

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

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Frontier Topics in Macro-Finance Conference

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- We live in times of (partly) realized macro tail events
  - ! Defined as a large drop in GDP, caused by financial crises, pandemics, wars
- Macro tail events expose firms to an unusual environment
  - ! Limited understanding of the impact on firm's business

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  - ! Limited understanding of the impact on firm's business
- Expectations matter for decision-making of firms
  - Gennaoli-Ma-Shleifer (2016) Kumar-Gorodnichenko-Coibion (2023)
- Macro tail risk drives assets prices and the business cycle in quantitative models
  - Longsta -Piazzesi (2004) Barro (2006) Gabaix (2012) Gourio (2012) Wachter (2013)

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This paper: Nature, role, and consequences of macro tail risk beliefs of firms

# 1. Characterize the nature of macro tail risk expectations of firms

## Subjective probability of a macro tail event realization

! Elicit macro tail risk expectations in large firm survey (3x)

GDP drop 5% / financial crisis / pandemic / geopolitical escalation

- Widely dispersed expectations
- Strong co-movement with expectations about own business  
macro tail risk \* ! business expectations+ and uncertainty \*

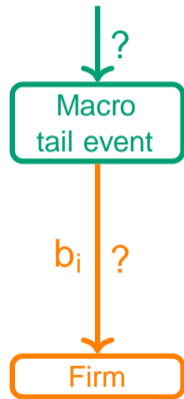
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## Firms' expected exposure to macro tail event

- ! Elicit exposure in terms of D sales scenarios & open-ended question
- Heterogeneous exposure expectations & high uncertainty about it:
  - ! 20 p.p. worst-case\$ best-case scenario (median)
  - ! Firms directly express that it is difficult/almost impossible



## 2. Macro tail risk expectations ! decision-making of rms

I: **Micro approach:** Exploit observed variation in macro tail risk expectations

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- Hypothetical macro scenarios with different skewness but same mean and variance

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Macro tail risk expectations \* ! investment + , c.p. 1st & second moment expectations

! Driven by rms that expect to be heavily exposed in the worst-case scenario

### 3. Quantitative heterogeneous firm model

[not today]

Many potential sources of non-linearity that generate effects beyond the first moment.

This paper: **Ambiguous exposure to macro tail events**

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Policy counterfactuals:

- **Monetary policy:** announce  $r \#$  in macro tail event
- ! General investment stimulus
- **Fiscal policy:** announce symmetric  $t$  in macro tail event (generous loss carryback)
- ! Particularly effective investment stimulus when firm-specific exposure is ambiguous

# Contribution to the literature

- Macro tail risk beliefs of investors and households

Shiller (2000) Giglio-Maggiori-Strobel-Utkus (2021) Dietrich-Müller-Schoenle (2022) Beutel-Stockerl (2023)  
Goetzmann-Kim-Shiller (2024); Backus-Chernov-Martin (2011) Kelly-Jiang (2014)

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Guiso-Parigi (1999) Gennaoili-Ma-Shleifer (2016) Kumar-Gorodnichenko-Coibion (2023) Fiori-Scoccianti (2023)

- Macro tail risk in asset-pricing and business-cycle models

Rietz (1988) Longstaffe-Piazzesi (2004) Barro (2006) Gabaix (2012) Gourio (2012) Wachter (2013) Kozlowski-Veldkamp-Venkateswaran (2020)

! Role of macro tail risk beliefs for investment { through 1.&2. moments and beyond

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- Heterogeneous firm models and ambiguity aversion

Cooper-Haltiwanger (2006) Bloom (2009) Bachmann-Bayer (2014) Bloom-Floetotto-Jaimovich-Saporta (2018) Salgado-Guvenen-Bloom (2023); Ilut-Schneider (2014) Dimmock-Kouwenberg-Mitchell-Peijnenburg (2016) Bianchi-Ilut-Schneider (2018) Bachmann-Carstensen-Lautenbacher-Schneider (2020)

! Stochastic environment of firms shaped by ambiguous exposure to macroeconomy

# Nature of Macro Tail Risk Expectations of Firms

# Large-scale firm survey

Ifo Business Survey:

- Monthly German firm panel
- Sophisticated respondents: > 75% are CEOs/owner of the firm
- Representative of the German economy (N=5000)

Relevant regular questions in the survey:

- Broad range of expectation questions
- Investment and employment decisions
  - ! Survey responses map into actual decision-making »
- Firm characteristics

# Elicitation of subjective probability of macro tail events

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%

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3. A pandemic (with an overall magnitude similar to the Covid-19 pandemic)

