The impact of interest: Firms' investment sensitivity to interest rates*

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Abstract

We use a novel survey approach with hypothetical vignettes to analyze firms' investment sensitivity to interest rates, allowing us to causally identify firms' investment adjustments in response to various changes in lending rates. In a large survey of German firms, we find a semi-elasticity of investment of 7 percent—about half the total impact of monetary policy on corporate investment. The average response is driven by a substantial fraction of non-adjusters—mainly due to high cash buffers and a lack of investment opportunities—and a significant intensive margin conditional on adjustment. Using direct survey measures, we find particularly strong effects for financially constrained firms and firms facing labor shortages. Finally, we establish a first-order importance of the (partial equilibrium) interest rate channel effect for aggregate investment dynamics.

Keywords: Interest rate, firm investment, survey data, hypothetical vignette, narratives, hurdle rate, monetary policy, aggregate investment

JEL-Codes: D25, E43, E52, G31

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1 Introduction

Identifying the relative importance of transmission channels of monetary policy into the macroeconomy is of key interest to both policymakers and academic economists. While the representative-agent New Keynesian literature has emphasized the transmission of monetary policy through the Euler equation and its direct effects on household consumption, the recent move to heterogeneous agents has shifted the focus to indirect channels from interest rates to consumption (Kaplan et al., 2018). Auclert et al. (2020) highlight in an estimated HANK model that the direct transmission through investment plays a pivotal role in generating these indirect effects. Time-series evidence based on identified monetary policy shocks—e.g., via recursive VAR ordering or high-frequency restrictions—points toward changes in interest rates having a significant and persistent effect on aggregate investment (e.g., Christiano et al., 2005), but this approach makes it difficult to distinguish partial- from general-equilibrium effects and to disentangle specific investment channels.

We approach the question of firms' investment sensitivity to interest rates from a different angle. We use a novel survey approach with hypothetical vignettes to elicit firms' investment adjustments in response to various changes in the interest rates on *loans*. This approach isolates the direct impact of external financing costs on investment, holding all other factors constant. The integration of open-ended text questions, other survey modules, a link to financial statements, and a long panel dimension allows for a comprehensive analysis of the micro and macro effects of interest rates on investment.

We find that a one percentage point reduction in the lending rate leads to an upward adjustment in investment of 7 percent over the following two years in a large and representative survey of German firms. This partial equilibrium response to a change in the lending rate is approximately half the size of the total effect of monetary policy on investment that we find in German time-series data. The average response in the survey is driven by a substantial fraction of non-adjusters and a significant intensive margin conditional on adjusting. We ask firms in open-ended text questions why they would not adjust at all. Two main narratives emerge: On the one hand, firms tell a narrative consistent with the pecking-order theory (Myers, 1984): They prefer internal funds for investment and have no financing needs due to high cash buffers. On the other hand, many firms explain non-adjustment by not being at the margin, consistent with being close to their optimal capital stock (low marginal return), or investing directly when opportunities emerge (high marginal return). Correlating these narratives with the quantitative survey measures confirms the two channels.

The firm-level investment responses in the large-scale survey allow for a comprehensive heterogeneity analysis. We find particularly strong effects for financially constrained firms and

larger firms with labor shortages. In contrast to unconventional monetary policy (Papoutsi et al., 2022), the response is largely orthogonal to firms' environmental impact. Additional vignettes on firms' adjustment of the hurdle rate—the minimum acceptable investment return rate—reveal a strong co-movement with the investment response.

How important is the identified interest rate channel via the external finance premium for the macroeconomy? First, we compare the sensitivity of investment to the responses of firms in the real world following the interest rate hikes in 2022–2023. The results are very similar, suggesting a first-order importance of the partial equilibrium effect for aggregate investment dynamics. Second, we exploit the panel dimension of the survey and analyze the impact of monetary policy shocks. Again, the firm-level vignette responses align closely with the identified dynamics following monetary policy shocks.

In more detail, firms are asked to imagine a situation where, over the next two years, the loan interest rates for all maturities would be 0.5, 1.0, 3.0, or 4.0 percentage points (p.p.) lower than currently anticipated. The size of the interest rate reduction is randomized across firms in four groups to causally test for non-linearities. Given the hypothetical rate cut, firms are then asked about the percent change in their planned total investments for the years 2024 and 2025—if they had previously stated that they planned to invest in one of the years—and we also elicit firms' extensive margin responses when they did not plan to invest at all.

Note that the hypothetical vignette is designed to cleanly identify the partial equilibrium investment response of firms to interest rate changes by shifting only the external finance premium. We emphasize in the questionnaire that the change in loan interest rates should be considered under the assumption that all other credit conditions, as well as firm-specific and macroeconomic factors, would remain constant. In doing so, our vignette design is also closely linked to the credit channel of monetary policy. In contrast, a general change in interest rates would introduce several potential general equilibrium effects that would complicate interpreting the results and the mapping to theory.

We conduct the vignette in the December 2023 wave of the ifo Business Survey (IBS), a monthly firm panel with around 6,000 participants. The survey is administered by the Munich-based ifo institute and is mainly answered by the firms' CEOs or owners (Hennrich et al., 2023). At the time of the survey, the ECB's main refinancing rate was at 4.5 percent and expected to be elevated over the coming years (European Central Bank, 2023).

Our main finding is that a one p.p. increase in the interest rate on loans results in an upward revision of investment by six percent in the subsequent year and an additional seven percent upward revision in the year after that. The investment response is very similar for a one-half p.p. decrease in the interest rates. Large reductions in loan rates of three or four p.p. induce an upward investment revision of 12–15 percent. Hence, firms' investment

sensitivity decreases with the size of the interest rate changes. If we consider solely those firms that adjust their investment in response to a decline in the interest rates on loans (intensive margin), the investment adjustment amounts to approximately 18–23 percent for small interest rate cuts (0.5–1 p.p.) and 27–30 percent for more substantial ones (3–4 p.p.). The large difference from the overall effect sizes indicates that a significant fraction of firms do not adjust their investment at all in response to changes in borrowing costs. Overall, only about 30–35 percent of firms adjust their investment (extensive margin). Thus far, our analysis has focused on firms that had plans to invest in the next two years. Firms that did not intend to invest at all were significantly less likely to respond to interest rate changes, suggesting that there are significant fixed capital adjustment costs.

To gain a deeper understanding of nonadjustment, we ask firms in open-ended text questions why they would not adjust at all. The main advantage of this approach is that we do not prime respondents on a specific set of response categories; see Haaland et al. (2024) for a review of open-ended questions. We develop a coding scheme that classifies the responses into 11 categories. Two main overarching narratives emerge: About 37 percent of firms tell a story consistent with the pecking order theory: They prefer internal funds for investment and have no financing needs due to high cash buffers. A second main explanation given by about 38 percent of firms is that they are not at the margin to change their investment decisions. This is either because of a *low* marginal product of capital ("low opportunity firms"), which is consistent with being close to their optimal capital stock or because of a *high* marginal product of capital, which leads firms to invest directly when the opportunity arises ("high opportunity firms"). We then correlate the classified narratives with quantitative survey measures to confirm the identified channels. Indeed, firms classified in the first narrative have higher equity and cash-to-assets ratios. "Low opportunity firms" have a higher share of replacement investment and a more certain business model, while "high opportunity firms" have an overall better business situation.

Another reason for interest rate insensitivity can be sticky and conservative decision rules. For example, Graham (2022) and Gormsen and Huber (2025) find that firms adjust their required rate of return for new investment projects—the so-called hurdle rate—only infrequently. To analyze how firms' investment adjustment is linked to changes in the hurdle rate, we ask firms whether they would adjust their hurdle rate in the above hypothetical scenario. Lowering the interest rates on loans should, in theory, reduce firms' weighted average cost of capital that the expected return of new investment projects is evaluated against. In line with the prior literature, our results suggest a high degree of stickiness as the majority of firms are not adjusting their hurdle rate following a decrease in the loan rate. The share of adjusters is 17 percent for a 0.5 p.p. decrease and 36 percent for a 4 p.p.

decrease. While hurdle rate and investment adjustments are highly correlated at the firm level, firms are overall more likely to adjust their investment than to adjust their hurdle rate. This suggests that the insensitivity of hurdle rates to transitory changes in the loan rate does not necessarily hinder investment.

We then further analyze the heterogeneity of investment adjustment along the extensive and intensive margins with other survey measures and additional data sources. First, we exploit several direct measures of financial constraints, such as a question in the survey on firms reporting financing problems. Financially constrained firms show a 20 p.p. higher extensive margin response on average, while the intensive margin is mostly unaffected. Second, we examine potential interaction effects with labor shortages. Again, we exploit an additional question from the survey that directly elicits whether firms have a lack of skilled labor. Firms lacking skilled labor tend to respond stronger in the vignette at the intensive margin. This effect is driven by large- and medium-sized firms, which increase their investment by 7 p.p. more when faced with labor shortages, consistent with a substitution effect.

In addition, we exploit the broad coverage of the survey across sectors to test whether the investment sensitivity to interest rates is correlated with the environmental impact of firms. As a baseline measure for the environmental impact, we use Scope 1 CO2 emission—direct emissions from the firm's operations— at the industry level. We find that the response of firms is similar across CO2 emission intensities. This implies monetary neutrality of the bank lending channel, which contrasts with the ECB's unconventional policies that are biased towards high-emission sectors (Papoutsi et al., 2022).

We use two approaches to examine the importance of the identified interest rate channel via the external finance premium for macroeconomic investment dynamics. First, we compare the sensitivity of investment in the vignette with the responses of firms in the real world due to the interest rate increases in 2022–2023, when interest rates changed for the whole economy. In the survey, we determine ex post the extent to which firms adjusted investment downward due to the aggregate interest rate increases.[1] We find that firms' real-world response strongly correlates with their response in the vignette. If general equilibrium effects were a major driver of firms' investment response, this would likely operate at the industry level, for example, due to industry-specific exposure to changes in demand. The variation across sectors is overall very similar in the real-world response and the vignette response. This suggests a first-order importance of the partial equilibrium effect via the external finance premium for macro investment dynamics. Second, we exploit the panel dimension of the survey and analyze the impact of monetary policy shocks. Specifically, we analyze the output dynamics of firms following Jarociński and Karadi (2020) monetary policy shocks over the

[1]Best et al. (2024) summarize the findings of the real-world response in more detail in a policy report.

past 23 years. We find that firms that do not adjust investment in the vignette also exhibit lower output responses following monetary policy shocks. This underscores the importance of firms' investment sensitivity to interest rates for the monetary transmission mechanism.

The paper is organized as follows. In the remainder of the introduction, we place the paper in the context of the literature and outline its contribution. The next section introduces our experimental design and describes the data sets we use. Section 3 presents our main results from the hypothetical vignettes, discusses narratives for non-adjustment, further analyzes the heterogeneity of investment adjustment, and provides evidence on hurdle rates. In Section 4, we examine the importance of the identified interest rate channel for macroeconomic investment dynamics. A final section concludes.

Related Literature. This paper contributes to four strands of the literature. First, it is directly related to the literature assessing the relevance of firms' cost of capital (and its components) for their investment decisions. Early work typically struggled to identify significant cost of capital effects (e.g., surveyed by Chirinko, 1993). One way to overcome the identification issue is to use natural experiments in tax policy that shift various components of the user cost of capital, such as the tax rate, the depreciation schedule, or the price of capital goods (e.g., Zwick and Mahon, 2017; Cummins et al., 1994; Chirinko et al., 1999; Ohrn, 2018; Cummins et al., 1996; Link et al., 2023a). This literature finds larger effects of the user cost of capital, but it remains ambiguous what the overall user cost elasticity implies for the *interest rate* elasticity specifically.[2] Due to a lack of exogenous variation in the interest rates that firms face, it is difficult to identify the interest elasticity using conventional methods. Instead, Sharpe and Suarez (2021) assess the relevance of interest rates for firms' investment decisions qualitatively, using a survey question that asks about the extensive margin response to a change in the borrowing rate in a low-interest rate environment. Overall, their results suggest a very low sensitivity of firms' investment to the borrowing rate.[3] We take the approach to the next level and directly elicit the effect of a change in the loan rate on firms' investment in hypothetical vignettes, overcoming the identification problem. A key difference to Sharpe and Suarez (2021) is that we elicit the magnitude of the investment response to rate changes so that we obtain a *quantitative* measure of the semi-elasticity of investment to the loan rate. In addition, our survey took place outside of the persistent low-interest rate environment,

[2]For example, Schaller (2006) estimates a large long-run user cost elasticity using cointegration methods. However, when decomposing the user cost, the interest rate elasticity appears close to zero.

