertainty Shocks, Asset Supply and Pricing over the Business Cycle." *Review of Economic Studies*, 85(2): 810–854.
- Bloom, Nicholas. 2009. "The Impact of Uncertainty Shocks." *Econometrica*, 77(3): 623–685.
- **Bloom, Nicholas, Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen J. Terry.** 2018. "Really Uncertain Business Cycles." *Econometrica*, 86(3): 1031–1065.
- **Born, Benjamin, Zeno Enders, Gernot J. Müller, and Knut Niemann.** 2022. "Firm Expectations About Production and Prices: Facts, Determinants, and Effects." In *Handbook of Economic Expectations*., ed. Rüdiger Bachmann, Giorgio Topa and Wilbert van der Klaauw, 355–384. Elsevier.
- **Born, Benjamin, Zeno Enders, Manuel Menkhoff, Gernot J. Müller, and Knut Niemann.** 2024. "Firm Expectations and News: Micro V Macro." CEPR Discussion Paper 17768.
- Bouwman, Christa H. S., and Ulrike Malmendier. 2015. "Does a Bank's History Affect Its Risk-Taking?" American Economic Review: Papers & Proceedings, 105(5): 321–325.
- Brown, Tom, Benjamin Mann, Nick Ryder, Melanie Subbiah, Jared D. Kaplan, Prafulla Dhariwal, Arvind Neelakantan, Pranav Shyam, Girish Sastry, and Amanda Askell. 2020.
 "Language Models Are Few-Shot Learners." Advances in Neural Information Processing Systems, 33: 1877–1901.
- Buchheim, Lukas, Jonas Dovern, Carla Krolage, and Sebastian Link. 2022. "Sentiment and Firm Behavior During the Covid-19 Pandemic." *Journal of Economic Behavior & Organization*, 195: 186–198.
- **Buchheim, Lukas, Sebastian Link, and Sascha Möhrle.** 2024. "Inflation and Wage Expectations of Firms and Employees." IZA Discussion Paper 17269.
- Busch, Christopher, David Domeij, Fatih Guvenen, and Rocio Madera. 2022. "Skewed Idiosyncratic Income Risk over the Business Cycle: Sources and Insurance." *American Economic Journal: Macroeconomics*, 14(2): 207–242.
- **Bybee, Leland.** 2023. "The Ghost in the Machine: Generating Beliefs with Large Language Models." Working Paper.

- Bybee, Leland, Bryan Kelly, Asaf Manela, and Dacheng Xiu. 2024. "Business News and Business Cycles." *Journal of Finance*, forthcoming.
- Caldara, Dario, and Matteo Iacoviello. 2022. "Measuring Geopolitical Risk." *American Economic Review*, 112(4): 1194–1225.
- **Carroll, Christopher D.** 2003. "Macroeconomic Expectations of Households and Professional Forecasters." *Quarterly Journal of Economics*, 118(1): 269–298.
- Chahrour, Ryan, Kristoffer Nimark, and Stefan Pitschner. 2021. "Sectoral Media Focus and Aggregate Fluctuations." *American Economic Review*, 111(12): 3872–3922.
- **Coibion, Olivier, Yuriy Gorodnichenko, and Saten Kumar.** 2018. "How Do Firms Form Their Expectations? New Survey Evidence." *American Economic Review*, 108(9): 2671–2713.
- **Coibion, Olivier, Yuriy Gorodnichenko, and Tiziano Ropele.** 2020. "Inflation Expectations and Firm Decisions: New Causal Evidence*." *Quarterly Journal of Economics*, 135(1): 165–219.
- **Cooper, Russell W., and John C. Haltiwanger.** 2006. "On the Nature of Capital Adjustment Costs." *Review of Economic Studies*, 73(3): 611–633.
- Deutsche Bundesbank. 2020. "Monthly Report June 2020." 72(6).
- **Dew-Becker, Ian.** 2024. "Real-Time Forward-Looking Skewness Over the Business Cycle." *Review of Economic Dynamics*, 54: 101233.
- **Dietrich, Alexander M, Gernot J. Müller, and Raphael Schoenle.** 2023. "Big News: Climate Change and the Business Cycle." Working Paper.
- **Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, and Kim Peijnenburg.** 2016. "Ambiguity Aversion and Household Portfolio Choice Puzzles: Empirical Evidence." *Journal of Financial Economics*, 119(3): 559–577.
- **Dolls, Mathias, Clemens Fuest, and Andreas Peichl.** 2012. "Automatic Stabilizers and Economic Crisis: US vs. Europe." *Journal of Public Economics*, 96(3): 279–294.
- **Dovern, Jonas, Lena Sophia Müller, and Klaus Wohlrabe.** 2023. "Local Information and Firm Expectations About Aggregates." *Journal of Monetary Economics*, 138: 1–13.
- Edgerton, Jesse. 2010. "Investment Incentives and Corporate Tax Asymmetries." *Journal of Public Economics*, 94(11-12): 936–952.
- Ellsberg, Daniel. 1961. "Risk, Ambiguity, and the Savage Axioms." *Quarterly Journal of Economics*, 75(4): 643–669.
- Enders, Zeno, Franziska Hünnekes, and Gernot J. Müller. 2022. "Firm Expectations and Economic Activity." *Journal of the European Economic Association*, 20(6): 2396–2439.
- **Epstein, Larry G., and Martin Schneider.** 2003*a*. "IID: Independently and Indistinguishably Distributed." *Journal of Economic Theory*, 113(1): 32–50.