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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)

! Elicited in October 2022, April 2023, and October 2023

# Macro tail events are perceived as likely to occur on average

▶ Relation to past GDP point forecasts

# Macro tail risk expectations are highly dispersed in the cross-section

! Variance decomposition: 52%-62%  $r_{mfe}$ , 1%-13% time fe

▶ All four macro tail events

▶ Relation with  $r_{mfe}$  characteristics

## Subjective probability of macro tail events co-moves with firms' expectations and uncertainty about their own business

	(1)	(2)	(3)	(4)	(5)
	Business Expectations		Business Uncertainty		
Subj. Prob. GDP Drop 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)
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

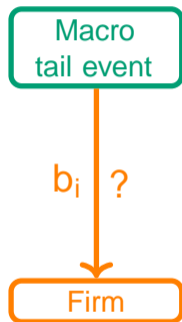
Business Expectations (first moment) Expectations about the next six months: our expected business state in economic terms: [continuous slider from 0 (rather worse) to 100 (rather better)]

Business Uncertainty (second moment) We estimate the uncertainty regarding our business expectations in the next six months as: [continuous slider from 0 (low) to 100 (high)]

## Elicitation of firms' exposure beliefs $b_i$ to macro tail events

Imagine a macroeconomic crisis in Germany (GDP drops by 5% in a year). To what extent do you expect your firm to 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: \_\_\_ %



# Heterogeneous firms' exposure beliefs to macro tail events

! Median: 20 p.p. span betw. best- & worst-case implies significant exposure uncertainty

» correlation with past exposure

» correlation with subj. probability of macro tail event

» by industry

» by firm size

## Open-ended question on firms' exposure beliefs to macro tail risk

Q: 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:

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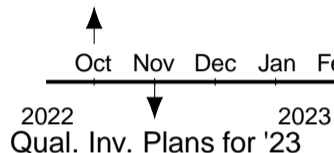
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3. Reference to (heterogeneous) exposure to past macro tail events
  - Relying on a small set of experiences (Great Recession and Covid)

Macro Tail Risk Expectations! Investment

I: Micro Approach

# Do macro tail risk expectations explain investment decisions?

Macro Tail Risk Expectations

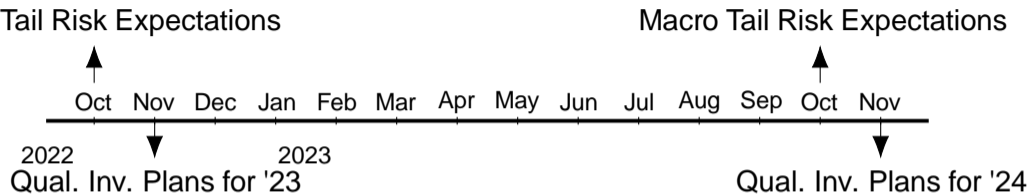


Macro Tail Risk Expectations



$$1f DInvestment_{i,t+1} < 0g = a_t + bP_{i,t}(\text{MacroTailEvent}) + gX_{i,t} + d + e_{i,t}.$$

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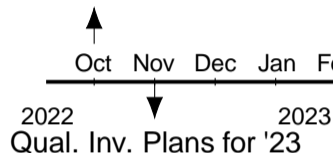


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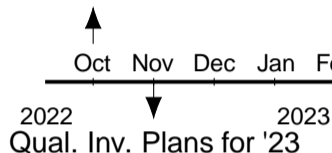


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- Idiosyncratic investment plans 6! macro tail risk
- Shielded from being driven by general sentiment
  - I: Different survey waves
  - II: Control for business situation, expectations and uncertainty
- Not driven by fixed firm characteristics (firm fe)

# Higher macro tail risk expectations ! lower investment plans

Raw relation in the cross-section

SD \* in subj. probability of macro tail event ! share of lower investment \* by 7.5 p.p.