[3]A related literature uncovers relevant management practices that potentially dampen the interest rate sensitivity of firms' investment, such as the use of large and sticky hurdle rates (Graham and Harvey, 2001; Graham, 2022; Jagannathan et al., 2016; Gormsen and Huber, 2023, 2025). We provide further evidence on the reasons for loan rate insensitivity using open-ended questions and directly assess the responsiveness of the firms' hurdle rates to changes in the loan rate.

revealing a greater interest rate sensitivity than found by Sharpe and Suarez (2021). Our large sample size, long panel dimension, and integration with additional survey modules enable a comprehensive analysis to yield insights into macroeconomic investment dynamics.

Second, our findings have implications for the literature on the investment channel of monetary policy. The aggregate effect of monetary policy shocks on investment is traditionally found to be significant and persistent (e.g., Christiano et al., 2005). We complement this literature by causally identifying the direct effect of changes in the interest rate on investment and showing that it is of first-order importance for firms' response to monetary policy. In addition, our open-ended questions and rich set of survey questions allow for a thorough heterogeneity analysis, which is related to the recent literature identifying several dimensions of heterogeneity in the responsiveness of firms' investment to monetary policy shocks: The firms' default risk (Ottonello and Winberry, 2020), financial frictions related to the firms' life-cycle and size (Durante et al., 2022; Cloyne et al., 2023; González et al., 2024; Gertler and Gilchrist, 1994), as well as the firms' financing structure, e.g., the share of outstanding debt (Jungherr et al., 2022) and the balance sheet liquidity (Jeenas, 2023).

Third, our methodology is related to the literature that uses hypothetical scenarios to elicit parameters in surveys that are otherwise difficult to identify from observational data (e.g., Fuster et al., 2021; Jappelli and Pistaferri, 2014; Colarieti et al., 2024; Ameriks et al., 2020; Christelis et al., 2025, 2021, 2019). On the firm side, hypothetical vignettes have been recently used to study the reaction to uncertainty shocks (Dibiasi et al., 2021) and oil price shocks (Drechsel et al., 2022), as well as price pass-through dynamics (Gödl-Hanisch and Menkhoff, 2024). Similar to Colarieti et al. (2024), we not only elicit the parameter of interest but also assess the rationale behind firms' decisions in open-ended questions. Thereby, we also relate to the growing literature using open-ended questions to understand agents' beliefs and choices, surveyed by Haaland et al. (2024).

Fourth, we contribute to the ongoing debate on the relevance of the lumpiness of micro-level investment for aggregate dynamics (e.g., Khan and Thomas, 2008; Bachmann et al., 2013; Caballero and Engel, 1999; Winberry, 2021). Koby and Wolf (2020) show that the aggregation result crucially depends on the partial equilibrium interest rate elasticity of investment. General equilibrium price effects smooth out the dependence on the cross-sectional distribution of capital holdings only if investment is sufficiently price elastic. Our semi-elasticity of investment to the loan rate of 6–7 percent lies in the range of the elasticities derived by Koby and Wolf (2020) and assumed by Winberry (2021), and thus supports the argument that the observed price elasticity of investment is too small for significant general equilibrium smoothing.

2 Experimental design and data

In this section, we introduce our experimental design and describe the data sets we use.

2.1 Experimental design

We design hypothetical vignettes for a firm survey with the objective of estimating the causal effect of real interest rate changes on investment. The use of hypothetical scenarios in household and firm surveys for the analysis of (causal) economic mechanisms that are otherwise difficult to assess has recently seen wider adoption; see Haaland et al. (2023) and Stantcheva (2023) for reviews. The design of the vignette is guided by two main objectives in our context. First, the vignette should cleanly identify a partial equilibrium investment response that can be directly mapped to macroeconomic models. Simply exposing firms to general changes in interest rates would introduce several potential general equilibrium effects that firms might neglect in their answer. This would weaken the mapping to theory. Second, we aim for scenarios that are intuitive to firms and reflect situations they have encountered in the past. This is crucial for bridging the potential gap between responses to hypothetical scenarios and actual decision-making.

Specifically, we confront firms in the vignettes with a change in interest rates on loans. The vignette is designed to cleanly identify the partial equilibrium investment response of firms to interest rate changes by shifting only the cost of external finance. We explicitly state that loan rates also change for the firms' competitors to avoid changes in strategic competition, while other drivers of investment remain constant.[4] By design, the vignettes abstract from potential inattention to interest rate changes.

From a modeling perspective, the hypothetical scenarios can be viewed as an innovation in the financial sector that reduces the external finance premium. Prior to the vignette, the firm's investment plans for the next two years are elicited in order to adjust the response format in the vignette accordingly. The scenario is as follows:

For the following questions, please imagine that the ***financing conditions improve*** *for you and your competitors. For the next 2 years,* ***loan interest rates*** *for all maturities are* ***X percentage points lower*** *than currently expected. Assume that nothing else changes in terms of credit conditions, firm-specific or macroeconomic conditions.*

[*If investments were planned in 2024/2025*]

[4] In principle, the change of interest rate in one industry could change relative prices in general equilibrium. However, most firms likely face only a handful of direct competitors and therefore, for instance, do not influence relative labor costs. Moreover, most variation is within-industry, see Section 4.

To what extent would you adjust the amount of the planned total investments for 2024 and 2025 as a result (in %)? (Rough estimate is sufficient) 2024:__ / 2025:__

[*If investments were not planned*]
In this case, would you plan investments for [2024/2025]? Yes / No / I don't know

We elicit firms' investment responses in terms of percentage revisions relative to current plans, thereby providing a natural scale for the managers.[5] This quantitative elicitation directly provides us with a semi-elasticity of investment with respect to interest rates at the firm level. Additionally, we elicit firms' extensive margin responses when they did not plan to invest at all. To cover short- and medium-term investment sensitivities, we elicit firms' responses for both one year and two years ahead. It is important to note that we assume a reduction in interest rates across the entire yield curve to keep the hypothetical vignette as simple as possible.

The investment response might not scale linearly with the change in interest rates. We explore the possibility of non-linearities in the investment response to interest rate reductions by varying the size of the interest rate reduction. Each firm is confronted with only one hypothetical vignette, as we randomized the size of the reduction across firms in four groups (0.5 / 1.0 / 3.0 / 4.0 p.p.).[6] This between-firm setup ensures that the burden on managers is minimized which typically increases response quality and avoids potential experimenter demand effects. Note that we focus only on interest rate *reductions*, as this was the relevant and more realistic scenario at the time.

Subsequently, if firms state that they do not adjust investment plans after a change in financing costs, we directly ask them to provide reasons for their non-adjustment. The use of an open-ended text format precludes the prompting of respondents with a specific set of response categories; see Haaland et al. (2024) for a review of open-ended questions. We classify firms' narratives into different economic mechanisms using a coding scheme described in detail in the following section.

Motivated by Graham (2022) and Gormsen and Huber (2025), one potential driver of the non-adjustment of investment after interest rate changes is that firms' hurdle rates—the required rate of return for new investment projects—are sticky. To test this mechanism, we present firms with the exact same vignette as before; however, instead of eliciting changes in investment plans, we now ask firms:

Would you lower your hurdle rate in this scenario?

[5] In this survey, investment is usually defined as expenditure on structures, equipment, software, databases, and R&D.

[6] The randomization is stratified at the industry level (services, manufacturing, trade, and construction) to ensure a good coverage across all sectors of the economy for all groups

To introduce the concept of hurdle rates and test for potential interaction effects related to level differences across firms, we also ask firms for their current hurdle rates before the vignette, see Appendix C for the exact wording.

2.2 ifo Business Survey

We conduct our survey experiment in the ifo Business Survey (IBS), which is one of the oldest and largest surveys of firms currently available (Born et al., 2023), and has in recent years been increasingly used for studying firm behavior (see, e.g., Bachmann et al., 2019; Link et al., 2023b). The IBS is a monthly survey launched in 1949 that covers a sample of around 6,500 German firms across four main industries: manufacturing, construction, trade (retail/wholesale), and services. The monthly questionnaire consists of a broad set of questions assessing general firm characteristics, as well as various dimensions of the firms' state of business and expectations. This variety of firm-level measures allows us to thoroughly assess the heterogeneity in the responses to our survey experiment. Further, we can leverage the long panel dimension to connect firms' responses in the survey experiment to their reaction to past monetary policy shocks. As an additional advantage of the IBS, for a subset of firms, we can match balance sheet data from the Orbis database to the survey.

Our main hypothetical vignette was added to the online module of the December 2023 wave of the IBS.[7] In total, 3,295 firms answered our survey questions (Manufacturing: 1094, Services: 986, Trade: 817, Construction: 398) leading to around 800 respondents per group.[8] Table 1 provides summary statistics on the characteristics of the firms in our sample. The median firm has 26 employees, was founded 45 years ago, and invested 150,000€ in 2021 (Panel A). The subsample of firms which initially planned investments for 2024 and 2025 is somewhat larger with 52 employees and 410,000€ of investment (Panel B). Figure A.1 in the appendix shows that the groups are assigned random with respect to the relevant firm characteristics. In the following survey wave, in January 2024, we repeated the hypothetical vignette but asked about the firms' hurdle rate adjustments.

Two factors are crucial for the external validity of our results. First, our question is ideally answered by individuals who are responsible for making investment decisions. Reassuringly, in more than 85 percent of the firms, the IBS is completed by individuals in top-management positions, such as the firm's owners, CEOs, or board members (Hennrich et al., 2023), increasing the likelihood that we receive sophisticated answers from individuals with significant decision-making power in their firms.

[7]While there is still the option to answer the survey on paper, the online module is used by vast majority of firms. In the December 2023 wave that was 85% of all respondents.

[8]The four industry-specific surveys are harmonized according to Link (2020).

Table 1: Summary statistics

	Mean	Std. Dev.	P10	P25	Median	P75	P90	N
Panel A: Full sample								
Employees	152	916	0	4	26	88	250	3,017
Firm Age	61	49	20	28	45	85	121	1,841
Equity ratio (%)	46	28	11	25	41	65	90	1,754
Cash ratio (%)	21	20	2	8	15	30	50	1,012
Investment 2021 (TEUR)	5,930	75,295	5	33	150	870	3,001	2,158
Revenues 2021 (TEUR)	706,353	21,558,241	550	2,100	6,900	25,000	84,000	2,293
Panel B: Firms that planned investments in 2024 and 2025								
Employees	247	1,252	0	11	52	160	430	1,531
Firm Age	65	49	21	31	52	93	123	958
Equity ratio (%)	46	26	15	25	42	64	86	956
Cash ratio (%)	20	20	2	8	15	29	50	576
Investment 2021 (TEUR)	9,881	101,146	24	100	410	1,522	5,000	1,165
Revenues 2021 (TEUR)	1,292,718	29,592,573	1,500	4,129	12,000	4,4753	129,000	1,216

Notes: Panel A: Summary statistics of relevant firm characteristics for all firms answering to the vignette question. Panel B: Summary statistics for all firms answering to the vignette question and having planned investments for 2024 and 2025. The number of observation varies, as not all characteristics are elicited in the same wave. Firm age: year since founding, elicited in 2018. Equity Ratio: as of end of 2019. Cash-to-total assets: as of March 2020. Investment and Revenues in 2021: nominal, elicited in 2023. See Appendix C for the wording of the corresponding survey questions.