- **Epstein, Larry G., and Martin Schneider.** 2003b. "Recursive Multiple-Priors." *Journal of Economic Theory*, 113(1): 1–31.
- **Epstein, Larry G., and Martin Schneider.** 2008. "Ambiguity, Information Quality, and Asset Pricing." *Journal of Finance*, 63(1): 197–228.
- Fiore, Nicola Maria, Thorsten Martin, and Florian Nagler. 2024. "Fiscal Constraints, Disaster Vulnerability, and Corporate Investment Decisions." Working Paper.
- Fiori, Giuseppe, and Filippo Scoccianti. 2023. "The economic effects of firm-level uncertainty: Evidence using subjective expectations." *Journal of Monetary Economics*, 140: 92–105.
- Focus Economics. 2020. "Consensus Forecast Major Economies August 2020." Consensus Forecast Major Economies.
- Friedman, Milton. 1964. "Monetary Studies of the National Bureau." *The National Bureau Enters Its 45th Year*, (44th Annual Report): 7–25.
- Friedman, Milton. 1993. "The "Plucking Model" of Business Fluctuations Revisited." *Economic Inquiry*, 31(2): 171–177. Publisher: Wiley Online Library.
- **Fuest, Clemens, and Florian Neumeier.** 2023. "Corporate Taxation." *Annual Review of Economics*, 15: 425–450.
- Gabaix, Xavier. 2012. "Variable Rare Disasters: An Exactly Solved Framework for Ten Puzzles in Macro-Finance." *Quarterly Journal of Economics*, 127(2): 645–700.
- Gennaioli, Nicola, Yueran Ma, and Andrei Shleifer. 2016. "Expectations and Investment." *NBER Macroeconomics Annual*, 30: 379–431.
- Giglio, Stefano, Matteo Maggiori, Johannes Stroebel, and Stephen Utkus. 2021. "Five Facts about Beliefs and Portfolios." *American Economic Review*, 111(5): 1481–1522.
- Gilboa, Itzhak, and David Schmeidler. 1989. "Maxmin Expected Utility with Non-Unique Prior." *Journal of Mathematical Economics*, 18(2): 141–153.
- Goetzmann, William N., Dasol Kim, and Robert J. Shiller. 2024. "Emotions and Subjective Crash Beliefs." National Bureau of Economic Research NBER Working Paper 32589, Cambridge, Mass.
- Gourio, François. 2012. "Disaster Risk and Business Cycles." *American Economic Review*, 102(6): 2734–2766.
- **Graham, John R.** 2022. "Presidential Address: Corporate Finance and Reality." *Journal of Finance*, 77(4): 1975–2049.
- Guerrieri, Veronica, Guido Lorenzoni, Iván Werning, and Ludwig Straub. 2022. "Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?" *American Economic Review*, 112(5): 1437–1474.

- Guiso, Luigi, and Giuseppe Parigi. 1999. "Investment and Demand Uncertainty." *Quarterly Journal of Economics*, 114(1): 185–227.
- Guvenen, Fatih, Serdar Ozkan, and Jae Song. 2014. "The Nature of Countercyclical Income Risk." *Journal of Political Economy*, 122(3): 621–660.
- **Gödl-Hanisch, Isabel, and Manuel Menkhoff.** 2023. "Firms' Pass-Through Dynamics: A Survey Approach." CESifo Working Paper 10520.
- Haaland, Ingar, Christopher Roth, and Johannes Wohlfart. 2023. "Designing Information Provision Experiments." *Journal of Economic Literature*, 61(1): 3–40.
- Haaland, Ingar, Christopher Roth, Stefanie Stantcheva, and Johannes Wohlfart. 2024. "Measuring What Is Top of Mind." NBER Working Paper 32421.
- Halevy, Yoram. 2007. "Ellsberg Revisited: An Experimental Study." *Econometrica*, 75(2): 503–536.
- Handelsblatt. 2001. "Putin lehnt Bushs Pläne ab." Handelsblatt Media Group, 1.
- Hassan, Tarek A, Stephan Hollander, Laurence Van Lent, and Ahmed Tahoun. 2019. "Firm-Level Political Risk: Measurement and Effects." *Quarterly Journal of Economics*, 134(4): 2135–2202.
- Hassan, Tarek A., Stephan Hollander, Laurence van Lent, Markus Schwedeler, and Ahmed Tahoun. 2023. "Firm-Level Exposure to Epidemic Diseases: COVID-19, SARS, and H1N1." *Review of Financial Studies*, 36(12): 4919–4964.
- Hennrich, Jonas, Stefan Sauer, and Klaus Wohlrabe. 2023. "Who Reports the Mood in German Boardrooms? Evidence from the Ifo Business Survey." CESifo Working Paper 10571.
- **Hiersemenzel, Magdolna, Stefan Sauer, and Klaus Wohlrabe.** 2022. "On the Representativeness of the ifo Business Survey." CESifo Working Paper 9863.
- Horton, John J. 2023. "Large Language Models as Simulated Economic Agents: What Can We Learn from Homo Silicus?" NBER Working Paper 31122.
- Ilut, Cosmin, and Hikaru Saijo. 2021. "Learning, Confidence, and Business Cycles." *Journal of Monetary Economics*, 117: 354–376.
- Ilut, Cosmin, and Martin Schneider. 2014. "Ambiguous Business Cycles." American Economic Review, 104(8): 2368–2399.
- **Ilut, Cosmin, and Martin Schneider.** 2022. "Modeling Uncertainty as Ambiguity: A Review." In *Handbook of Economic Expectations*. , ed. Rüdiger Bachmann, Giorgio Topa and Wilbert van der Klaauw, 749–777. Elsevier.
- **Iseringhausen, Martin, Ivan Petrella, and Konstantinos Theodoridis.** 2023. "Aggregate Skewness and the Business Cycle." *Review of Economics and Statistics*, 1–37.

- Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review*, 95(1): 161–182.
- Kelly, Bryan, and Hao Jiang. 2014. "Tail Risk and Asset Prices." *Review of Financial Studies*, 27(10): 2841–2871.
- Kerssenfischer, Mark, and Maik Schmeling. 2024. "What Moves Markets?" *Journal of Monetary Economics*, 145: 103560.
- Keynes, Johan Maynard. 1921. "A Treatise on Probability." In *The Collected Writings of John Maynard Keynes.*, ed. Elizabeth Johnson and Donald Moggridge. London:Macmillan.
- Knight, H. Frank. 1921. *Risk, Uncertainty and Profit*. Boston and New York: Houghton Mifflin Company.
- Kozlowski, Julian, Laura Veldkamp, and Venky Venkateswaran. 2020. "The Tail That Wags the Economy: Beliefs and Persistent Stagnation." *Journal of Political Economy*, 128(8): 2839–2879.
- Kumar, Saten, Yuriy Gorodnichenko, and Olivier Coibion. 2023. "The Effect of Macroeconomic Uncertainty on Firm Decisions." *Econometrica*, 91(4): 1297–1332.
- Lettau, Martin, Matteo Maggiori, and Michael Weber. 2014. "Conditional Risk Premia in Currency Markets and Other Asset Classes." *Journal of Financial Economics*, 114(2): 197–225.
- Link, Sebastian, Andreas Peichl, Christopher Roth, and Johannes Wohlfart. 2023. "Information Frictions among Firms and Households." *Journal of Monetary Economics*, 135: 99–115.
- Link, Sebastian, Andreas Peichl, Christopher Roth, and Johannes Wohlfart. 2024. "Attention to the Macroeconomy." CESifo Working Paper 10858.
- Longstaff, Francis A., and Monika Piazzesi. 2004. "Corporate Earnings and the Equity Premium." *Journal of Financial Economics*, 74(3): 401–421.
- Malmendier, Ulrike, and Geoffrey Tate. 2015. "Behavioral CEOs: The Role of Managerial Overconfidence." *Journal of Economic Perspectives*, 29(4): 37–60.
- Malmendier, Ulrike, and Stefan Nagel. 2011. "Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?" *Quarterly Journal of Economics*, 126(1): 373–416.
- Malmendier, Ulrike, and Stefan Nagel. 2016. "Learning from Inflation Experiences." *Quarterly Journal of Economics*, 131(1): 53–87.
- Manski, Charles F. 2018. "Survey Measurement of Probabilistic Macroeconomic Expectations: Progress and Promise." *NBER Macroeconomics Annual*, 32: 411–471.
- Maćkowiak, Bartosz, and Mirko Wiederholt. 2018. "Lack of Preparation for Rare Events." *Journal of Monetary Economics*, 100: 35–47.
- Moll, Benjamin, Moritz Schularick, and Georg Zachmann. 2023. "The Power of Substitution: The Great German Gas Debate in Retrospect." *Brookings Papers on Economic Activity*, Fall 2023.