# Higher macro tail risk expectations ! lower investment plans

Raw relation in the cross-section

Conditioned on business expectation and uncertainty

At least half of the relation persists after controlling for subjective first & second moments

# Higher macro tail risk expectations ! lower investment plans

Only within firm variation

» heterogeneity » within industry » first moment » other tail events » resilience » robustness » other outcomes » model

# Higher macro tail risk expectations ! lower investment plans

Only within  $\sigma$  variation

Only within  $\sigma$  variation - split by exposure

» heterogeneity

» within industry

» 1st moment

» other tail events

» resilience

» robustness

» other outcomes

» model

Macro Tail Risk Expectations! Investment

II: Experimental Approach

## Investment choice in hypothetical macroeconomic outlooks

- Present managers two simplistic macroeconomic outlooks with different skewness but the same mean and variance in the Ifo Management Survey
- Managers choose the outlook in which they are more likely to make major investments

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  - Symmetric outlook A (low macro tail risk,  $m=2, s=3$ )
  - Neg. skewed outlook B (high macro tail risk,  $m=2, s=3$ )
- ! Causal effect of macroeconomic tail risk on investment conditional on the first and second moment
- ! Relate investment decision in the vignette to firms' exposure beliefs  $b_i$

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## Wording and visualization of baseline vignette

Compare the following two simplistic macroeconomic outlooks.

### Outlook A:

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

### Outlook B:

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

## Wording and visualization of baseline vignette

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

A - no difference - B

## Wording and visualization of shifted vignette

Compare the following two simplistic macroeconomic outlooks.

### Outlook A:

The German economy (measured by the GDP) will either grow by 1% with 50% probability or grow by 7% with 50% probability in the next year.

### Outlook B:

The German economy (measured by the GDP) will either decline by -5% with 10% probability or grow by 5% with 90% probability in the next year.

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

A - no difference - B

## Firms tend to invest less in the negatively skewed scenario

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

Full sample

Only owners

## More negative expected worst-case exposure predicts higher investment in symmetric scenario

	Base scenarios		Shifted scenarios	
	(1) 1: sym; 0: no di -1: skew	(2) 1: sym 0: no di 0: skew	(3) 1: sym 0: no di -1: skew	(4) 1: sym 0: no di 0: skew
$b_{i,worst}$ (exposure to GDP# 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

! Firms act on their worst-case exposure, consistent with ambiguous exposure

## Concluding remarks

### Summary of findings:

- Dispersed macro tail risk expectations and uncertain exposure to it
- Consistent finding across three empirical approaches:  
Macro tail risk expectations \* ! investment +  
(conditional on first & second moment)
- Mechanism: Firms are ambiguity averse about exposure to macro tail events

### Policy implications:

- Policy is particularly effective if expected worst-case exposure is mitigated  
! automatic stabilizers (e.g. loss carrybacks)

# Appendix

## Survey responses on investment map into actual decision-making [▶ back](#)

$$DCapital_{i,t} = b1 [DInvestment_{i,t} < 0] + g_{t,s} + d + e_{i,t}$$

# Subjective probability of macro tail events

» back

# Average macro tail risk expectations and firm characteristics [▶ back](#)

# Macro tail risk expectations co-move with micro expectations

» back

	(1)	(2)	(3)	(4)	(5)
	Business Expectations		Business Uncertainty		
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

# Macro tail risk expectations co-move with sales expectations [▶▶ back](#)

		Sales Expectations		Sales Uncertainty		
		(1)	(2)	(3)	(4)	(5)
Subj. Prob. GDP Drop	5%	-0.91 (0.17)	-0.35 (0.20)	1.33 (0.19)	0.36 (0.20)	0.39 (0.21)
Average Sales Forecast						0.081 (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

## Relation of macro tail risk to unemployment rate expectations [▶ back](#)

Sep. Unemployment Rate (pooled)    Sep. Unemployment Rate (within)

Dez. Unemployment Rate (pooled)    Dez. Unemployment Rate (within)

## Relation of macro tail risk to unemployment rate uncertainty

▶ back

Sep. Unemployment Rate (pooled)    Sep. Unemployment Rate (within)

Dez. Unemployment Rate (pooled)    Dez. Unemployment Rate (within)

Macro tail risk expectations are only weakly correlated with past GDP growth expectations [▶ back](#)

# Expected worst-case exposure and realized exposure to past macro tail risk events [▶▶ back](#)

	Expected worst-case rm 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	1252	1252	1252	3167	3167	3167
Industry FE	-	-	X	-	-	X

# Relation of subjective probability of macro tail event occurrence and rm exposure beliefs

» back

worst-case exposure (raw relation)

worst-case exposure (within relation)

## Firms' exposure beliefs to macro tail events by industry [▶▶ back](#)

## Firms' exposure beliefs to macro tail events by industry [▶▶ back](#)

! Less than 15% of variation explained by 4-digit industry fe

# Exposure beliefs and rm size [▶▶ back](#)

worst case exposure belief and rm size

worst case exposure belief and rm size by export

## Open-ended question on firm-specific exposure to macro tail event

"Very difficult to assess, probably slump in sales up to 40%, [...]"

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"Very difficult to assess, probably slump in sales up to 40%, [...]"