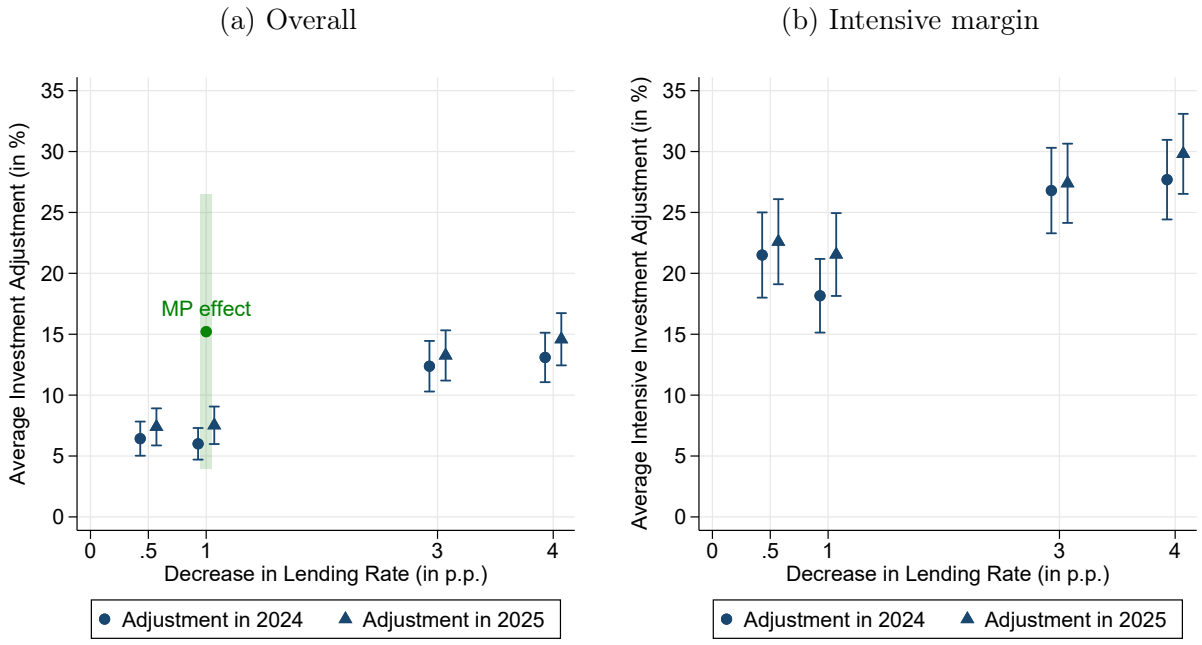
Second, in order to draw meaningful conclusions about aggregate effects, responses should be based on a representative sample of firms. Table A.1 in the appendix shows that the industry and size distribution of our sample generally matches that of the German firm population. Compared to the unweighted distribution of German firms, we somewhat oversample manufacturing firms and medium-sized firms. However, weighting the distribution of German firms by employees or gross value added reveals the large importance of exactly these firms for the German economy.[9] The macroeconomic relevance of the sample is further underlined by the fact that indicators constructed from the IBS, such as the highly regarded ifo Business Climate, have significant forecasting power for the German economy (Lehmann, 2023) and drive movements in global asset prices (Kerssenfischer and Schmeling, 2024).

3 Empirical results

We first present our main results from the hypothetical vignettes, which establish *causal* evidence for firms' investment adjustments in response to changes in lending rates and provide

[9]For further results on the representativeness of the regular IBS sample in terms of firm size, industry, and region, see Hiersemenzel et al. (2022).

Figure 1: Semi-elasticity



Notes: Panel (a): average investment adjustment in percent following hypothetical change in loan rate; Panel (b): average adjustment conditional on adjusting. Bars represent 95% confidence intervals. Investment adjustment winsorized at 100%; sample restricted to firms that initially planned to invest in 2024 and 2025. Panel (a) also includes the average aggregate investment response in the first year after a monetary policy shock (green dot with shaded 90% confidence interval); response scaled to 1 percentage point reduction in firms' cost of external financing. See the text for details about construction.

quantitative estimates of the responses along extensive and intensive margins. We then discuss narratives of non-adjustment using firms' responses to open-text questions. We then further analyze the heterogeneity of investment adjustment along both margins by linking with other measures from the survey and additional data sources. We conclude this section with evidence on hurdle rates.

3.1 Results from hypothetical vignettes

In what follows, we discuss the results from the hypothetical vignettes introduced in Section 2.1. Figure 1 presents the main results. The horizontal axis depicts the four hypothetical interest rate reductions (0.5 / 1.0 / 3.0 / 4.0 p.p.) and the vertical axis represents the average investment adjustment in 2024 (blue circles) and 2025 (blue triangles) for firms that planned to invest in 2024 *and* 2025.[10] The bars indicate 95 percent confidence intervals.

Focusing first on Panel (a), a one percentage point (p.p.) increase in the interest rate on loans leads to an upward revision of investment by 6 percent in the next year and an

[10]Table A.2 in the appendix provides numerical results pooled across the two years.

additional 7 percent upward revision in the year after that. The investment response is very similar for a one-half p.p. decrease in the interest rates. Large reductions in loan rates of three or four p.p. induce an upward investment revision of 12–15 percent. Hence, firms' investment sensitivity decreases with the size of the interest rate changes.

Because the investment response does not scale linearly with the magnitude of the loan rate reduction, the elasticity is smaller for larger interest rate changes. One possible explanation for the decreasing interest rate sensitivity is that investment plans are discrete, meaning that firms decide either to realize an additional project or to leave plans unchanged. A small interest rate reduction might make the marginal project profitable for most firms, while a larger reduction may not induce further projects, for example due to convex capital adjustment costs (e.g., Hamermesh and Pfann, 1996).

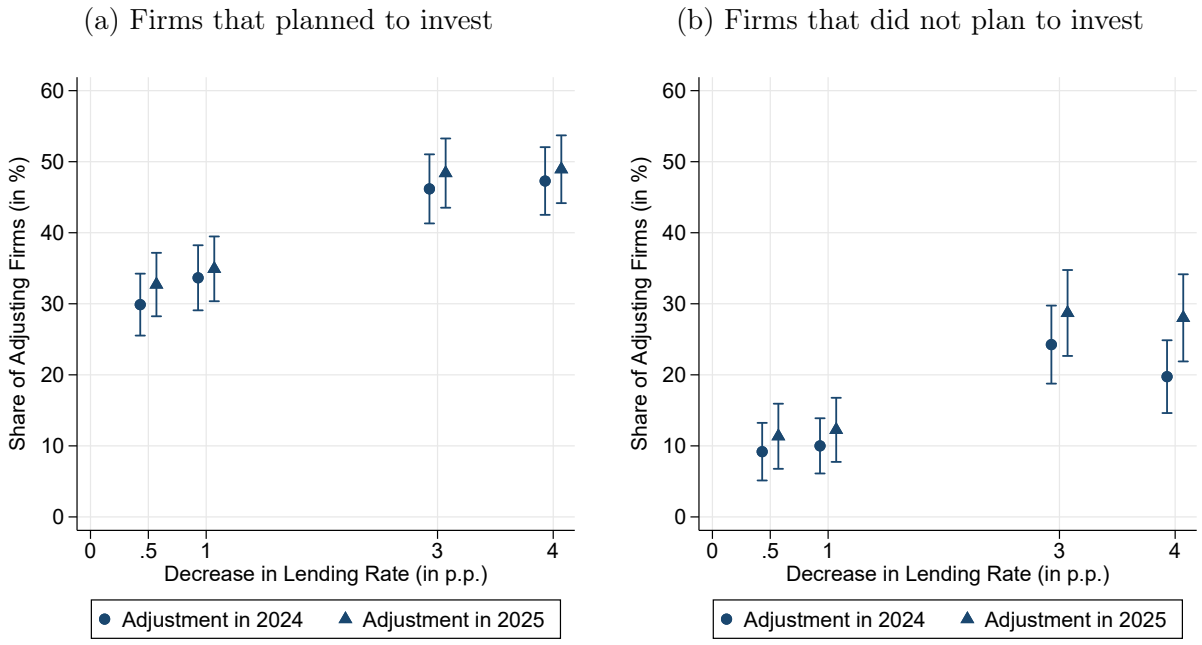
This explanation aligns well with the large intensive margin investment adjustments that we observe across all rate reductions. In Panel (b) of Figure 1, we consider only firms that adjust investment after a decline in the interest rates on loans (intensive margin). Here, the investment adjustment amounts to about 18–23 percent for small interest rate cuts (0.5–1 p.p.) and 27–30 percent for large ones (3–4 p.p.). The large difference from the overall effect sizes in Panel (a) implies that a significant fraction of firms does not adjust investment at all following changes in borrowing costs.

Comparison to overall effect of monetary policy On average, the partial-equilibrium semi-elasticity of investment to changes in the lending rate amounts to 7 percent across the different rate changes. To determine the importance of this channel in the the overall effect of monetary policy on investment, we compare this number to the aggregate corporate investment response to monetary policy shocks.

To this end, we use the high-frequency monetary policy shocks identified in Jarociński and Karadi (2020) and estimate local projections (Jordà, 2005) at a quarterly frequency from 1999 to 2019. See the full impulse response function (IRF) in Appendix Figure A.2, Panel (a). On average, the average effect in the first year after the shock is a 19 percent increase in investment, peaking at 27 percent.[11]

[11]The estimated investment response is consistent with the response of aggregate corporate goods production in Germany. The average effect in the first year after the shock amounts to 13 percent; see Appendix Figure A.2, Panel (b). In Appendix Table A.4, we provide an overview of estimates of the investment response one year after monetary policy shocks. The reviewed estimates range from 13 to 30 percent of the investment response in the first year following a one percentage point monetary policy shock.

Figure 2: Semi-elasticity: extensive margin



Notes: Figure shows share of firms adjusting their investment plans following hypothetical change in loan rate. Panel (a): firms that initially planned to invest in 2024 and 2025; Panel (b): firms that did not plan to invest in respective year. Bars represent the 95% confidence intervals.

We scale the average effect in the first year to reflect a one percentage point reduction in firms' cost of external financing.[12] This scaled effect amounts to approximately 15 percent, as shown by the green dot in Figure 1, Panel (a).

Thus, the partial equilibrium response to a change in the lending rate is approximately half the size of the total effect of monetary policy on investment. The wide confidence intervals around the aggregate response further highlight the greater statistical uncertainty involved in using time-series data to identify the effect of monetary policy on investment, as compared to our partial-equilibrium, survey-based approach.

Extensive margin We investigate the extensive-margin decision further in Figure 2. Panel (a) shows that only about 30–35 percent of firms that planned to invest in the next two years adjust their investment plans. Firms that did not plan to invest at all are significantly less likely to respond to interest rate changes, see Panel (b) of Figure 2. This indicates significant fixed capital adjustment costs. Additional evidence for the role of capital adjustment costs is presented in Table A.3 in the appendix: Relative to firms that planned to invest in both

[12]Appendix Figure A.3 shows that a one percentage point monetary policy shock on impact translates into a 1.2 percentage point change in corporate bond yields. These yields serve as a proxy for firms' cost of external financing and are highly correlated with movements in the lending rate ($\rho = 0.8$).

2024 and 2025, firms that planned to invest in 2025 but not in 2024 are almost 30 p.p. more likely to adjust their investment plans for 2025: It takes time to adjust.

One possible explanation is that investment projects tend to be spread over several years. Therefore, a decision to start an additional project in 2024 will also affect the investment plans for 2025. This close relationship between investment plans for 2024 and 2025 for firms that planned to invest in both years is also underlined when looking at firms that initially planned to invest only in 2025. These firms have more time to adjust their plans, resulting in greater flexibility.

Comparison to prior estimates in the literature. Sharpe and Suarez (2021) use a survey to elicit the extensive margin investment response to changes in borrowing costs. Specifically, they ask U.S. firms about the necessary change in their borrowing costs to "initiate, accelerate, or increase investment projects in the next year" (Sharpe and Suarez, 2021, p. 7). They find a lower interest rate sensitivity with 68 percent (37 percent) of their sample saying they would not react to a fall (rise) in the borrowing costs. However, their survey was conducted in September 2012 when interest rates were at the zero lower bound (the federal funds rate was at 0.14 percent), which is a possible explanation for the comparatively low sensitivity. They do not ask about the size of the investment response. To get a sense of the magnitude of our semi-elasticity, we can compare it to estimates of the investment response to changes in the tax term of the user cost of capital, such as those reviewed in Zwick and Mahon (2017). Under a set of assumptions set out in Appendix B, our interest rate semi-elasticity of 7 percent translates into a user cost elasticity of 1.3. While this is only a fifth of the user cost elasticity suggested by Zwick and Mahon (2017), Curtis et al. (2021) show that the user cost elasticity implied by tax term estimates falls significantly when financial frictions are added to the model. Using this richer model but the same variation as Zwick and Mahon (2017), Curtis et al. (2021) arrive at an estimate for the user cost elasticity of investment of 1.4, which is close to the estimate implied by our interest rate semi-elasticity.

3.2 Narratives of non-adjustments

In a frictionless world, the non-adjustment of existing investment plans after changes in interest rates is hard to rationalize. However, the median firm in the survey does not adjust at all in the hypothetical vignettes. To open up the black box of non-adjustment, we ask firms in open-ended text questions why they would not adjust at all. 77% of the firms that do not adjust investment in the vignette provide an explanation. The average answer is 45 characters long and most answers are of high quality, referring to specific economic mechanisms.