- Montiel Olea, José Luis, and Mikkel Plagborg-Møller. 2021. "Local Projection Inference is Simpler and More Robust Than You Think." *Econometrica*, 89(4): 1789–1823.
- Nakamura, Emi, Jón Steinsson, Robert Barro, and José Ursúa. 2013. "Crises and Recoveries in an Empirical Model of Consumption Disasters." *American Economic Journal: Macroeconomics*, 5(3): 35–74.
- **Orlik, Anna, and Laura Veldkamp.** 2022. "Understanding Uncertainty Shocks and the Role of Black Swans." Working Paper.
- **Rietz, Thomas A.** 1988. "The Equity Risk Premium a Solution." *Journal of Monetary Economics*, 22(1): 117–131.
- **Ropele, Tiziano, Yuriy Gorodnichenko, and Olivier Coibion.** 2022. "Inflation Expectations and Corporate Borrowing Decisions: New Causal Evidence." NBER Working Paper 30537.
- Roth, Christopher, and Johannes Wohlfart. 2020. "How Do Expectations about the Macroeconomy Affect Personal Expectations and Behavior?" *Review of Economics and Statistics*, 102(4): 731–748.
- Roth, Christopher, Mirko Wiederholt, and Johannes Wohlfart. 2023. "The Effects of Monetary Policy: Theory with Measured Expectations." CESifo Working Paper 10216.
- Salgado, Sergio, Fatih Guvenen, and Nicholas Bloom. 2023. "Skewed Business Cycles." NBER Working Paper 26565.
- Sauer, Stefan, Moritz Schasching, and Klaus Wohlrabe. 2023. Handbook of ifo Surveys. ifo Beiträge zur Wirtschaftsforschung.
- Shiller, Robert J. 2000. "Measuring Bubble Expectations and Investor Confidence." *Journal of Psychology and Financial Markets*, 1(1): 49–60.
- Tauchen, George. 1986. "Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions." *Economics Letters*, 20(2): 177–181.
- **Theil, Henri.** 1955. "Recent Experiences with the Munich Business Test: An Expository Article." *Econometrica*, 23(2): 184–192.
- **Trautmann, Stefan T., and Gijs Van De Kuilen.** 2015. "Ambiguity Attitudes." In *The Wiley Blackwell Handbook of Judgment and Decision Making*., ed. Gideon Keren and George Wu, 89–116. Wiley.
- Vaswani, Ashish, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. 2017. "Attention is All you Need." Vol. 30. Curran Associates, Inc.
- Wachter, Jessica A. 2013. "Can Time-Varying Risk of Rare Disasters Explain Aggregate Stock Market Volatility?" *Journal of Finance*, 68(3): 987–1035.

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 second quarter of 2014 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 the second quarter of 2014 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 second quarter of 2014 all in all a change of:

B Additional Figures





Notes: The figure relates 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, to first moment GDP growth expectations for 2020 (in orange) and 2021 (in blue), elicited in August 2020. The lines represent the prediction from a kernel-weighted local polynomial regression. Confidence intervals refer to the 95% level. The long dashed lines show the GDP forecast for Germany of the Bundesbank from June 2020 (Deutsche Bundesbank, 2020) and the short dashed lines show the GDP forecast for Germany of the median professional forecaster from June 2020 (Focus Economics, 2020).



Figure A2: Relation of subjective probability of macro tail event occurrence and firm exposure beliefs

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 to firm-specific exposure expectations to a drop in GDP of 5% in terms of real sales changes elicited in 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 A3: Relation of macro tail risk to unemployment rate expectations

Notes: This figure displays binned scatter plots between subjective firm-level expectations of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years (elicited in October 2022/2023) and subjective firm-level unemployment rate expectations one year ahead (first row: elicited in September 2022/2023, second row: elicited in December 2022/2023). Panel (b) and (d) absorb firm fixed effects.



Figure A4: Relation of macro tail risk to unemployment rate uncertainty

Notes: This figure displays binned scatter plots between subjective firm-level expectations of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years (elicited in October 2022/2023) and subjective firm-level uncertainty about the unemployment rate one year ahead (first row: elicited in September 2022/2023, second row: elicited in December 2022/2023), measured on a scale from 1 (low) to 5 (high). Panel (b) and (d) absorb firm fixed effects.



Figure A5: Firms' macro tail risk expectations and investment plans: all four macro tail risk scenarios

Notes: This figure shows the point estimates and corresponding 90% confidence interval based on Equation (4) with and without fixed effects for the four different macro tail risk scenarios. The dependent variable is an indicator that is one for a planned decline in investment in the next year compared to the previous year, elicited in the November wave 2022 and 2023. The macro tail risk variables are firm-level expectations of occurrence in the next five years, elicited in the October wave 2022 and 2023. Section 2 discusses the macro tail risk expectations questions in more detail. Standard errors are clustered at the firm level.





Notes: This figure shows binned a scatterplot based on Equation (4). The dependent variable is an indicator that is one for a planned decline in investment in the next year compared to the previous year, elicited in the November wave 2022 and 2023. The explanatory variable shown on the horizontal axis is subjective probability of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years, elicited in the October wave 2022 and 2023. All explanatory variables are interacted with an indicator for above median average-case exposure to a macro tail event. Standard errors are clustered at the firm level.

Figure A7: Business expectations - only within firm variation



Notes: This figure shows binned a scatterplot based on Equation (4). The dependent variable is a slider (0-100) on business expectations for the next six months, elicited in the October wave 2022 and 2023. The explanatory variable shown on the horizontal axis is subjective probability of the occurrence of a large decline in annual GDP (\geq 5%) in the next five years, elicited in the October wave 2022 and 2023. All explanatory variables are interacted with an indicator for above median average-case exposure to a macro tail event. Standard errors are clustered at the firm level.