"These effects are difficult to assess, but a decline in sales of 25% is conceivable."

## Open-ended question on firm-specific exposure to macro tail event

"Very difficult to assess, probably slump in sales of up to 40%, [...]"

"These effects are difficult to assess, but a decline in sales of 25% is conceivable."

"Difficult to assess. I expect China to attack Taiwan and cause a global economic crisis in the next 5-10 years."

## Open-ended question on firm-specific exposure to macro tail event

"Very difficult to assess, probably slump in sales up to 40%, [...]"

"These effects are difficult to assess, but a decline in sales of 25% is conceivable."

"Difficult to assess. I expect China to attack Taiwan and cause a global economic crisis in the next 5-10 years."

"A 5% drop in GDP leads to a drop in sales between 40% and 60% for us, so it has huge consequences for our business. There are analogies to the financial crisis and the coronavirus crisis with similar effects."

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"Not assessable. The event industry has always tended to come through economic crises very well, with the exception of the coronavirus pandemic."

"This is rather irrelevant for our product portfolio and customer base."

## Examples of positive exposure beliefs to macro tail events

"It is very difficult to estimate because our industry tends to hold its own well in crises. This is due to the "cocooning effect" of people. "In crises, I make my home beautiful." This happened impressively in the Corona years. In addition, our company survived two world wars. [...]"

"It is manageable for us; it has a positive impact on us when people drive their cars for longer."

"Our business is to support and enable change - as a rule, benefit from large change projects at our customers."

"We are not affected by such a crisis, quite the opposite. Such a scenario is favorable for us due to the processing of insolvencies."

Macro Tail Risk Expectations! Investment

Stylized Model

## Stylized rm choice problem

- Objective: maximize profits (risk-neutral)
- Technology:  $AK^a$
- $k = \frac{aE[A_{t+1}]}{1+r} \frac{1}{1-a}$
- $E[A_{t+1}|A^h] = p_h A^h + p_l A^l$

# Firms have heterogeneous exposure to macro tail risk events

- Objective: maximize profits (risk-neutral)
- Technology:  $AK^a$
- $k = \frac{aE[A_{t+1}]}{1+r} \frac{1}{1-a}$
- $E[A_{i,t+1}|A^h] = p_h A^h + p_l [A^h + E[b_i](A^h - A^l)]$

## What about effects beyond the first moment?

- Objective: maximize profits (risk-neutral)
- Technology:  $AK^a$
- $k = \frac{aE[A_{t+1}]}{1+r} \frac{1}{1-a}$
- $E[A_{i,t+1}|A^h] = p_h A^h + p_l [A^h + E[b_i](A^h - A^l)]$

! Many potential sources of non-linearity that generate effects beyond the first moment

! This paper: focus on **Knightian uncertainty** about firm-specific exposure  $b_i$

# Not confident enough to assign probabilities to exposure scenarios

- Objective: maximize profits (risk-neutral)
  - Technology:  $AK^a$
  - $k = \frac{aE[A_{t+1}]}{1+r} \frac{1}{1-a}$
  - $E[A_{i,t+1}|A^h] = p_h A^h + p_l [A^h + E[b_i](A^h - A^l)]$
  - Firm-specific exposure is ambiguous  
 $b_i \in [b_{\text{worst}}, b_{\text{average}}, b_{\text{best}}]$
- ! act as if worst-case exposure will occur (rational behavior)

## Negative effect on investment beyond average expectations

▶▶ more

- Objective: maximize profits (risk-neutral)
  - Technology:  $AK^a$
  - $k = \frac{aE[A_{t+1}]}{1+r} \frac{1}{1-a}$
  - $E[A_{i,t+1}|A^h] = p_h A^h + p_l [A^h + E[b_i](A^h - A^l)]$
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(rational behavior)

▶▶ back

Heterogeneity in investment responses across firm characteristics  
conditional on high worst case exposure [▶ back](#)

# Higher macro tail risk expectations !    lower investment plans [» back](#)

Raw relation in the cross-section  
(within time X industries)

Conditioned on business expectation and uncertainty  
(within time X industries)

# Higher macro tail risk expectations !    lower investment plans [▶▶ back](#)

Only within  $r_m$  variation  
(within time X industries)

Only within  $r_m$  variation - split by exposure  
(within time X industries)

# Comparison of all four macro tail events [▶▶ back](#)

## Other outcomes [» back](#)

- Employment plans [»](#)
- R&D plans [»](#)
- Inflation expectations and price plans (geopolitical escalation scenario) [»](#)
- Resilience measures [»](#)
- Cash holdings [»](#)