Table 2: Reasons for not adjusting investment

	Total		By Size of Interest Rate Change					
			0.5 – 1 p.p.		3 – 4 p.p.		Difference	
	N	%	N	%	N	%	p.p.	SE
Sufficient internal funds								
no financing needs	219	29	113	27	106	31	-4.34	3.32
always internally financed	58	8	21	5	37	11	-5.89	2.00
High return to capital – Interest rate not decisive								
interest rate not decisive	154	20	86	20	68	20	0.43	2.93
Low return to capital – Overhang of capital								
no opportunities	97	13	53	13	44	13	-0.35	2.44
necessary	40	5	25	6	15	4	1.53	1.60
High adjustment costs								
adjustment costs	60	8	40	10	20	6	3.62	1.92
non linear	29	4	29	7	0	0	6.89	1.24
Expectations								
demand	32	4	14	3	18	5	-1.97	1.50
uncertainty	18	2	12	3	6	2	1.09	1.08
Constraints								
constraints	18	2	11	3	7	2	0.55	1.10
Other								
other	36	5	17	4	19	6	-1.55	1.57
Total	761	100	421	100	340	100	–	–

Notes: Distribution of the answers to the open-ended question across the hand-coded categories. Column 3–4: Firms that were confronted with a 0.5 or 1 p.p. interest rate change in the vignette. Column 5–6: Firms that were confronted with a 3 or 4 p.p. interest rate change in the vignette. Column 7-8: Difference between share of answers in 0.5–1 p.p. group and 3–4 p.p. group with corresponding standard errors.

We develop a coding scheme that classifies the responses into ten categories that can be grouped into six broader areas, see Table A.5 in the appendix for the codebook with example responses. Almost all explanations can be uniquely assigned to a single category, so we do not classify responses into multiple categories. Two authors independently hand-coded the responses. To validate the identified channels, we correlate the classified categories with several quantitative firm characteristics in the survey.

Table 2 presents the classifications of the open-ended text questions, and Figure 3 visualizes averages with 95% confidence intervals of various quantitative firm characteristics across the

reasons for not adjusting investment after a change in interest rates. As a reference group, there is also the average plotted in orange, for the group of firms that do adjust investment in the vignettes.

Two main narratives emerge: First, there are about 37% of firms that explain the non-adjustment with sufficient internal funds. Almost a quarter of them argue that they nearly *always* use internal funds for investments ("always internally financed" category), while the other three quarters report having enough funds *at present* ("no financing needs" category). This is consistent with the pecking order theory (Myers, 1984): Firms prefer internal funds for investment and have no financing needs due to high cash buffers. Indeed, focusing on Panels (a) and (b) of Figure 3, we observe significantly larger cash buffers and a higher equity ratio for firms that report sufficient internal funds compared to those that adjust investment in the vignettes. The differences are quantitatively meaningful: the cash-to-asset ratio is around 8 p.p. higher, and the equity ratio is around 20 p.p. higher. The results are corroborated by financial statement data that we can link to the survey for a subset of firms, allowing us to calculate averages over several years, see Appendix Figure A.4. As cash buffers have significantly increased over the last decades (Graham and Leary, 2018; Schnabel, 2024), this implies a lower sensitivity of investment to interest rate changes.[13]

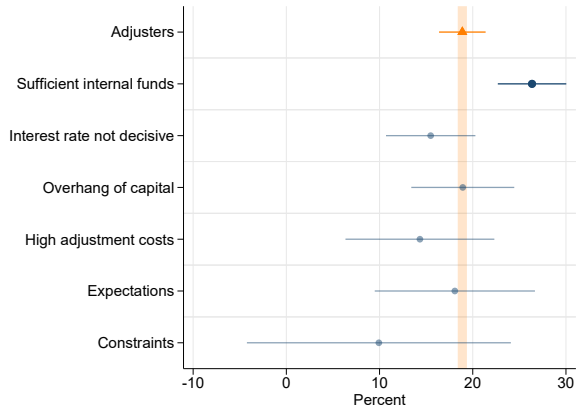
A second main narrative given by about 38% of firms—summarizing the second and third group in Table 2—is that they are not at the margin to change their investment decisions. The underlying reasons for that can be rationalized by dividing the firms into two groups. On the one hand, there are "high return to capital" firms. These firms indicate that interest rates do not significantly influence their investment decisions ("interest rate not decisive" category), primarily because the returns on their investments are sufficiently high. Thus, these firms are currently on a positive growth trend and have a *high* marginal product of capital. Consequently, they invest immediately when opportunities arise and have likely already exhausted their managerial resources in planning and coordinating investment projects. In line with this channel, we observe significantly higher business expectations and capacity utilization rates for this group; see Panels (c) and (d) of Figure 3.

On the other hand, "low return to capital" firms do not perceive significant benefits from additional investment. In other words, they have a *low* marginal product of capital, which is consistent with an overhang of capital due to trading frictions related to physical capital Ottonello (2024). In the IBS, there are regular annual questions about the focus of investment and R&D activities. Consistent with the narrative of being above to their optimal capital

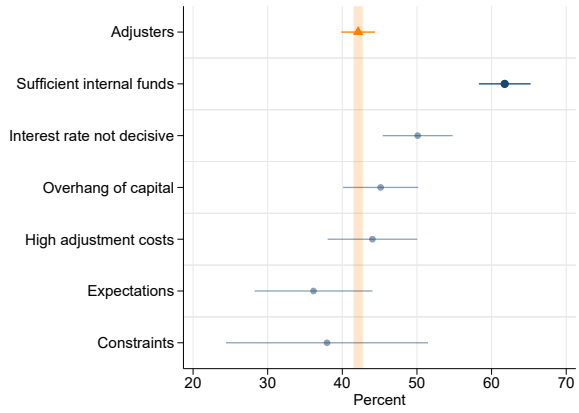
[13]While firms with larger cash buffers are less affected by borrowing costs, they may be more sensitive to deposit rate changes. For example, Altavilla et al. (2022) find stronger investment responses to negative deposit rates among highly liquid firms.

Figure 3: Firm characteristics by reasons for not adjusting investment

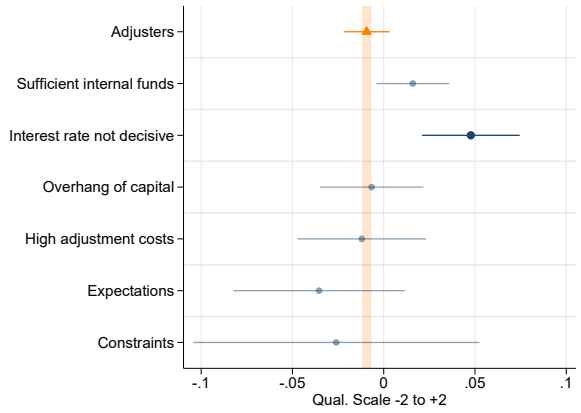
(a) Cash to Total Assets 2020



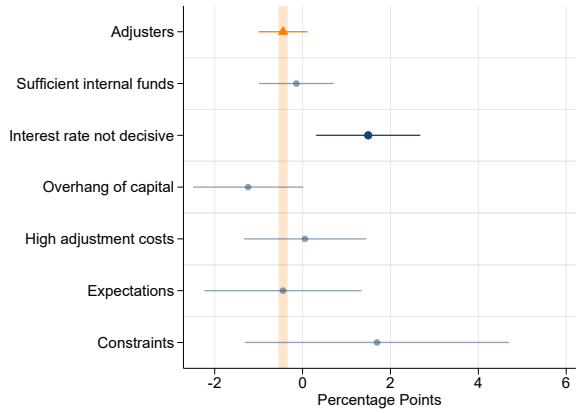
(b) Equity Ratio 2022



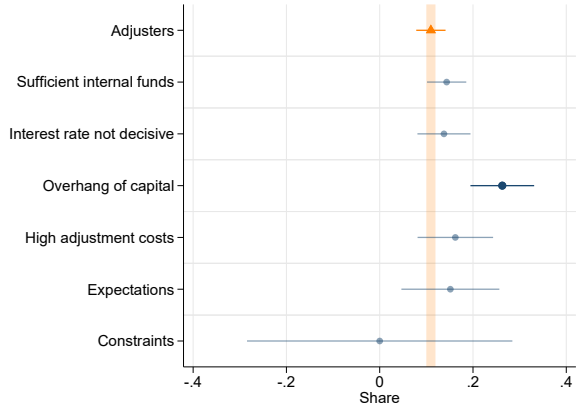
(c) Business Expectations 2021–23 Relative to Firm Average



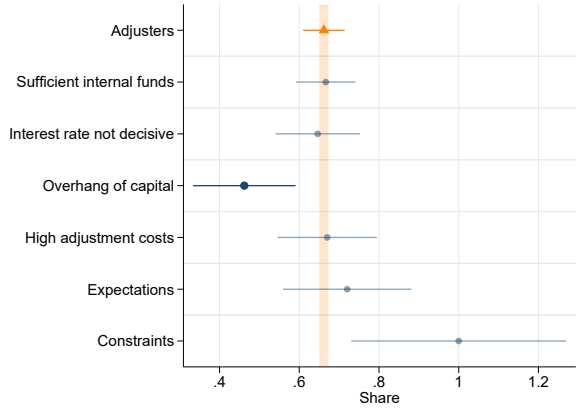
(d) Capacity Utilization 2021–23 Relative to Firm Average



(e) Focus on Replacement Investment 2021–23



(f) R&D Activity 2021 – 2023



Notes: This figure shows average values of different firm characteristics for the classified non-adjustment narratives. The average values for the group that adjusts investment plans in the vignette is shown in orange. Panel (a): cash-to-asset ratio in March 2020. Panel (b): equity ratio at the end of 2022. Panel (c): average business expectations (−1/0/1) 01/2021 – 12/2023 minus long-run firm-average. Averages are calculated after absorbing month fixed effects to account for non-balancedness of the panel. Panel (d): average capacity utilization in 01/2021–10/2023 minus to long-run firm-average. Panel (e): share of firms focusing investment only on replacement investment in 2021–2023. Panel (f): share of firms engaging in R&D activity in 2021–2023. See Appendix C for wording of the survey questions. Bars represent 95% confidence intervals.

stock, these firms are more likely to solely focus on replacement investments and less likely to engage in R&D, as shown in Panels (e) and (f). Additionally, they operate in a less volatile environment, as measured by their subjective uncertainty of the business outlook in recent years (see Appendix Figure A.4). This implies a state-dependent sensitivity of investment to interest rates over different horizons. From a short-run perspective, non-convex capital adjustment costs cause firms to overshoot their optimal capital stock. In these times, they are less sensitive to changes in interest rates. From a medium-run perspective, after several years of expansion during the mature stage of the business cycle, many firms have invested heavily, potentially overaccumulated capital, and have become less sensitive to interest rate changes. From a long-run growth perspective, investment sensitivity is lower in advanced economies, where potential growth is less dynamic.

12% of firms provide explanations related to high adjustment costs of investment plans. Consistent with fixed adjustment costs, this argument is particularly prevalent when firms face small interest rate changes of 0.5 or 1 p.p. Another reason for not adjusting, mentioned by 6% of firms, is that demand expectations or economic uncertainty are the main drivers of their investment decisions. 2% of firms do not adjust due to constraints on other production inputs, and 5% of responses cannot be classified. Appendix Table A.6 shows the classifications broken down by the years 2024 and 2025. There are no major differences between the years, indicating that the reasons for non-adjustment do not depend on the planning horizon.

3.3 Hurdle rate sensitivity

A large share of firms is does not adjust investment in response to a change in the interest rate. Reasons for not adjusting investment include adjustment frictions such as a low return to capital and high adjustment costs for adjusting investment plans. While these frictions hinder the investment adjustment in the short-term, the firms may still incorporate the change in the interest rate in their decision-making, bringing them closer to the margin to adjust investment. To see if this is the case, we can further zoom into the investment decision process of the firms. Specifically, we can analyze how firms' required return on investments is influenced by the vignette. The adjustment of the required return can be viewed as the preceding decision level that is not impacted by capital adjustment costs or missing investment opportunities. In theory, the value-maximizing strategy is to realize investment projects that yield a return above the cost of capital and neglect investment projects with a lower return. Thereby, changes in the cost of capital directly impact the investment decision. As noted by Graham (2022), the majority of firms use related concepts for evaluating investment projects that

are based on a required minimum return, often referred to as the hurdle rate.[14] However, the hurdle rate often deviates from the cost of capital. Firms usually require returns that are above their cost of capital (Jagannathan et al., 2016; Gormsen and Huber, 2025), for example due to managerial constraints and idiosyncratic risk that is not priced into the cost of capital (Jagannathan et al., 2016). In addition, the hurdle rates are found to be sticky, meaning that they do not change one by one with changes in the cost of capital (Graham, 2022; Gormsen and Huber, 2025). As argued by Gormsen and Huber (2025), the fact that hurdle rates exceed the cost of capital and do not change one by one with it can reduce the investment sensitivity to the cost of capital by up to a factor of ten.