Notes: This figure displays robustness checks of the baseline regression specification, see Equation (4). "baseline" refers to the baseline specification, see Table A3. In the other specifications, controls include quantitative sales growth expectations (proxy for subjective first moments), sales growth uncertainty (measured as the span between best- and worst-case scenarios, a proxy for subjective second moments), and the realized growth rate in the previous quarter to control for current conditions. 'short-term' refers to forecasts for the next quarter, 'mid-term' refers to forecast for the next year, and 'long-term' refers to average yearly sales growth expectations two to four years ahead. The transparent red estimates are based on the smaller sample of firms that also report long-term sales growth expectations. 90% confidence intervals are shown. Standard errors are clustered at the firm level.



Figure A9: Robustness check: first and second moment macro controls (unemployment rate)

Notes: This figure displays robustness checks of the baseline regression specification, see Equation (4). Unemployment rate expectations controls consist of firms' expectations of the unemployment rate in September and December over a 12-month horizon and the certainty of that forecast on a scale of 1 (low) to 5 (high). 90% confidence intervals are shown. Standard errors are clustered at the firm level.





Notes: This figure shows the baseline line vignette. Both outlooks have the same mean (2) and variance (9), but different skewness (A: neutral skewness 0; B: negatively skewed $-2.\overline{6}$). In Section 3.3, the corresponding wording of the question is displayed.





Notes: This figure 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, the corresponding wording of the question is displayed.



Figure A12: Local projections: impact on production of investment goods (other macro moments)

Notes: This figure shows local projections of investment good production in response to an interquartile-range increase in the average macro expectations index (*MacroAvg* index) in the left panel and to an interquartile-range increase in the upside risk macro expectations index (*MacroUp* index) in the right panel based on Equation 5. Confidence bands are shown at the 68% and 90% level based on lag augmented standard errors (Montiel Olea and Plagborg-Møller, 2021).



Figure A13: Local projections: impact on production of investment goods (robustness)

Notes: This figure shows local projections of investment good production in response to an interquartile-range increase in the macro tail risk expectations index (*MacroTail* index) based on Equation 5. In Panel (a), it is controlled for the average macro expectations index (*MacroAvg* index), and in Panel (b) additionally for the macro upside risk expectations index (*MacroVp* index). The solid blue line shows the baseline estimates from Figure 10. Confidence bands are shown at the 90% level based on lag augmented standard errors (Montiel Olea and Plagborg-Møller, 2021). The short (long) dashed red (green) line shows the results based on a specification of three (one) lags of all variables. The long dashed orange line includes a dummy for the Great Recession period. The dotted dashed yellow line controls for the European Economic Policy Uncertainty Index (available since 1987). The dotted brown line controls for the log of the DAX (German stock market index) and the German VIX (standard deviation of the daily realized returns of the DAX for each month).

C Additional Tables

	Sales Expectations		Sales Uncertainty		
	(1)	(2)	(3)	(4)	(5)
Subj. Prob. GDP Drop $\geq 5\%$	-0.91***	-0.35*	1.33***	0.36*	0.39*
	(0.17)	(0.20)	(0.19)	(0.20)	(0.21)
Average Sales Forecast					0.081**
					(0.033)
Subj. Prob. Financial Crisis	-0.72***	-0.023	1.32***	0.47**	0.47**
	(0.16)	(0.18)	(0.19)	(0.20)	(0.20)
Average Sales Forecast					0.080**
					(0.032)
Subj. Prob. Pandemic	-0.18	0.12	0.18	0.26	0.25
	(0.17)	(0.19)	(0.18)	(0.20)	(0.20)
Average Sales Forecast					0.079**
					(0.033)
Subj. Prob. Geop. Escalation	-0.45***	-0.14	0.76***	0.15	0.16
	(0.14)	(0.18)	(0.16)	(0.18)	(0.18)
Average Sales Forecast					0.080**
					(0.033)
Observations	5268	5268	5268	5268	5268
Q-on-Q Sales Growth $(t-1)$	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	No	Yes	Yes
Year X Industry FE	Yes	Yes	Yes	Yes	Yes

Table A1: Relation of macro tail risk expectations and sales expectations

Notes: The table presents the estimation results based on linear regressions of firms' subjective probability of a GDP drop of at least 5% / financis cris / pandemic / geopolitical escalation in the next five years on firms' sales expectations for the next year (Columns 1-2) and firms' sales uncertainty for the next year (Columns 3-5). Sales uncertainty is measures as the span between best- and worst-case scenarios. Appendix A provides the wording of the questions. The macro tail risk expectations are normalized by their cross-sectional standard deviation. Standard errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01

	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%				

Table A2: Distribution of firms' expected exposure to a 5% decline in GDP

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.

		Indicator for a Decline in Investment							
	(1)	(2)	(3)	(4)	(5)	(6)			
Panel (a): Baseline Controls (Visual Analog Sliders)									
Prob. GDP Drop $\geq 5\%$	0.0025*** (0.00031)	0.0014*** (0.00030)	0.0012*** (0.00045)	0.0012** (0.00048)					
imes low worst-case eta					0.00015 (0.00060)	0.000026 (0.00073)			
imes high worst-case $m eta$					0.0020*** (0.00064)	0.0018*** (0.00069)			
Observations	2982	2982	2982	2982	2982	2982			
Panel (b): Alternative Controls (Quantitative Sales Expectations)									
Prob. GDP Drop $\geq 5\%$	0.0023*** (0.00044)	0.0019*** (0.00042)	0.0015*** (0.00055)	0.0018*** (0.00063)					
\times low worst-case β					0.00090 (0.00070)	0.00031 (0.00086)			
imes high worst-case $meta$					0.0020** (0.00082)	0.0026*** (0.00094)			
Observations	1372	1372	1372	1372	1372	1372			
Controls Year FE	No Yes	Yes Yes	Yes Yes	Yes No	Yes Yes	Yes			
Firm FE Year X Industry FE	No	No	Yes	Yes	Yes	Yes			