# Higher macro tail risk expectations ! lower employment plans [▶ back](#)

Raw relation in the cross-section

Conditioned on business expectation and uncertainty

# Higher macro tail risk expectations !    lower employment plans [▶ back](#)

Only within rm variation

Only within rm variation - split by exposure

# Higher macro tail risk expectations ! lower R&D plans [▶▶ back](#)

Raw relation in the cross-section

Conditioned on business expectation and uncertainty

# Geopolitical risk and prices [▶ back](#)

Inflation expectations

Planned price increases

# Effects in resilience increase in macro tail risk expectations

[▶▶ back](#)

		(1) Diversification	(2) Domestic Supplier	(3) EU Supplier	(4) Monitoring	(5) Insourcing	(6) Storage
Prob. GDP Drop	5%	0.0013 (0.00060)	0.00034 (0.00054)	0.0012 (0.00049)	0.0011 (0.00056)	0.00061 (0.00048)	0.0022 (0.00064)
Prob. Fin. Crisis		0.00076 (0.00066)	0.00039 (0.00066)	0.0010 (0.00054)	0.00070 (0.00060)	0.00061 (0.00061)	0.00096 (0.00070)
Prob. Pandemic		0.0026 (0.0011)	0.0014 (0.00100)	0.0019 (0.00089)	0.0027 (0.0010)	0.00055 (0.00100)	0.0035 (0.0012)
Prob. Geop. Escalation		0.00077 (0.00067)	0.0014 (0.00056)	0.0015 (0.00053)	0.0012 (0.00064)	0.00099 (0.00055)	0.0017 (0.00073)
Observations		1072	1072	1072	1072	652	1072
Controls		X	X	X	X	X	X
Industry FE		2-Digit	2-Digit	2-Digit	2-Digit	2-Digit	2-Digit

Standard errors in parentheses

$p < 0.10$ ,  $p < 0.05$ ,  $p < 0.01$

# Macro tail risk expectations and cash holdings [▶ back](#)

## Robustness checks [» back](#)

- Different controls
  - Quantitative sales growth expectations and span [»](#)
  - First and second moment macro expectations [»](#)
- Average vs. worst-case exposure split [»](#)
- Different investment outcomes
  - Investment revisions [»](#)
  - Quantitative investment realizations [»](#)

# Ctrls: Quantitative sales growth expectations and uncertainty

▶▶ back

		Indicator for a Decline in Investment					
		(1)	(2)	(3)	(4)	(5)	(6)
Prob. GDP Drop	5%	0.0023 (0.00044)	0.0019 (0.00042)	0.0015 (0.00055)	0.0018 (0.00063)		
	low worst-case b					0.00090 (0.00070)	0.00031 (0.00086)
	high worst-case b					0.0020 (0.00082)	0.0026 (0.00094)
Observations		1372	1372	1372	1372	1372	1372
Controls		No	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	No	Yes	No
Firm FE		No	No	Yes	Yes	Yes	Yes
Year X Industry FE		No	No	No	Yes	No	Yes

# First and second moment controls for different horizons

» back

## Worst case vs average case exposure [▶ back](#)

Only within  $\sigma$  variation - split by worst case

Only within  $\sigma$  variation - split by average case

# Effect on business expectations - only within firm variation

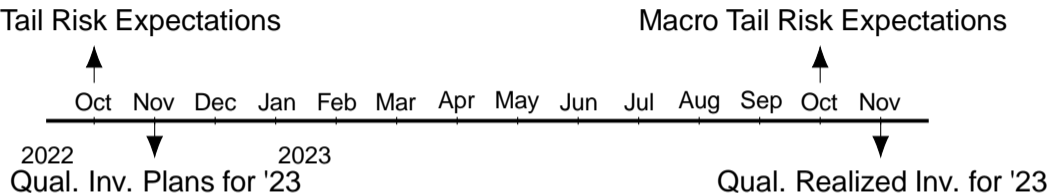
▶ back

Worst case

Average case

## Control for macro expectations (average and uncertainty) [▶▶ back](#)

# Relate changes in macro tail risk expectations to investment revisions



Exploit investment revisions:  $InvRev_{i,t} = DInvestment_{i,t} E_{i,t-1}[DInvestment_{i,t}]$

$$InvRev_i = a + bDE_i[MacroTailRisk] + g_1 DMean_i + g_2 DUnc_i + g_3 DSituation_i + d_j + e_i$$

Identifying assumption: The change in macro tail risk expectations within firms is independent of other investment revision determinants  $j$  industry, change in business situation, expectation and uncertainty