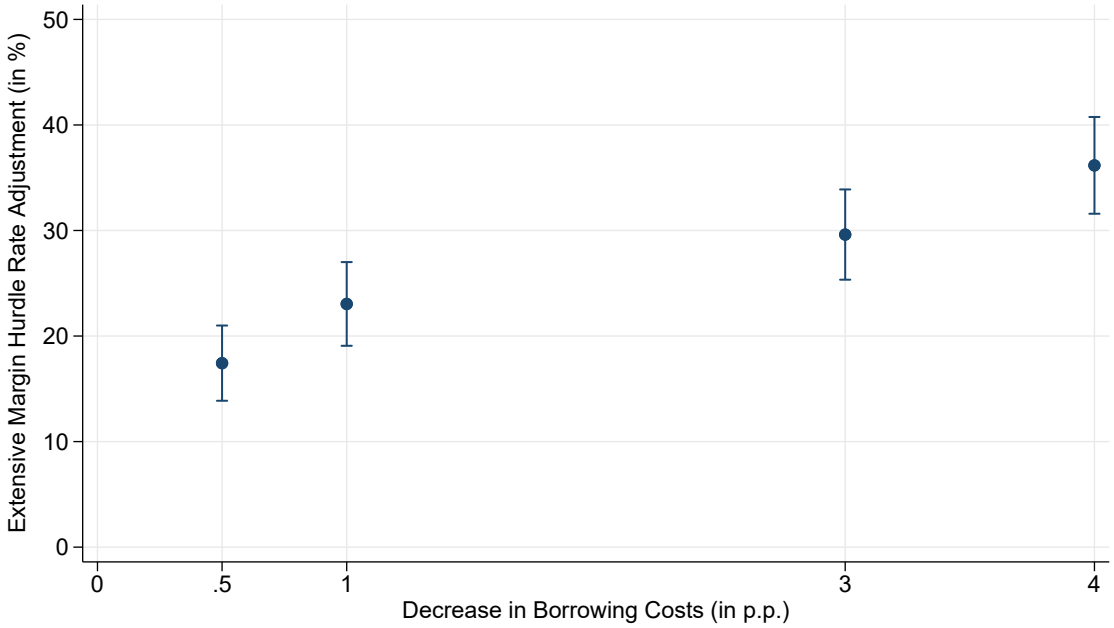
Our survey first elicits the current hurdle rate of the firms in our sample. The mean hurdle rate is 11%, which is in line with the average hurdle rate for German firms predicted by Gormsen and Huber (2025).[15] However, two-thirds of the firms state that they do not know their hurdle rate, which hints at the usage of an alternative investment decision-rule. Column 1 of Appendix Table A.7 shows that firms are more likely to know their hurdle rate if the survey was answered by the CEO or the owner of the firm, the respondent is at least college educated, the firm is more investment intensive, as measured by the investment-to-employee ratio, and the firm has a higher share of externally financed investment. These results are in line with Graham and Harvey (2001), who find that the investment decision rule is strongly dependent on CEO characteristics and the leverage of a firm.

After eliciting the current hurdle rate level, we confront firms again with our hypothetical vignette and ask whether they would adjust their hurdle rate following the decline in the interest rate on loans. As described above, the hurdle rate adjustment should be independent of capital adjustment frictions and the availability of investment opportunities. Thus, we would expect an adjustment of the hurdle rate, if it is used, in response to change in the loan rate for each firm. However, Figure 4 shows that less than half of the firms, which provided us with a reasonable hurdle rate, choose to adjust it in response to a decline in the interest rate on loans. In addition, the share of firms that adjust their hurdle rate increases in the magnitude of the loan rate reduction. This indicates fixed costs for adjusting the hurdle rate, which is in line with the high degree of stickiness identified by Graham (2022) and Gormsen and Huber (2025). The initial level of the hurdle rate does not impact whether firms adjust it or not, as shown in Appendix Figure A.6. This is further underlined by Panel (a) of Figure 5 showing that the level of the hurdle rate does not significantly differ between the adjusting

[14] Either firms determine the internal rate of return (IRR) on a project and evaluate it against the required return (hurdle rate) or they derive the net present value (NPV) using the hurdle rate as the discount rate and invest if the NPV is positive. See Gormsen and Huber (2025) for a discussion on the equivalence of the two approaches.

[15] Appendix Figure A.5 shows the heterogeneity behind this average, trimmed at the 1%-level.

Figure 4: Semi Elasticity – Extensive Margin

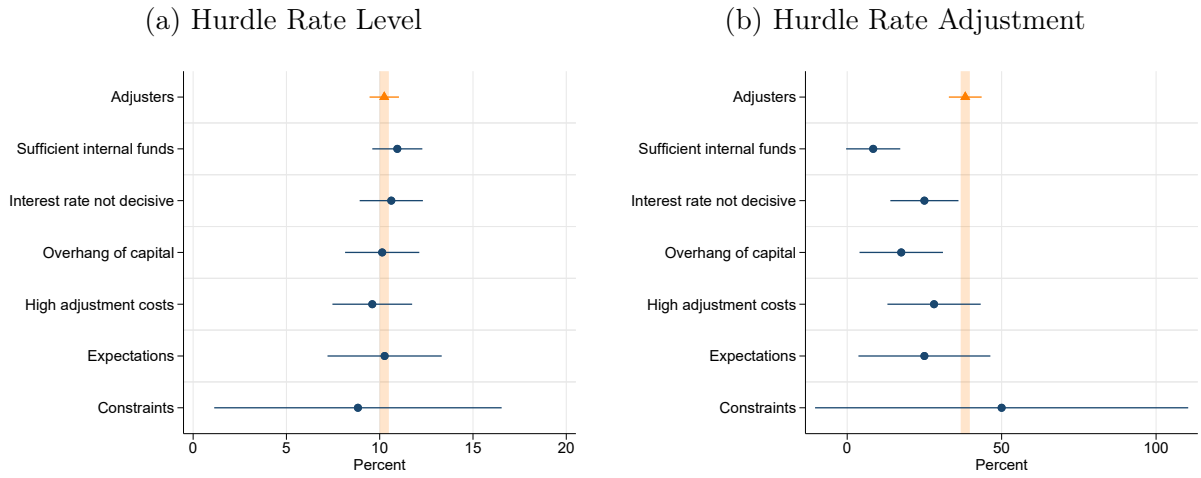


Notes: Figure shows share of firms adjusting their hurdle rate following hypothetical change in loan rate. Bars represent the 95% confidence intervals. Bars represent 95% confidence intervals.

firms and each of the non-adjustment narratives. Non-adjustment is therefore not driven by particularly high required returns on investment. As would be expected, the adjustment of the hurdle rate and investment are highly correlated at the firm level. Column 1 of Table 3 shows that firms that would adjust their hurdle rate in the vignette are also about 27 percentage points more likely to adjust investment. Thus, the hurdle rate adjustment, elicited one month after the investment adjustment, also validates our main result by confirming consistency across survey waves. The hurdle rate adjustment is not correlated with the magnitude of the investment adjustment conditional on adjusting, as shown in Column 2.

Even though investment and hurdle rate adjustments are correlated, we do not see a one-to-one relation. In fact, 37% of the firms adjust only one of the two and leave the other unchanged. About a quarter of these firms adjusts only its hurdle rate but not its investment. As described above, this could be rationalized by missing investment opportunities or high adjustment costs. However, Panel (b) of Figure 5 shows that only about 20% of the firms rationalizing their non-adjustment of investment with related narratives adjust their hurdle rate. Overall, there is little heterogeneity in the hurdle rate adjustment across the narratives for not adjusting investment. The remaining three quarters adjust only investment but leave the hurdle rate unchanged. This is puzzling at first sight when considering that the interest rate on loans influences investment through the cost of capital and thereby through the

Figure 5: Hurdle Rate & Adjustment by Narratives



Notes: This figure shows average values of different variables for the classified investment non-adjustment narratives. The average values for the group that adjusts investment plans in the vignette is shown in orange. Panel (a): mean of the current hurdle rate as of January 2024. Panel (b): share of firms adjusting their hurdle rate following the hypothetical decline in the loan rate.

Table 3: Investment Adjustment and Hurdle Rate Adjustment

	Extensive margin	Intensive margin
	(1)	(2)
Extensive margin HR adjustment	0.269***	0.026
	(0.039)	(0.033)
Constant	36.215***	24.497***
	(2.288)	(1.417)
Observations	577	249
R^2	0.056	0.003

Notes: This Table shows OLS regression results of the extensive margin investment adjustment (0/100) and intensive margin investment adjustment (0–100%) on the extensive margin hurdle rate adjustment (0/100). Sample is restricted to firms that planned to invest in 2024 and 2025. Standard errors clustered at the 2-digit industry level in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

hurdle rate. However, as noted by Graham (2022), the minority of firms realize all investment projects with an expected return that exceeds the hurdle rate. This implies that the implicit buffer on the cost of capital is even larger than indicated by the hurdle rate, leaving room for additional investment without adjusting the hurdle rate. Column 3 of Appendix Table A.7 shows that especially firms that reduced investment in response to the real-world interest rate hikes in 2022–23 are likely to adjust investment without adjusting their hurdle rate, suggesting that they would catch up their forgone investment.

3.4 Heterogeneity in the semi-elasticity of investment

The investment sensitivities to interest rates at the firm level in combination with other measures from the survey and external data allow for a detailed heterogeneity analysis.

3.4.1 Financial conditions

Motivated by the observed lack of investment response to interest rate changes attributed to high cash buffers, we begin the heterogeneity analysis by further examining the role of financial conditions. While others typically rely on proxies for financial constraints and the need for borrowing, such as firm size, age, leverage, or the cash-to-asset ratio (Cloyne et al., 2023; Jeenas, 2023; Gertler and Gilchrist, 1994; Ottonello and Winberry, 2020), we exploit several direct measures on financial conditions from the survey.

Table 4 presents the regression results of the extensive margin adjustment (upper panel) and intensive margin adjustment (lower panel) in the vignette on different measures for the financial conditions of a firm. In all specifications, we control for the firm size and firms' overall business conditions to ensure that estimates are not affected by omitted variable bias. We proxy firm size with the log number of employees. Larger firms are significantly less likely to adjust investment in case of a decrease in loan interest rates. A ten percent increase in the number of employees is associated with 20 percentage points lower probability to adjust investment. This is consistent with the idea that managerial costs of planning and conducting investment projects increase with firm size. To condition on the idiosyncratic state of the firm, we control for the average business state of the firm in the past two years. It turns out that there is no strong state dependence with respect to the business state.

The extent of external financing should be of first-order importance in reacting to changes in external financing costs. In Column 1, we relate the adjustment of investment in the vignette to the share of externally financed investment in 2024. Reassuringly, there is a strong positive relation between the share of external financing and the probability to adjust investment when interest rates on loans change. Also, at the intensive margin—the strength of investment adjustment—there is a positive relation. We include the variable in the subsequent specifications to control for the overall usage of external financing.

Next, we consider whether it matters if firms are at the margin of taking out a loan. Specifically, in Column 2, we find that firms that conducted loan negotiations in the past three months (21% of firms) are 15 percentage points more likely to adjust. This demonstrates the important role of already being at the margin of taking out a loan in shaping the investment response to interest rate changes. The insignificant interaction regarding whether the bank acted restrictively during the negotiations in the third column suggests that the

loan conditions are more crucial than the mere granting of the loan.[16] The null effect at the intensive margin indicates substantial fixed costs associated with bank contact.

Relatedly, in Column 4, we consider a question that elicits whether financing conditions are relevant for investment decisions in 2024. For the 14% of firms that report a high importance of financing, we observe a 19 percentage point increase in the probability of adjusting investment following a decline in loan rates. Conditional on adjusting, these firms would increase investment by additional 8 percentage points compared to those that do not report that financing conditions are relevant.

In the last column, we analyze to what extent self-reported constrained business activity due to problems of financing predicts the response in the vignette. We find that firms facing financing problems (only 4%), a direct measure of financial constraints, have a 19 percentage point higher probability of adjusting investment. At the intensive margin, we observe no differences.

We conclude that financial conditions are a core state variable that shapes firms' investment sensitivity to interest rates. Translating cross-sectional heterogeneity into the time-series implies that during periods when a higher share of firms in the economy rely on external financing, are at the margin to take up new loans, or face financial constraints, then monetary policy is more effective in stimulating firms' investment.

3.4.2 Labor shortages

Germany and other advanced economies have faced increasing labor shortages in recent years. The ifo survey includes a regular quarterly question on whether firms are constrained by skilled labor shortages. As capital and labor are typically thought of as complementary inputs, we consider whether firms would also increase investment following a decline in loan interest rates even when they do not have sufficient labor input.