Table A3: Macroeconomic tail risk expectations and investment decisions

Notes: This table presents the regression results based on Equation (4). The dependent variable is an indicator that is one for a planned decline in the next year compared to the previous year, elicited in the November wave 2022 and 2023. The macro tail risk variables are firm-level expectations of an annual GDP drop $\geq 5\%$ in the next five year, elicited in the October wave 2022 and 2023. In Panel (a), controls include business expectations (proxy for first moment expectations), business uncertainty (proxy for second moment expectations), and business situation, all measured on a visual analog scale ranging from 0 to 100. In Panel (b), controls include quantitative sales expectations for the next year (proxy for first moment expectations), sales uncertainty (measured as the span between best- and worst-case scenarios, a proxy for second moment expectations), and the realized growth rate in the previous quarter. Appendix A provides the wording of the questions. Standard errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01
	Downward Investment Revision Indicator			
	(1)	(2)	(3)	(4)
Δ GDP Drop \geq 5%	0.00088** (0.00038)			
Δ Fin. Crisis		0.0016*** (0.00046)		
Δ Pandemic			0.0016** (0.00063)	
Δ Geop. Escalation				0.00074* (0.00045)
Δ Business expectations	-0.00053 (0.00068)	-0.00049 (0.00068)	-0.00064 (0.00068)	-0.00066 (0.00068)
Δ Business uncertainty	0.00011 (0.00062)	0.00011 (0.00061)	0.00014 (0.00062)	0.00014 (0.00062)
Δ Business situation	-0.0020*** (0.00058)	-0.0020*** (0.00058)	-0.0020*** (0.00058)	-0.0020*** (0.00058)
Constant	0.24*** (0.015)	0.25*** (0.015)	0.23*** (0.013)	0.23*** (0.012)
Observations	1433	1433	1433	1433

Table A4: Revisions in macroeconomic tail risk expectations and investment decisions

Notes: This table shows regression results based on revisions of macroeconomic tail risk expectations and revisions of investment plans. The dependent variable is an indicator that is one if a firm invested less in 2023 and initially planned in November 2022. Standard errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01

	$\Delta \log$ Investment (2022 - 2021)			Δ log Investment (2023 - 2021)				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Prob. GDP ≥ 5% (Oct. 2022)	-0.0019*** (0.00056)	-0.0019*** (0.00056)	-0.0017*** (0.00063)	-0.0021*** (0.00066)			0.00074 (0.0010)	0.00076 (0.0011)
Prob. GDP ≥ 5% (Apr. 2023)			-0.00064 (0.00081)	-0.00030 (0.00093)	-0.0032** (0.0012)	-0.0032*** (0.0012)	-0.0028** (0.0013)	-0.0021 (0.0015)
Prob. GDP $\geq 5\%$ (Oct. 2023)				-0.00051 (0.00089)				-0.0012 (0.0014)
$\Delta \log$ Sales (2022 - 2021)		0.54*** (0.100)	0.54*** (0.10)	0.59*** (0.10)				
$\Delta \log$ Sales (2023 - 2021)						0.48*** (0.081)	0.48*** (0.081)	0.51*** (0.085)
Observations	1961	1961	1961	1728	1557	1557	1557	1444
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	No	No	Yes	Yes
R^2	0.13	0.14	0.15	0.16	0.16	0.18	0.18	0.20

Table A5: Expected probability of a large decline in GDP and quantitative investment

Notes: The table shows the regression results based on the expected probability of a large decline in GDP and change of log quantitative investment volumes from 2021 to 2022 (Columns 1-4) and from 2021 to 2023 (Columns 5-8), elicited in March 2023 and 2024 respectively. Standard errors are clustered at the firm level. * p < 0.10, ** p < 0.05, *** p < 0.01

	MacroTail	MacroAvg	MacroUp
MacroTail	1.00	-0.72	-0.85
MacroAvg	-0.72	1.00	0.74
MacroUp	-0.85	0.74	1.00
VIX (DAX)	0.29	-0.50	-0.25
EPU (Europe)	0.56	-0.15	-0.54
VIX (S&P 500)	0.36	-0.51	-0.33
CBOE SKEW (S&P 500)	0.11	0.33	-0.03

Table A6: Correlations of macro beliefs based on newspaper data and other indices

Notes: This table presents correlation coefficients between macro expectations, classified by GPT 3.5, and other uncertainty indices, at the monthly level. All correlations are significant at the 5% level, expect the correlation between CBOE SKEW (S&P 500) and *MacroUp*.

	(1)	(2)	(3)	(4)	(5)	(6)
	MacroT	$Tail \neq 0$	Macro	$Avg \neq 0$	Macro	$Up \neq 0$
Relative to news about	t the aggrega	te economy:				
Financial	-0.0023	-0.0032	-0.021***	-0.025***	-0.017***	-0.020***
	(0.0023)	(0.0023)	(0.0027)	(0.0027)	(0.0040)	(0.0040)
Idiosyncratic	-0.0096***	-0.0097***	0.020***	0.019***	-0.065***	-0.063***
	(0.0018)	(0.0018)	(0.0021)	(0.0021)	(0.0031)	(0.0031)
International Politics	-0.039***	-0.039***	-0.086***	-0.085***	-0.084***	-0.081***
	(0.0020)	(0.0020)	(0.0023)	(0.0023)	(0.0035)	(0.0034)
National Politics	-0.024***	-0.024***	-0.098***	-0.097***	-0.018***	-0.018***
	(0.0026)	(0.0026)	(0.0031)	(0.0031)	(0.0046)	(0.0046)
Observations	187342	187342	187342	187342	187342	187342
Time FE	No	Yes	No	Yes	No	Yes

Table A7: Macro expectations and news topics

Notes: This table presents regressions that relate a change in macro expectations, classified by GPT 3.5, to news topic, classified by a dictionary approach, at the article level. Table A8 lists the dictionaries. Robust standard errors in parenthesis. * p < 0.10, ** p < 0.05, *** p < 0.01