# Change in tail risk expectations!    revision of investment

▶▶ back

		Investment Revision		
		(1: upward, 0: no change, -1: downward)		
		(1)	(2)	(3)
Panel A:				
D GDP Drop	5%	0.00097*** (0.00034)	0.00084** (0.00034)	0.00088** (0.00038)
Panel B:				
D Financial Crisis		0.0017*** (0.00041)	0.0015*** (0.00041)	0.0016*** (0.00046)
Panel C:				
D Pandemic		0.0016*** (0.00056)	0.0015*** (0.00055)	0.0016** (0.00063)
Panel D:				
D Geopolitical Escalation		0.00076* (0.00042)	0.00069* (0.00041)	0.00074* (0.00045)
Observations		1433	1433	1433
Controls		No	Yes	Yes
Industry FE		No	No	4-Digit

# Higher macro tail risk expectations !    lower quant. investment [▶▶ back](#)

		D log Investment (2022 - 2021)				D 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	5% (Oct. 2023)				-0.00051 (0.00089)				-0.0012 (0.0014)
D log Sales	(2022 - 2021)		0.54 (0.100)	0.54 (0.10)	0.59 (0.10)				
D 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 <sup>2</sup>		0.13	0.14	0.15	0.16	0.16	0.18	0.18	0.20

## Summary statistics on firm-specific exposure to 5% GDP drop

---

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%

---

## Variation of firm-specific exposure to a recession

▶▶ back

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.

- Assessment of strong recession:
  - Assessment: Does the likelihood of a strong recession (Gross Domestic Product falls by at least 5%) in Germany over the next 12 months increase or decrease ?  
f increases, decreases, neutral
  - Explanation: General explanation for this assessment, maximum 15 words.

- 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?  
f increases, decreases, neutral
  - Explanation: General explanation for this assessment, maximum 15 words.
- Assessment on average:
  - Assessment: In the most likely scenario, how will the economic development in Germany evolve in the next 12 months?  
f negative, positive, neutral
  - Explanation: General explanation for this assessment, maximum 15 words.

## Example of classification of an article [▶ back](#)

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. "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 opposed.

GPT classification:

- macro tail risk expectation: decreases
- average macro forecast: neutral
- upside risk expectation: neutral

GPT explanation for decrease in macro tail risk:

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

# Macro tail risk expectations generated with GPT [» back](#)

MacroTail index

MacroAvg index

# Upward trend in macro tail risk expectations generated with GPT

▶▶ back

MacroUp index

Investment production

An IQR increase in macro tail risk expectations leads to a 7% decrease in investment (robustness) [» back](#)

Ctrl for avg. macro news  
(MacroAvg)

Ctrl for avg. and upside risk macro news  
(MacroAvg and MacroUp)

Macro Tail Risk Expectations! Investment

III: Macro Approach

# How do beliefs about macro tail risk evolve over time?

Combination of two ideas:

1. Firms' macro tail risk expectations are formed through news consumption
2. Large language models have demonstrated an increasing ability to behave like humans

# How do beliefs about macro tail risk evolve over time?

Combination of two ideas:

1. Firms' macro tail risk expectations are formed through news consumption
2. Large language models have demonstrated an increasing ability to behave like humans

Disentangle different moments of macro expectations ! isolate macro tail risk

- Data: German Business Newspaper 1986-2023 (Handelsblatt)
- Generate macro expectations with prompting instruction-tuned LLM (GPT)

Assessment of strong recession Does the likelihood of a strong recession (Gross Domestic Product falls by at least 5%) in Germany over the next 12 months increase or decrease?  
f increases, decreases, neutral

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

! (i) MacroTail index, (ii) MacroAvg index, (iii) MacroUp index

# An IQR increase in macro tail risk expectations predicts a 7% decrease in investment

Ctrl for avg. macro forecasts  
(MacroAvg)

Ctrl for avg. macro forecasts and macro upside risk  
expectations (MacroAvg and MacroUp)

$$I_{t+h} - I_{t-1} = a_h + b_{1,h} \text{MacroTail}_t + b_{2,h} \text{MacroAvg}_t + b_{3,h} \text{MacroUp}_t + \beta X_t + e_{t+h}$$

▶▶ robustness

▶▶ other macro news

▶▶ heterogeneity by co-movement in upside risk

# Investment response to an increase in average and upside risk macro expectations

▶ back

MacroAvg

MacroUp

# Heterogeneity by co-movement in upside risk: an increase in macro tail risk is typically accompanied by a decrease in macro upside risk