In Table 5 Column 1, we analyze whether firms that currently report a lack of skilled labor—which is the case for 39% of firms in October 2023—differ in their investment response. The results show that firms with labor shortages tend to react *stronger* than those without, especially larger firms (Column 2). In Columns 3 and 4, we examine firms that have consistently reported above-average lack of skilled labor over the past five years to obtain a more robust measure. Here, we observe significant effects at both the extensive and intensive margins: firms with labor shortages are 5.4 percentage points more likely to adjust investment in the vignette, and the adjustment is, on average, 3.6 percentage points larger.

The findings suggest that labor shortages do not decrease firms' investment sensitivity to interest rate changes. In fact, firms with labor shortages seem to react more strongly,

[16] Note that only 4% of firms were in credit negotiations and experienced that the bank acted restrictively.

consistent with a substitution effect. This could be explained, for example, by increasing efforts to automate tasks and replace labor with machines as relative input prices change.

3.4.3 Environmental impact

The ECB is concerned about the environmental impact of monetary policy, since climate change can have effects on price stability. Our firm-level estimates allow for a detailed accounting exercise: Are firms with a larger environmental footprint stimulated more by decreases in loan interest rates?

We analyze two different measures of environmental footprint. First, we exploit a special survey question on firms' energy costs in 2021 that was asked in April 2022. In Panel (a) of Figure 6, we show a binned scatter plot with this energy cost intensity measure on the horizontal axis and firms' investment adjustment in the vignette on the vertical axis. We find a significant positive relationship between energy cost intensity and firms' investment adjustments in the hypothetical scenarios. An increase of 5 percentage points in energy intensity is associated with a 2 percentage point greater investment adjustment at the firm level. One potential explanation is that more energy cost-intensive firms face greater needs to invest in energy efficiency, which were further amplified by the rising energy costs during the 2022/23 energy crisis. Note, however, that energy does not necessarily have a negative impact on the environment if it comes from renewable sources.

To have a more precise measure of the environmental footprint, we merge Scope 1 CO_2 intensity at the two-digit NACE industry level with the survey. Scope 1 CO_2 emissions refer to direct greenhouse gas emissions from sources that are owned or controlled by a firm, such as on-site fuel combustion, company-owned vehicles, and industrial processes. Panel (b) of Figure 6 shows that there is no observable relationship between CO_2 intensity and investment sensitivity to interest rates at the industry level. This suggests that the direct investment effect of the change in lending rates is orthogonal to the environmental footprint of firms, which contrasts with the ECB's unconventional policies that are biased towards high-emission sectors (Papoutsi et al., 2022).

Table 4: Investment Adjustment and Financial Conditions

	(1)	(2)	(3)	(4)	(5)
Panel (a): Extensive Margin Adjustment (0/100)					
Loan negotiations past 3 months		14.892***	12.743***		
		(3.711)	(4.366)		
Loan negotiations past 3 months × Bank acted restrictive			10.775		
			(7.702)		
Financing conditions relevant for investment 2024				18.892**	
				(7.474)	
Financially constrained					19.945***
					(6.650)
Share of externally financed investment 2024 (in %)	0.208***	0.135***	0.136***	0.170***	0.179***
	(0.041)	(0.046)	(0.047)	(0.054)	(0.042)
Log employees	-2.729***	-2.303**	-2.220**	-2.225**	-1.961**
	(0.896)	(0.922)	(0.940)	(0.986)	(0.906)
Avg. business state past 2 years	-2.434	-0.933	-0.372	-0.778	-3.945
	(3.517)	(3.530)	(3.371)	(4.154)	(3.986)
Constant	46.656***	41.988***	41.559***	41.209***	43.007***
	(4.289)	(4.596)	(4.643)	(4.890)	(4.565)
Observations	1,012	956	956	788	930
R^2	0.025	0.036	0.038	0.044	0.029
	(1)	(2)	(3)	(4)	(5)
Panel (b): Intensive Margin Adjustment (in %)					
Loan negotiations past 3 months		0.200	0.045		
		(3.090)	(3.241)		
Loan negotiations past 3 months × Bank acted restrictive			0.643		
			(2.326)		
Financing conditions relevant for investment 2024				8.236***	
				(2.938)	
Financially constrained					-3.034
					(3.280)
Share of externally financed investment 2024 (in %)	0.100**	0.080	0.080	0.080*	0.084*
	(0.038)	(0.051)	(0.051)	(0.045)	(0.046)
Log employees	-0.939*	-0.909*	-0.902*	-0.732	-1.015*
	(0.507)	(0.492)	(0.495)	(0.564)	(0.525)
Avg. business state past 2 years	0.684	1.189	1.226	0.883	-1.413
	(1.736)	(1.900)	(1.937)	(1.891)	(1.820)
Constant	23.639***	23.904***	23.868***	21.952***	24.754***
	(1.938)	(2.245)	(2.281)	(2.400)	(2.065)
Observations	400	366	366	298	364
R^2	0.028	0.020	0.020	0.059	0.024

Notes: OLS regression results. Panel (a): Dependent variable is 0 for firms not adjusting investment in the vignettes and 100 for adjusting firms. Panel (b): The sample is restricted to firms that adjust investment in response to the vignette and the dependent variable is the investment adjustment in %, winsorized at 100%. "Share of externally financed investment": asked in November 2023. "Financing conditions relevant": asked in November 2023. "Loan negotiations" and "Bank acted restrictive": asked in December 2023 referring to the three prior months. "Financially constrained": asked in October 2023. "Log employees" is winsorized at the 1%-level. "Avg. business state" is the average of the qualitative business sate (-1/0/1) from 11/2021–11/2023 after absorbing month fixed effects. See Appendix C for the wording of the corresponding questions. The sample is restricted to firms that have planned investments in 2024 and 2025. Standard errors clustered at the 2-digit industry level in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Investment Adjustment and Labor Constraints

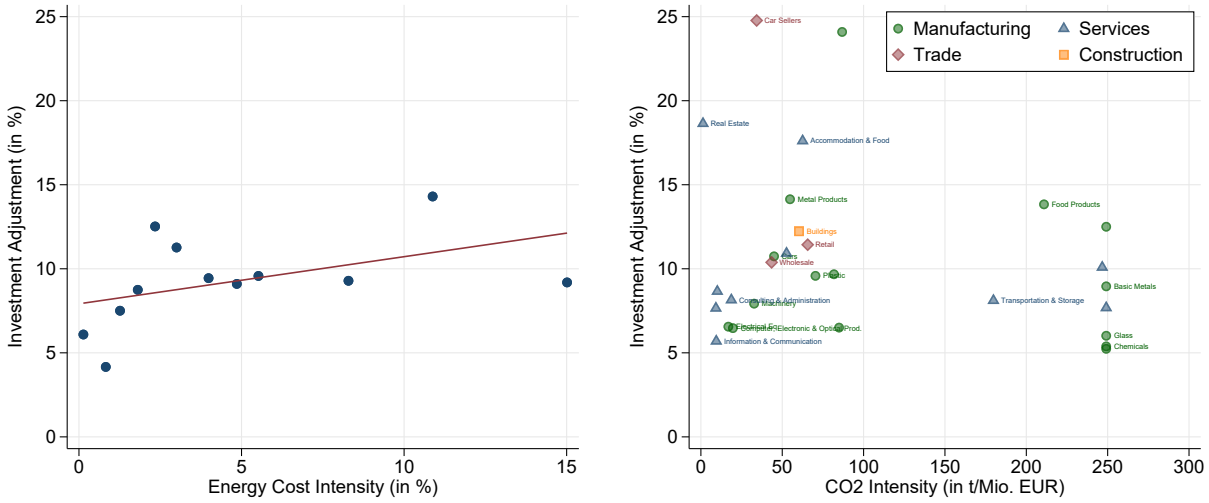
	(1)	(2)	(3)	(4)
Panel (a): Extensive Margin Adjustment				
Lack of skilled labor 10/2023	4.585	2.697		
	(3.297)	(4.014)		
Lack of skilled labor 10/2023 × Large or medium-sized firm		3.720		
		(4.790)		
Lack of skilled labor past 5 years			5.386**	6.677*
			(2.474)	(3.989)
Lack of skilled labor past 5 year × Large or medium-sized firm				-2.501
				(5.048)
Large or medium-sized firm	-5.153	-6.592*	-5.054	-3.931
	(3.389)	(3.507)	(3.321)	(4.658)
Business state 10/2023: good	-9.002	-9.010	-9.005	-8.997
	(5.488)	(5.488)	(5.502)	(5.525)
Business state 10/2023: medium	0.884	0.838	0.836	0.834
	(4.469)	(4.492)	(4.523)	(4.535)
Constant	43.332***	44.126***	42.724***	42.137***
	(5.884)	(6.088)	(5.825)	(6.359)
Observations	1,329	1,329	1,334	1,334
R^2	0.011	0.012	0.012	0.012
	(1)	(2)	(3)	(4)
Panel (b): Intensive Margin Adjustment				
Lack of skilled labor 10/2023	2.846*	-0.698		
	(1.615)	(1.881)		
Lack of skilled labor 10/2023 × Large or medium-sized firm		7.266**		
		(2.720)		
Lack of skilled labor past 5 years			3.609**	-0.697
			(1.550)	(2.121)
Lack of skilled labor past 5 years × Large or medium-sized firm				8.756***
				(2.884)
Large or medium-sized firm	1.471	-1.528	1.394	-2.812
	(1.813)	(2.242)	(1.897)	(2.746)
Business state 10/2023: good	1.584	1.518	2.045	2.091
	(2.209)	(2.171)	(2.268)	(2.221)
Business state 10/2023: medium	-0.396	-0.599	0.043	0.000
	(2.818)	(2.823)	(2.815)	(2.821)
Constant	21.638***	23.257***	20.702***	22.834***
	(2.056)	(2.183)	(1.981)	(2.082)
Observations	537	537	540	540
R^2	0.007	0.015	0.010	0.022

Notes: OLS regression results. Panel (a): dependent variable is 0 for firms not adjusting investment in the vignettes and 100 for adjusting firms. Panel (b): the sample is restricted to firms that adjust investment in response to the vignette and the dependent variable is the investment adjustment in %, winsorized at 100%. "Lack of skilled labor Oct. 2023": dummy for current labor shortages. "Lack of skilled labor past five years": dummy for > 0 average residual labor shortages over past five years after absorbing month fixed effects. "Large or medium sized firm": dummy for > 49 employees. "Business state": qualitative assessment of the business state. Base category is "bad". See Appendix C for the wording of the corresponding questions. The sample is restricted to firms that have planned investments in 2024 and 2025. Standard errors clustered at the 2-digit industry level in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 6: Investment response and environmental impact

(a) Energy Cost Intensity

(b) Scope 1 CO_2 Intensity



Notes: Panel (a): binned scatter plot of the investment adjustment in the vignette (in %) on the share of revenues spent on energy in 2021 (in %). Energy cost intensity is trimmed at p75. Panel (b): scatter plot of the average investment adjustment in the vignette (in %) and the CO_2 intensity (Scope 1 CO_2 emissions in tonnes by million Euro of gross value added) at the two-digit industry level. CO_2 intensity is winsorized at 250. Investment adjustment in both panels is winsorized at 100%.

4 Hypothetical scenarios and macroeconomic reality

We use two approaches to examine the importance of the identified interest rate channel via the external finance premium for macroeconomic investment dynamics. First, we compare the sensitivity of investment in the vignette with the responses of firms in the real world due to the interest rate increases in 2022–2023, when interest rates changed for the whole economy. Second, we exploit the panel dimension of the survey and employ local projections and high-frequency monetary shocks to link the investment sensitivity that firms exhibit in the vignette to their real-world output responses following monetary policy shocks.

4.1 The ECB's 2022-2023 hiking cycle

So far, we have described firms' direct interest rate sensitivity in clean hypothetical vignettes. To get a first idea of how much firms' hypothetical investment adjustment in the vignette matters for their real-world response to changes in the interest rate, we review the recent monetary policy tightening cycle. During the period from June 2022 to December 2023, the ECB raised its key interest rate in six steps by a total of 4.5 p.p. and interest rates were expected to remain elevated over the course of 2024–2025, according to the Survey of

Table 6: Investment Adjustment in real-world and vignette

	Real-world response		
	Overall adjustment	Extensive margin	Intensive margin
Hypothetical response			
Overall adjustment	0.362***		
	(0.038)		
Extensive margin		0.247***	
		(0.020)	
Intensive margin			0.494***
			(0.055)
Constant	3.014***	10.000***	17.886***
	(0.418)	(1.249)	(2.098)
Observations	1,366	1,374	183
R^2	0.160	0.092	0.302

Notes: OLS regression results. "Overall adjustment": investment adjustment in %, winsorized at 100%. "Extensive Margin": Dummy that is 1 for adjusting firms, and 0 for others. "Intensive Margin": investment adjustment in %, the sample is restricted to adjusting firms. The sample is restricted to firms that have planned investments in 2024 and 2025. Standard errors clustered at the 2-digit industry level in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Professional Forecasters (SPF). Over the same horizon, the average interest rate on newly issued loans to non-financial corporations in Germany increased by 4 p.p.