Table A8: Dictionary for classifying articles into news topics

Торіс	Words
Aggregate economy	business cycle, GDP, inflation, unemployment, employment, growth, interest rate, industry, mone- tary policy, budget, government spending, tax cut, consumer spending, trade, export, import, trade balance, current account, economic forecast, stimulus package, forecasts, forecast, gross capital investment, national debt, money supply, labor market, wage development, productivity, economic policy, economic reforms, market economy, social market economy, globalization, international relations, world economy, economic development, industrial production, investment, trade agree- ment, export promotion, economic research, business survey, corporate profits, fiscal policy, central bank, economic report, economic analysis, economic advisor, economic development, economic reporting, labor costs, trade volume, investment activity, deficit, price, commodity prices, commod- ity, environmental economics, job security, technology sector, consumer prices, business climate, money market policy, public debt, economic indices, economic research institutes, trade wars, economic data, infrastructure investments, inflation rate, trade policy, production costs, business friendliness, labor productivity, trading partner, industrial development, social expenditures, price stability, credit conditions, employment prospects, job growth, economic relations, capital flow, labor shortage, fiscal discipline, industrial policy, employment level, industrial location, economic outlook, consumer sentiment, budget deficit, economic power, economic indicators, domestic product, technology, finance, energy, healthcare, automotive, real estate, bubble, finance minister, economic minister, central bank governor, economy, G20, consumption, dollar, DAX, Dow Jones, Nasdaq, trade minister, World Bank, production, ECB, USA, China, money, recession, boom, crisis, worldwide.
Financial economy	stock exchange, stock market, stocks, finance, financial market, financial crisis, securities, investor, investment, investors, trading, prices, index, indices, performance, dividends, investment strategy, portfolio, asset allocation, risk management, return, ECB, Fed, interest rate, interest rate policy, volatility, volatile, financial instruments, capital, capital market, investment, financial products, investment funds, central bank, monetary policy, ETF, options, futures, certificates, derivatives, hedge funds, commodities, bonds, precious metals, foreign exchange market, forex trading, cur- rencies, currency, exchange rates, forex, asset classes, asset management, investment strategies, trading, securities trading, stock exchange trading, financial analysis, market analysis, chart analysis, fundamental analysis, technical analysis, trend, market movements, stock prices, market news, fi- nancial news, financial reporting, analyst recommendations, stock exchange reports, trading volume, trading activities, investor behavior, capital flow, investor sentiment, trading strategies, investment opportunities, investment potential, return expectations, risk appetite, investment opportunities, market efficiency, return on capital, trading platforms, financial institutions, market liquidity, trading fees, financial market regulation, financial market participants, market trends, stock performance, investment goals, market capitalization, investor portfolios, portfolio, investment decisions, trading strategies, market volatility, investment strategies, investment opportunities, stock indices, stock val- uations, stockbroker, financial advisor, trading algorithms, investment vehicles, investment portfolios, investment options, stock traders, market developments, trading platforms, capital management, financial market experts, securities markets, cryptocurrencies, Bitcoin, DAX, Deutsche Bank, Commerzbank, Bundesbank, BaFin, savings banks, cooperative banks, HypoVereinsbank, KfW Bankengruppe, Allianz, Siemens, BMW, SAP,

Idiosyncratic (firms)	company, hrm, corporation, CEO, board of directors, shareholder, share, revenue, profit, loss, merger, merger negotiations, takeover, insolvency, restructuring, expansion, layoffs, product, market, new hires, production outage, market launch, market withdrawal, business model, industry leader, corporate strategy, product development, market position, competitive advantage, market leadership, market share, growth prospects, corporate goals, business unit, corporate governance, annual report, analyst report, company valuation, stock price, dividend, invest, capital increase, financial result, balance sheet, quarterly report, annual financial statement, fiscal year, liquidity, capital, auditor, compliance, accounting, corporate policy, revenue development, corporation, stake, legal, lawyer, cost structure, economic situation, business partner, customer relations, employer, employer side, supply chain, supplier, sales channel, marketing strategy, advertising campaign, customer loyalty, marketing, customer satisfaction, brand image, product quality, customer service, customer acquisition, complaint management, sales strategy, trade partner, contract conclusion, partnership, joint venture, alliance, cooperation, supply contract, exclusivity, negotiating partner, contract extension, contract design, compensation, wage negotiation, bonus payment, collective bargaining, salary structure, salary increase, performance incentive, compensation package, salary policy, works council, employee survey, working time model, personnel management, employee development, further training, occupational safety, working conditions, employee satisfaction, Volkswagen, Siemens, BMW, Daimler, Adidas, Bosch, Lufthansa, Deutsche Bank, SAP, BASF, Apple, Amazon, Microsoft, Google, Facebook, Tesla, Alibaba, Tencent, industry, sector, service, Samsung, Toyota, retail, food, health, pharmaceuticals, healthcare services, telecommunications, entertainment, media, consumer electronics, automotive, technology, steel, metal, software, fashion, mail ord
International politics	foreign minister, European Union, international relations, refugee, conflict, Erdoğan, Moscow, sanction, worldwide, Russia, Israel, France, Iran, Turkey, UN, soldiers, war, politics, Trump, China, Chinese, president, Russian, world, Ukraine, American, Putin, international
National politics	president, prime minister, federal chancellor, chancellor, head of state, finance minister, trade minister, head of government, law, bill, parliament, opposition leader, party chairperson, G20, federal government, government, politics, banks, coalition, parliament, bill, elections, election, party, politician, ministerial council, political parties, government program, opposition leader, members of parliament, election campaign, constitution, democracy, federal president, domestic politics, social policy, environmental policy, education policy, tax policy, social minister, environment minister, coalition negotiations, cabinet meeting, opposition party, legislation, vote, federal council, Bundestag, governing coalition, head of state, interior minister, justice minister, family policy, labor market policy, Merkel, SPD, CDU, union, FDP, Greens, environment, regulation, expenditures, federal bank, budget, tax, union, decision, municipality, community

Notes: This table presents the dictionaries that classify articles into news topics. The words were generated from ChatGPT with the prompt: "Imagine you are reading a Handelsblatt article and want to distinguish whether the article is about macroeconomic developments, idiosyncratic news, purely political developments or articles about the financial market. Name 50 words that you would interpret as an indicator for a XXX article.". Additionally, I added words from prompts asking for relevant companies etc. Finally, I separated politics into national and international by prompting "Look at this word list and extract all keywords that indicate news exclusively on German politics and words that indicate international politics:".

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

What are the drivers of the level differences in macro tail risk expectations across firms? To answer this question, I regress the firm fixed effects on a set of firm characteristics and additionally control for industry fixed effects. Figure A14 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 significantly correlated with average macro tail risk expectations. 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. Also, 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 large GDP decline or 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). Note that the R^2 of this regression is still relatively low with 4.5-7.9%. This means that the level differences between firms are mostly due to other unobserved characteristics.



Figure A14: Drivers of level differences between firms' macroeconomic tail risk expectations

Notes: The figure shows the coefficients of a joint regression, relating the fixed effect of firms' subjective macro tail risk expectations—elicited in October 2022, April 2023, and October 2023—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 based on robust standard errors.

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.