Relation of changes in the tails

Split MacroTail by co-movement with MacroUp

# Effect of different degrees of risk aversion on optimal capital stock

# Quantitative Heterogeneous Firm Model

# Firm choice problem with ambiguous firm-specific exposure to macro tail events

$$V(k, z, b, A) = \max_{k^0} \left( (1 - \tau)(Azk^a - dk - y(k^0, k) - g_0 - g_1k) \right) \\ k^0 + k + \frac{1}{1+r} \min_{b_w, b_{avg}, b_b} E[V(k^0, z^0, b, A^0)]$$

3 aggregate states: I:  $A^h, p_{h!}$  | low II:  $A^h, p_{h!}$  | high III:  $A^l$

Exposure to macro tail event:  $A_i^l = A^h - b_i(A^h - A^l)$

- Firm-specific exposure  $b_i$  in case of a macro tail event is ambiguous  
! act as if worst-case exposure is going to be realized
- Solve model for firms at the 10th, 25th, 50th, 75th, and 90th percentiles of the cross-sectional worst-case exposure beliefs distribution

## Fiscal policy counterfactual:

### Introduction of symmetric CIT in the macro tail event

Ambiguous exposure

No ambiguous exposure

Transition from agg. state I:  $A^h, p_{h|l} = 1\%$  to II:  $A^h, p_{h|l} = 4\%$  in  $t = 0$  [▶ more](#)

! Fiscal policy mitigate decline in capital stock by 20{25% (insurance mechanism)

# Parameter calibration in the model (quarterly level) [▶▶ back](#)

Technology		
$r$	0.005	Annual interest rate of 2%
$a$	0.33	Decreasing return to scale
$d$	0.03	Depreciation of capital stock
$r_z$	0.95	Persistence of idiosyncratic productivity
$s_z$	5%	Standard deviation of innovations to idiosyncratic productivity
Additional production costs		
$g_0$	0.7	Fixed production costs
$g_1$	0.12	Linear production costs
$t$	0.3	Corporate income tax rate
Macro tail risk exposure		
$b_{worstp10}$	0.5	0.5 avg. exposure of median firm (survey)
$b_{worstp25}$	1.5	1.5 avg. exposure of median firm (survey)
$b_{worstp50}$	2.5	2.5 avg. exposure of median firm (survey)
$b_{worstp75}$	4	4 avg. exposure of median firm (survey)
$b_{worstp90}$	6	6 avg. exposure of median firm (survey)
Adjustment costs		
$f_1$	0.1%	Fixed capital adjustment cost
$f_2$	6	Quadratic capital adjustment cost
$f_3$	97.5%	Resale capital adjustment cost
Transition probabilities of macro productivity states		
$p_{lowA/highA, low\_risk}$	0.01	Probability of macro tail event in low macro risk state
$p_{lowA/highA, high\_risk}$	0.04	Probability of macro tail event in high macro risk state
$p_{lowA/lowA}$	0.8	Probability of staying in macro tail event

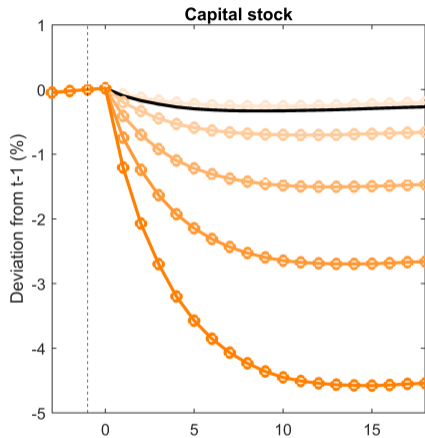
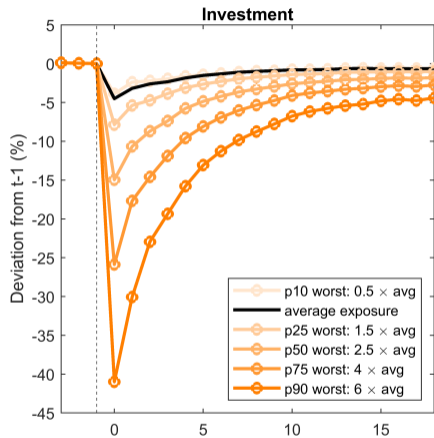
## Capital adjustment costs » back

$$V(k, z, b, A) = \max_{k^0} \left( (1-t)(Azk^a - dk + y(k^0, k) - g_0 - g_1 k) - \frac{1}{1+r} \min_{b \geq b_w, b_{avg}, b_b, g} E[V(k^0, z^0, b, A^0)] \right)$$