In December 2023, in the same survey wave in which we conducted our experiment, we asked firms how they have adjusted their investment plans in response to the interest rate increases or the tighter credit conditions since June 2022 (see Appendix C for the exact wording of the questions). This formulation is more general than the hypothetical vignettes, which isolated the direct effect of changes in the lending rate. While it still refers explicitly to the impact of interest rates and credit conditions on firms' investment, firms may now also take into account interest rate-driven changes in demand. Another difference from the clean vignettes is that the interest rate on loans increased by 4 p.p. on average, but the increase can vary across firms, while it was the same for all firms in the vignettes. For example, financially constrained firms may face a stronger increase in the external finance premium, resulting in a larger increase in the interest rates on loans for them.

Overall, we find that firms have reduced their investment by 8.6% in response to the interest rate hikes. Only 20.3% of firms adjusted their investment at all, but when they did, they reduced their investment by a substantial 41.5%.[17] Table 6 shows that the response is

[17]Best et al. (2024) summarize the findings of the real-world response in more detail in a policy report.

highly correlated with the firms' hypothetical investment adjustment in the vignettes. Column 1 shows the relation for the overall investment adjustment. The investment adjustment in the vignette explains about 16% of the variation in the real-world investment adjustment. Considering the relation at the extensive and intensive margins, we find that firms that adjust their investment in the vignette are also 25 p.p. more likely to have adjusted their investment in response to the recent interest rate hikes. Conditioning on adjusting in both scenarios, we find that a 1 p.p. larger adjustment in the vignettes corresponds to a 0.5 p.p. larger adjustment in the real world.

Appendix Table A.8 shows that especially firms in a better business state and firms not facing financial constraints or engaging in loan negotiations adjusted their investment *only* in the vignettes as opposed to in the vignettes *and* the real world. These effects are robust to adding industry fixed effects, which should absorb demand-driven adjustments in the real world. Among firms that do not adjust their investment in the vignettes, especially firms arguing with higher uncertainty and worse demand expectations or with being constraint are more likely to have adjusted their investment in response to the real-world interest rate hikes as shown in Appendix Figure A.7. This suggests that the differences between the investment adjustment in the vignettes and the real world are mainly driven by non-linear responses depending on the sign of the rate change or a heterogeneous exposure to the changes in the interest rates in the real world.

If general equilibrium effects were a major driver of firms' investment responses, this would likely operate at the industry level, for example, due to industry-specific exposure to changes in demand. Figure A.9 plots the overall investment adjustments in the real world against the response in the vignette. The variation across sectors is overall very similar in the real-world response and the vignette response. Figure A.8 also shows that the share of variation explained by industry fixed effects is similar for the real-world and vignette investment adjustments. This suggests a first-order importance of the partial equilibrium effect via the external finance premium for macro investment dynamics.

4.2 Monetary policy shocks, interest rate sensitivity and production

We will now exploit the panel dimension of the survey and employ local projections and high-frequency monetary shocks to link the investment sensitivity that firms exhibit in the vignette to their real-world output responses following monetary policy shocks.

4.2.1 Data and setup

We rely on the high-frequency identified (HFI) monetary policy shock series for the ECB provided by Jarociński and Karadi (2020).[18] Appendix Figure A.3 shows that the impulse responses to a 1 p.p. monetary policy shock can be roughly interpreted as the response to a 1 p.p. change in real yields, which serve as an indicator for firms' cost of external finance and are highly correlated with movements in the interest rate on loans ($\rho = 0.8$). Since the IBS does not have a long time dimension for questions on investment, we focus on the response of firms' production activity to monetary policy instead. For this, we rely on a subset of our baseline sample, namely, only manufacturing firms. For manufacturing firms, the IBS features a monthly question about firms' production activity in the previous month available since 1980. In particular, the question qualitatively elicits whether firms decreased (-1), kept unchanged (0), or increased (1) their domestic production. Our sample period is January 1999, which denotes the start of the monetary policy shock series, to December 2021. The end of the sample period is chosen to exclude the recent interest rate hikes starting mid-2022.

To estimate the dynamic response of firms' production activity to monetary policy shocks, we use local projections following Jordà (2005). Importantly, and following, e.g., Cloyne et al. (2023), we want to interact the monetary policy shock with an indicator function, in our case the firms' answers to our vignettes. The non-linear local projection is then given by:

$$\sum_{k=0}^{h} \Delta y_{i,t+k} = \alpha_i^h + \sum_{g=0}^{G} \beta_h^g \varepsilon_t^{MP} \times \mathbb{1}[X_i = g] + \Omega_h' Z_{i,t-1} + \sum_{j=1}^{6} \Gamma_h^{j'} Y_{t-j} + \upsilon_{i,t+h} \ . \tag{1}$$

As a dependent variable, we add the qualitative production changes from period t up to $t+h$ following Andrade et al. (2022), where $\Delta y_{i,t} \in \{-1, 0, 1\}$. ε_t^{MP} is the HFI monetary policy shock, which is scaled to represent a 1 p.p. *expansionary* shock. β_h is the coefficient of interest that represents the effect of a monetary policy shock on production at horizon h. α_i^h is a firm fixed effect controlling for firm-level differences in the cumulative production change at horizon h. $Z_{i,t-1}$ is a set of firm-level controls, including firms' state of business, their business expectations for the following six months, as well as their production expectations for the following three months, each measured in the month before the shock to ensure exogeneity. The firm-level controls are qualitative variables $\in \{-1, 0, 1\}$ and are included in the regression as a set of indicators. These firm-level controls purge movements in production that are to be expected already before the shock hits and are, therefore, not caused by the shock itself.

[18] To isolate the effect of the surprise monetary policy shift, Jarociński and Karadi (2020) decompose the series into a monetary policy and a central bank information shock using sign restrictions. We make use of their baseline method for the decomposition, that is, the median shock series satisfying the sign restrictions. Our results are robust to using their alternative so-called "poor-man's sign-restriction").

Finally, Y_t contains the year-on-year percentage change in the Industrial Production Index and the Consumer Price Index (CPI). We add six lags of Y_t, to control for the state of the business cycle. Importantly, X_i stands for a particular group of firms, such as adjusters or non-adjusters in the vignette. Not including time-fixed effects recovers the overall response to a monetary policy shock, including general equilibrium effects for each group. In contrast, we will also estimate a variant of Equation (1) where we add the non-interacted monetary policy shock ε_t^{MP}, such that β_h^g directly gives the additional effect on production for group g relative to a base group. We cluster standard errors at the firm level to account for correlation of the error within-firm over time. We additionally cluster standard errors at the 2-digit industry-by-month level to account for the correlation of errors within industries in a given month originating from differences in time-varying industry-specific conditions (Jeenas, 2023).

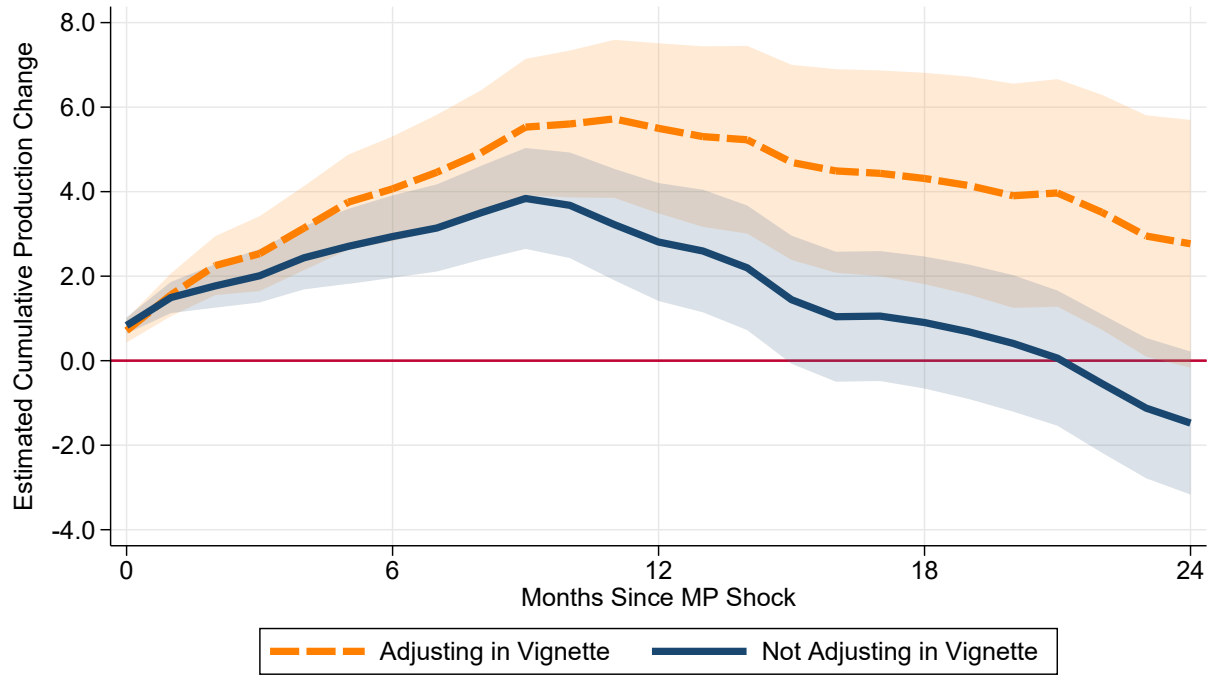
We estimate Specification (1) at monthly frequency for a maximum horizon (h) of 24 months. The estimation sample is restricted to firms that are observed over the whole horizon, ensuring that the impulse response function at each horizon is estimated based on the same sample. Since we are controlling for lags of the firm-level controls, as well as firm fixed effects, this implies that we only keep firms in the sample that are participating in the survey for a minimum of 52 months (2×26 contiguous months). This leaves us with a subsample of 438 manufacturing firms that also answered to our survey experiment. Like in all analyses, we only consider firms that have planned investments for 2024 and 2025. For some analyses, we do not need the firms' answers in the vignette experiment so that we can use the full available sample of manufacturing firms that fulfill our restriction on the observation horizon. This sample amounts to 4,383 firms.[19]

4.2.2 Response to monetary policy shock by interest rate sensitivity

In the following, we analyze differences in the average production response to monetary policy shocks by firms' revealed interest rate sensitivity in our survey experiment. Our vignette was designed to lower firms' cost of capital and reduce the external finance premium without changing anything else, thereby isolating the two direct channels of monetary policy on firms' investment, the interest rate channel and the amplifying credit channel. Now we consider monetary policy shocks that shift interest rates for the whole economy. There are three main differences from the vignette setting that can result in different relative responses of the two groups of firms. First, the direct effects on the firms' cost of capital differ. In the vignette, we only shift interest rates on loans, whereas monetary policy shifts the general interest rate environment. Equity or internally financed firms may be insensitive to the cost

[19]Figure A.10 in the appendix also shows that the average production response in the full manufacturing sample and the vignette sample are very similar.

Figure 7: Production Response to Monetary Policy Shock by Interest Sensitivity



Notes: Impulse response functions at monthly frequency of cumulative production to a 1 p.p. monetary policy shock estimated from equation (1). The sample is balanced over the horizons. Orange: firms adjusting investment in the vignettes. Blue: firms not adjusting investment in the vignettes. The sample is restricted to firms having planned investments for 2024 & 2025. Shaded areas represent the 90% confidence level. Standard errors are two-way clustered at the firm and the 2-digit-industry-by-month level.

of debt since incurring debt implies fixed costs, as argued in Section 3.4, but still respond to changes in the cost of equity or the opportunity cost of holding cash. Second, monetary policy also implies indirect effects on investment through aggregate demand and, ultimately, through general equilibrium effects on prices. Thus, an increase in aggregate demand can induce investment and production activity of otherwise interest rate-insensitive firms. Finally, we only have one observation on the firms' interest rate sensitivity from December 2023, while we now consider monetary policy shocks over the past 23 years. Although many of the determinants of firms' interest rate sensitivity that we identified in Sections 3.2 and 3.4 are rather slow-moving characteristics, such as size and financial structure, it could still be the case that firms, which are now at their optimal capital stock or have built up a large cash buffer, were more interest rate sensitive 20 years ago. Going forward, we keep these three differences between our vignette and actual monetary policy shocks in mind and discuss what our results imply for the relative importance of the direct lending rate channel isolated in the vignette.