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 pos- sible. 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	"The impact of a possible macroeconomic crisis in
	possible to assess ex-	Germany on our real sales can be estimated to a certain
	posure	extent []"
Easy to assess	Mentioning that it is	"The effects are easy to access because we have pro-
Lusy to ussess	when the first fir	The effects are easy to assess because we have pre-
	easy to assess expo-	cisely defined our customer base and can therefore

Expected sales changes (percent changes in numbers)

One number	Change in sales in one number	"Sales down 25%"
One number and ex- pressing uncertainty	Change in sales in one number, but ex- pressing 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 sce- nario number	Minimum sales change	"Impact 5% GDP on own sales > 20%."
Max exposure sce- nario number	Maximum sales change	"Difficult to estimate, sales losses of up to 30% con- ceivable"

Reference to past exposure

Great Recession refer-	Reference to the	"We already had this situation in the 2009 financial
ence	Great Recession / Financial Crisis (2008/2009)	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 sec- tors are affected. Example: Corona crisis and boom- ing 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 ex- periences	"Past crises of this magnitude have shown that the auto- motive industry is also affected, but recovers relatively quickly. We anticipate a 15-25% loss of sales in the relevant annual period"

Exposure strength (in	n 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 im- pact 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 im- pact 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 (sec- tor spillover)	Mentioning low de- mand from other sec- tors	"If GDP falls, this means that industry and commerce will suffer a sharp drop in sales and reduce their invest- ments. This would have a direct impact on the success of our company."
Demand shock (precautionary cus- tomers)	Mentioning low de- mand 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 cri- sis 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 tai	l event		
Reduce labor	Decline in number of employees, fire em- ployees	""Slump in sales and layoffs of employees. []"	
Reduce labor (cus- tomers / 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 con- sider short-time working"	
Reduce investment	Reduction in invest- ment	"[] stop of investments."	
Reduce investment (customers / general)	Reduction in invest- ment of customers, general lower invest- ment	"The impact is very high. Less is being invested and that affects us directly."	
Shrink	Overall decline in ac- tivities	"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 plan- ning 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"	

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Potential firm closure (customers / general)	Potential firm clo- sures of customers, general more exits	"[] as some customers and suppliers would certainly not survive such a crisis.""Crisis mode with job cuts and relocation of production abroad"	
Go abroad	Move the business to other countries		
Other responses			
Exposed	Only stating that the firm would be af- fected	"Certainly an impact on our sales! "	
Industry	Relating to the expo- sure of the entire in- dustry	"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: di- versification 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 scenar- ios	Discussion of two dif- ferent explicit scenar- ios, range in words	"As a manufacturer of consumer goods, we are nat- urally 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 macroeco- nomic figures."	
Politics	Frustration about pol- itics	"If we had a government instead of the current mis- sionaries, such a question would not arise. Honestly, Scholz and Co. are really weak and very clumsy."	

General pessimism	Overall pessimism	"This macroeconomic crisis is already here. Turnover	
	about low growth	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.*

Table A9: Classifications

Categories	Number of responses
Accessibility	
Not assessable	189
Difficult to assess	292
Assessable	17
Easy to assess	22
Expected sales changes (percent change	s 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 A10.

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:

$$\mathbb{E}[A_{t+1}|A^h] = (1-q_l)A^h + q_l p_{w|l}(A^l - s) + q_l(1-p_{w|l})(A^l + s)$$
(11)

$$\frac{\partial}{\partial q_l} = -A^h + p_{w|l}\beta_w(A^l - s) + (1 - p_{w|l})(A^l + s)$$
(12)

$$\frac{\partial}{\partial s \partial q_l} = 1 - 2p_{w|l} \tag{13}$$

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 Epstein and Schneider (2008). 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



Figure A15: 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.

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

$$\begin{split} \ln((1-q_l)h+q_ll) &= (1-p_l)\ln(h) + p_l\ln(l) \\ q_l &= \frac{h^{(1-p_l)}(h^{p_l}-l^{p_l})}{h-l} \end{split}$$

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

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

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 A15, 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 A15 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

Potential bankruptcy costs:
$$\frac{k_{t+1}}{a \times \mathbb{E}[A_{t+1}]^b}$$
, (14)

¹This 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 A16: 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.

where a > 0 and b > 1 translate the expected productivity in the next period into the probability of bankruptcy. In Panel (a) of Figure A16, the probability of bankruptcy is 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).

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 A17 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 A2. 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.

The model includes a series of capital adjustment costs. For quadratic adjustment costs, I follow Salgado, Guvenen and Bloom (2023) and set $\phi_1 = 6$. To achieve more dynamics in the change of firms that plan do 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 investment effects of volatility

Technology		
r	0.005	Annual interest rate of 2%
α	0.33	Decreasing return to scale
δ	0.03	Depreciation of capital stock
$ ho_z$	0.95	Persistence of idiosyncratic productivity
σ_z	5%	Standard deviation of innovations to idiosyncratic productivity
Additional production costs		
γο	0.7	Fixed production costs
γ_1	0.12	Linear production costs
au	0.3	Corporate income tax rate
Macro tail risk exposure		
$\beta_{worst p10}$	0.5	$0.5 \times$ avg. exposure of median firm (survey)
$\beta_{worstp25}$	1.5	$1.5 \times$ avg. exposure of median firm (survey)
$\beta_{worstp50}$	2.5	$2.5 \times$ avg. exposure of median firm (survey)
$\beta_{worstp75}$	4	$4 \times$ avg. exposure of median firm (survey)
$\beta_{worstp90}$	6	$6 \times$ avg. exposure of median firm (survey)
		Adjustment costs
ϕ_1	0.1%	Fixed capital adjustment cost
ϕ_2	6	Quadratic capital adjustment cost
<i>\phi</i> _3	97.5%	Resale capital adjustment cost
	Transiti	on 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

Table A11: Parameter calibration in the model (quarterly level)

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.

shocks through the "wait-and-see" mechanism these non-convex costs need to be high. In the present model, the mechanism does not hindge on these costs. Nonetheless, we observe in the sensitivity analysis in Figure A17 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





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 $\phi_1 = 6$). 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 with lower fixed costs ($\gamma_0 = 0.5$ instead of $\gamma_0 = 0.7$). The orange 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 with lower fixed costs ($\gamma_0 = 0.5$ instead of $\gamma_0 = 0.7$).

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.