Capital adjustment costs:  $y(k_{t+1}, k_t) = f_1 \mathbb{1}_{I_{i,t} \neq 0} + \frac{f_2}{2} \left( \frac{I_{i,t}}{K_{i,t}} \right)^2 + (1 - f_3) \mathbb{1}_{I_{i,t} < 0}$

- Fixed disruption cost  $f_1$  for non-zero investment
- Quadratic adjustment cost  $f_2$
- Resale cost  $f_3$  for net disinvestment, as capital is partially irreversible

# Macro tail risk news shock by exposure type



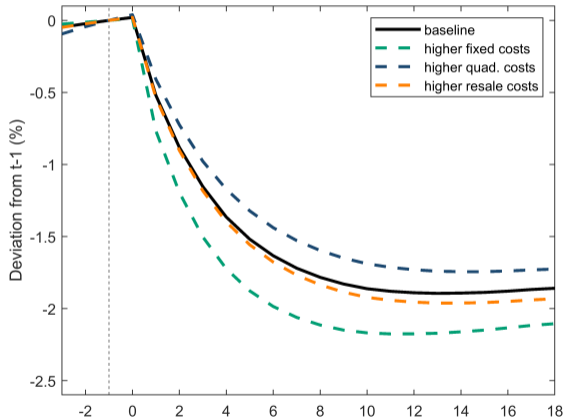
Transition from agg. state I ( $A^h, p_{h!}$  low) to II ( $A^h, p_{h!}$  high) in  $t = 0$

! Increased probability of macro tail risk event without realization

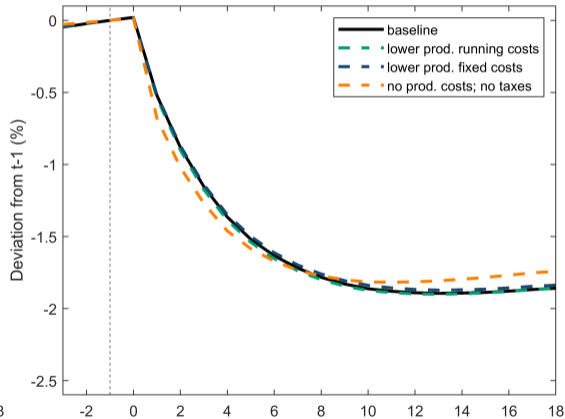
# Macro tail risk news shocks: dynamics of the aggregate capital stock

## – sensitivity analysis [▶▶ back](#)

Varying capital adjustment costs

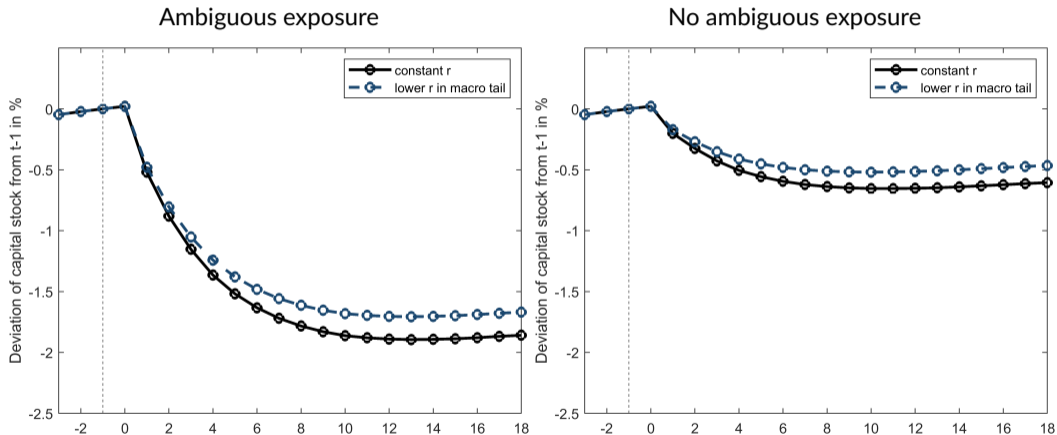


Varying additional production costs



Transition from agg. state I ( $A^h, p_h!$  low) to II ( $A^h, p_h!$  high) in  $t = 0$   
 / Increased probability of macro tail risk event without realization

# Monetary policy counterfactual: lower real interest rate in the macro tail risk event



Transition from agg. state I ( $A^h, p_h$  low) to II ( $A^h, p_h$  high) in  $t = 0$   
! Increased probability of macro tail risk event without realization