H Back-of-the-envelope calculation to map the empirical estimates to the model

- Baseline regression estimate β is 0.25 (Table A3 Column 1)
- Baseline regression estimate β is 0.12 after controlling for first and second moment expectations (Table A3 Columns 3-4).
- In the mode simulation, macro tail risk increases from 18% to 56% (five year horizon); a 38 percentage point (p.p.) increase.
- This increase in macro tail risk predicts an increase in the share of investment decreases by $0.25 \times 38 = 9.5$ p.p. and $0.12 \times 38 = 4.6$ p.p.
- Now, we map the indicator of investment decrease to a quantitative change in investment:
 - A planned decrease in investment in the survey predicts a decline in capital stock in balance sheet data by around 6% (see Section 2). Assuming an investment-to-capital (I/K) ratio of 1/12 implies a 72% decrease in investment.
 - A planned decrease in investment strongly predicts a realized decrease in investment in the survey. Using the planned decrease as in instrument for the realized decrease to estimate the effect on changes in quantitative investment (elicited in the survey) leads to a decline by 95%, see Table A12.
- The implied overall effects are:
 - $9.5\% \times 72\% = 6.8\%$ decline in investment.
 - $9.5\% \times 95\% = 9\%$ decline in investment.
- The implied effects beyond first- and second-moments are:
 - $4.6\% \times 72\% = 3.3\%$ decline in investment.
 - $4.6\% \times 95\% = 4.4\%$ decline in investment.

	(1) First stage $\mathbb{1}\{\Delta Investment_{i,t} < 0\}$	(2) IV $\Delta log(Investment_{i,t})$
$\mathbb{1}\{\Delta PlannedInvestment_{i,t+1} < 0\}$	0.311*** (0.0168)	
$\mathbb{1}\{\Delta Investment_{i,t} < 0\}$		-0.954*** (0.105)
Constant	0.203*** (0.00988)	0.337*** (0.0326)
F-Stat	343.4	
Time FE	Yes	Yes

Table A12: Prediction power of planned decrease in investment on quantitative changes in investment

Notes: The table presents the estimation results on the prediction power of a qualitative decrease in investment on quantitative changes in investment. The first column shows the first stage: a planned decrease in investment is highly predictive for a realized decrease in investment. The second column shows the effect of the instrumented decrease in investment on the change in log investment: . * p < 0.10, ** p < 0.05, *** p < 0.01

I Additional LLM information

GPT Prompt: You are a manager in a company who has to make macroeconomic forecasts for Germany based on information from newspaper articles.

Here is a newspaper article: [article]

Three forecasts are required, given the information from the article.

- 1. Assessment of strong recession:
 - Assessment: Does the likelihood of a strong recession (Gross Domestic Product declines of at least 5%) in Germany over the next 12 months increase or decrease?
 - Confidence: How confident are you in this assessment? (0 = not confident, 1 = confident)
 - Explanation: General explanation for this assessment, maximum 15 words.

The format for the response is as follows:

- {increases, decreases, neutral}
- {0,1}
- {Words: maximum 15}
- 2. Assessment of strong upturn:
 - Assessment: Does the likelihood of a strong upturn (Gross Domestic Product increases by at least 3%) in Germany over the next 12 months increase or decrease?
 - Confidence: How confident are you in this assessment? (0 = not confident, 1 = confident)
 - Explanation: General explanation for this assessment, maximum 15 words.

The format for the response is as follows:

- {increases, decreases, neutral}
- {0,1}
- {Words: maximum 15}
- 3. Assessment on average:
 - Assessment: In the most likely scenario, how will the economic development in Germany evolve in the next 12 months?
 - Confidence: How confident are you in this assessment? (0 = not confident, 1 = confident)

• Explanation: General explanation for this assessment, maximum 15 words.

The format for the response is as follows:

- {negative, positive, neutral}
- {0,1}
- {Words: maximum 15}

Please write the responses for the strong recession, the strong upturn, and the average economic development directly underneath each other, without additional text.

GPT Prompt (German):

Stell Dir vor Du bist ein Manager in einem Unternehmen, der herausfinden muss, wie die Informationen aus Nachrichten sich auf die deutsche Wirtschaft auswirken.

Hier is ein Zeitungsartikel: [article]

Es sind drei Prognosen gefragt, gegeben der Informationen aus dem Artikel.

- 1. Einschätzung starker Rezession:
 - Einschätzung: Erhöht oder verringert sich die Wahrscheinlichkeit einer starken Rezession (Bruttoinlandsprodukt fällt um mindestens 5%) in Deutschland in den nächsten 12 Monaten?
 - Konfidenz: Wie sicher bist Du Dir bei dieser Einschätzung? (0 = nicht sicher, 1 = sicher)
 - Erklärung: Generelle Erklärung zu dieser Einschätzung, maximal 15 Wörter.

Das Format für die Antwort ist folgendes:

- {erhöht, verringert, neutral}
- {0,1}
- {Wörter: maximal 15}
- 2. Einschätzung starker Aufschwung:
 - Einschätzung: Erhöht oder verringert sich die Wahrscheinlichkeit eines starken Aufschwungs (Bruttoinlandsprodukt steigt um mindestens 3%) in Deutschland in den nächsten 12 Monaten?
 - Konfidenz: Wie sicher bist Du Dir bei dieser Einschätzung? (0 = nicht sicher, 1 = sicher)
 - Erklärung: Generelle Erklärung zu dieser Einschätzung, maximal 15 Wörter.

Das Format für die Antwort ist folgendes:

- {erhöht, verringert, neutral}
- {0,1}
- {Wörter: maximal 15}
- 3. Einschätzung im Durchschnitt:
 - Einschätzung: Wie wird sich im wahrscheinlichsten Szenario die wirtschaftliche Entwicklung in Deutschland in den nächsten 12 Monaten entwickeln?
 - Konfidenz: Wie sicher bist Du Dir bei dieser Einschätzung? (0 = nicht sicher, 1 = sicher)
 - Erklärung: Generelle Erklärung zu dieser Einschätzung, maximal 15 Wörter.

Das Format für die Antwort ist folgendes:

- {negativ, positiv, neutral}
- {0,1}
- {Wörter: maximal 15}

Bitte schreibe die Antworten für die starke Rezession, den starken Aufschwung und die durchschnittliche wirtschaftliche Entwicklung direkt untereinander, ohne zusätzlichen Text.

I.1 Article example

Headline: Putin rejects Bush's plans (2001/18/06)

Despite differences on key security issues, US President George W. Bush and Russian President Vladimir Putin demonstrated unity at their first meeting in Slovenia. Russia and America are "not enemies", Putin emphasized at Brdo Castle near the Slovenian capital Ljubljana on Saturday. The differences weighed "far less than what unites us", he added after the two-and-a-half hour meeting.[...] However, the two heads of state remained at odds over the concept for a new global security system.[...] "We have found a good basis on which to build our relations," Putin emphasized. The existing differences of opinion were not of a "fundamental nature". Another controversial topic at the summit was the eastward expansion of NATO, which Moscow opposes. Handelsblatt (2001) **GPT classification:**

- macro tail risk: decreases
- average macro expectations: neutral
- upside risk expectations: neutral

GPT explanation for decrease in macro tail risk:

"Unity between the USA and Russia could help to stabilize the global security situation."