We start by estimating Equation (1) with X_i reflecting firms that would *adjust* or *not adjust* their investment in response to the hypothetical change in the loan rate. In the vignette experiment, the first group adjusted its investment on average by 19% in response to a 1 p.p. change in the interest rate on loans, and the other group did not adjust its investment at all. Figure 7 shows the impulse response functions of cumulative production for both groups. While the response is indistinguishable in the first months after the shock, there is a growing gap between the production dynamics of the two groups. The interest rate-sensitive firms increase their production significantly more often in response to the shock. Their response reaches a peak after eleven months at which they have increased their production two times (or 50%) more often than the non-adjusters, which reach their production peak three months earlier. While production activity declines rapidly after the peak for the non-adjusters, it remains elevated for the adjusters. Even though we cannot estimate the investment response directly, these production dynamics are at least in line with stronger investment activity at the end of the adjusting firms, allowing them to increase production capacity and maintain a higher level of production.

It is important to keep in mind that interest rate sensitivity is not an exogenous firm characteristic. So, what other potential drivers might be behind the observed difference in the firms' responses to monetary policy? First, differing demand conditions for the two groups of firms following the monetary policy shock may explain the different production responses. To address this concern, we add month-by-2-digit industry fixed effects to Equation (1). Appendix Figure A.11 shows that the resulting differential effect (red-dashed line) barely deviates from the baseline (blue-solid line). Second, to account for potential differences in firms' business cycle sensitivity, we control for the interaction between an indicator for the adjusting group and the first lag of our macro controls, i.e., industrial production growth and inflation following Ottonello and Winberry (2020). Figure A.11 in the appendix shows that the estimated difference from this specification (orange-dotted line) lies slightly below the baseline at the more distant horizons but does not differ significantly. Second, firms' flexibility in price setting can play a role in their production response to monetary policy. Using an additional monthly question in the IBS that asks firms if they have increased, kept unchanged, or decreased their prices in the previous month, we find that interest rate-sensitive firms are also adjusting prices more frequently. To account for this difference between the two groups, we estimate Equation (1) only on the subsample of firms that are flexible in their price setting, namely, firms that have adjusted their prices in the two years before the monetary policy shock more often than the median firm.[20] At the two-year horizon, we find that the estimated

[20]We do not require firms to be observed over the entire two years prior to the shock. Instead, before taking the median price adjustments over the past two years in each month and splitting the sample accordingly, we

difference among the price-flexible firms (green-dashed line in Appendix-Figure A.11) is about 50% larger than our baseline effect, suggesting that, if anything, this margin dampens our effect size. Finally, as discussed above, our distinction by interest rate sensitivity is based on a snapshot of December 2023. The fact that we find this interest rate sensitivity to matter may be because we implicitly overweight the more recent monetary policy shocks, as discussed in the previous section. The brown-dashed line in Appendix Figure A.11 shows that the estimated difference is actually somewhat larger than the baseline when the shocks are equally weighted. This suggests that there is little variation in firms' interest rate sensitivity over time.

In summary, we find that firms' direct investment sensitivity to interest rates is of first-order importance for their production response to monetary policy. This suggests that the *direct* monetary policy effects on investment play a significant role in the transmission process, as also argued by Auclert et al. (2020). This also implies that the determinants of the direct interest rate sensitivity matter for the response to monetary policy. In the following section, we review the responses of different groups of firms in more detail. Note that our results do not necessarily imply that all investment response is due to direct effects as found by Cao et al. (2023), who control for sales in their estimation of the investment response to monetary policy to isolate the direct effect. At least in terms of production, we also find a significant response for interest rate-insensitive firms.

4.2.3 Response to monetary policy shocks by non-adjustment narratives

We can further decompose the production response of the non-adjusters shown in Figure 7 into the narratives for non-adjustment described in Section 3.2. For this, we estimate Equation (1) with X_i representing, besides the adjusting group, the three largest narrative groups, that is, firms arguing with i) sufficient internal funds, ii) a high return, and iii) a low return to capital.

Figure 8 presents the results. Panel (a) compares the impulse response function of adjusting firms to the firms rationalizing their non-adjustment with having sufficient internal funds. The production response is significantly smaller for this group of firms, which shows that these firms are the main driver of the difference between adjusting and non-adjusting firms found in the last section. At its peak, this group has increased its production only half as often as the adjusting group. The results on the second narrative, the "high return to capital" group, in Panel (b) are less pronounced, but still indicate a smaller production response on the side of the high-return firms. This is in line with interpreting this narrative

absorb month-fixed effects from the price adjustments to account for the fact that firms can be observed over different sub-periods of the two years.

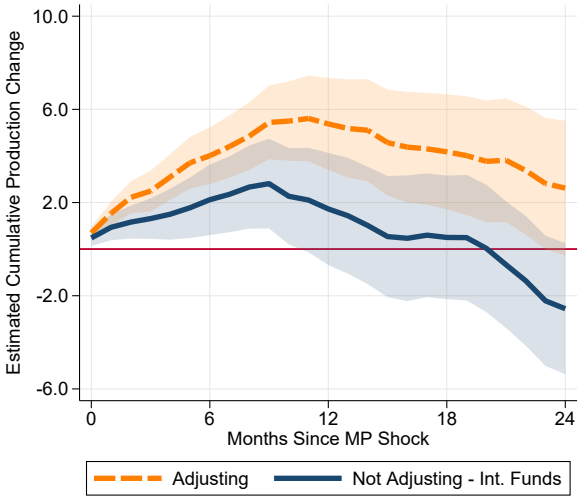
as being driven by time-invariant management practices rather than a particular state of the firm.

Finally, Panels (c) and (d) are both related to the "low return to capital" narrative. Panel (c) shows the impulse response for the narrative group compared to the adjusting group, showing that the production response is estimated to be very similar. On the one hand, this group may respond disproportionately strongly to the indirect effects, undoing the differences in interest rate sensitivity. However, given that these firms were found to operate in a less volatile environment, we would rather expect them to be less responsive to shocks. On the other hand, being close to the optimal capital stock is a time-varying state, so these firms may have been more interest rate sensitive in the past, resulting in the same average impulse response. To verify this reasoning, we use a proxy for the low-return narrative, for which we have a long panel dimension. In particular, we use the share of revenues that is attributable to products in the stagnation or shrinking phase as opposed to the innovation or growth phase. In Section 3.2 we show that this variable is strongly correlated with in the low return group. Panel (d) shows the impulse response functions for firms that, in the year prior to the shock, have a share of products in the stagnation and shrinking phase below the 25th percentile (orange) and above the 75th percentile (blue). We find that firms with a higher stagnation share increase their production less often in response to the monetary policy shock. This suggests that firms that *currently* expect a low return to additional investment because they have reached their optimal capital stock, are less responsive to monetary policy, but are in general not insensitive to changes in the interest rate.

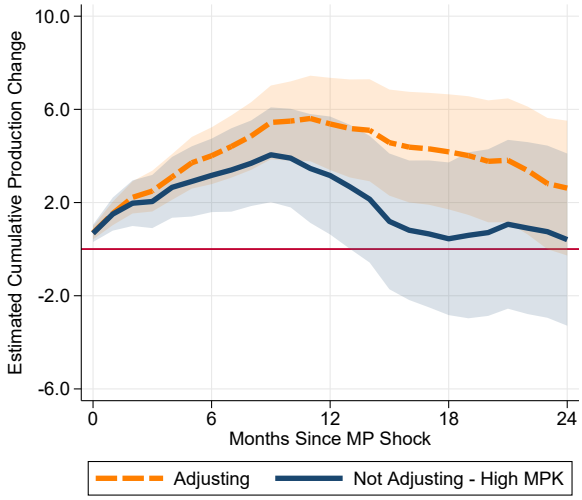
Overall, the results imply that all three narratives for not responding to changes in the interest rate are also relevant for the general equilibrium response to monetary policy. In particular, the most relevant narrative in our vignettes also results in the weakest response to monetary policy. This again underscores the relevance of the financial conditions of firms, such as their cash buffers, external financing needs, and financial constraints, for their responsiveness to monetary policy, which is reflected in the large number of contributions on this dimension of heterogeneity (Cloyne et al., 2023; Gertler and Gilchrist, 1994; Jeenas, 2023; Jungherr et al., 2022). In contrast to these papers, our results show that differences in the general equilibrium responses result from differences in the partial equilibrium interest rate sensitivity. In addition, there is a non-negligible share of firms that rationalizes its insensitivity to interest rates with non-financial reasons, in particular a lack of profitable investment opportunities and returns to investment above the cost of capital. Given the important role of investment in the overall monetary transmission identified by Auclert et al. (2020), the state of these determinants may also be of first-order importance for the effectiveness of monetary policy.

Figure 8: Production Response to Monetary Policy – By Non-Adjustment Narratives

(a) Sufficient Internal Funds

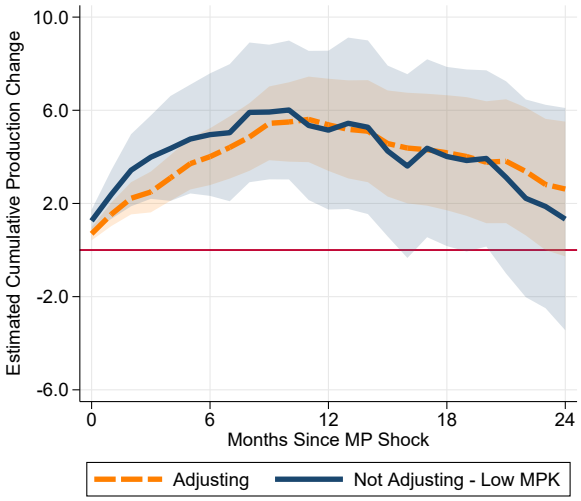


(b) High Return to Capital

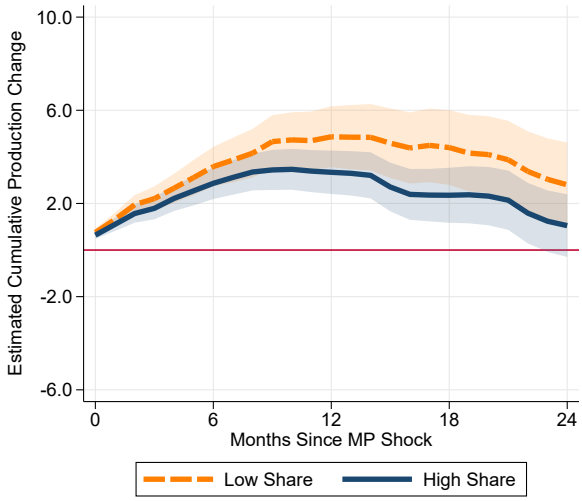


Low Return to Capital

(c) Narrative



(d) Time-varying Stagnation Share



Notes: Impulse response functions of cumulative production from estimating Equation (1). Panel (a): firms adjusting investment in the vignettes (orange) vs. firms not adjusting and arguing with "sufficient internal funds" (blue). Panel (b): firms adjusting investment in the vignettes (orange) vs. firms not adjusting and arguing with "high return to capital" (blue). Panel (c): firms adjusting investment in the vignettes (orange) vs. firms not adjusting and arguing with "low return to capital" (blue). Panel (d): firms with below p25 (orange) and above p75 share of stagnating and shrinking products in the year prior to the shock. The sample is restricted to firms that have planned investment for 2024 and 2025 in Panels (a)–(c) . Shaded areas represent the corresponding 90% confidence band. Standard errors are two-way clustered at the firm and 2-digit industry-by-month level.

5 Conclusion

Using a novel survey methodology that incorporates hypothetical vignettes, we analyze firms' investment sensitivity to interest rates, enabling us to causally identify how firms adjust their investments in response to varying lending rates. Based on an extensive survey of German firms, we find that a one percentage point decrease in the lending rate leads to a 7 percent increase in investment over the subsequent two years. This average response is influenced by a considerable proportion of non-adjusting firms—primarily due to high cash reserves and a lack of investment opportunities—and by a significant intensive margin among those firms that do adjust. Employing direct survey measures, we observe particularly strong effects among financially constrained firms and those facing labor shortages. Finally, we establish the primary importance of the interest rate channel effect via the external finance premium on aggregate investment dynamics within a partial equilibrium framework.

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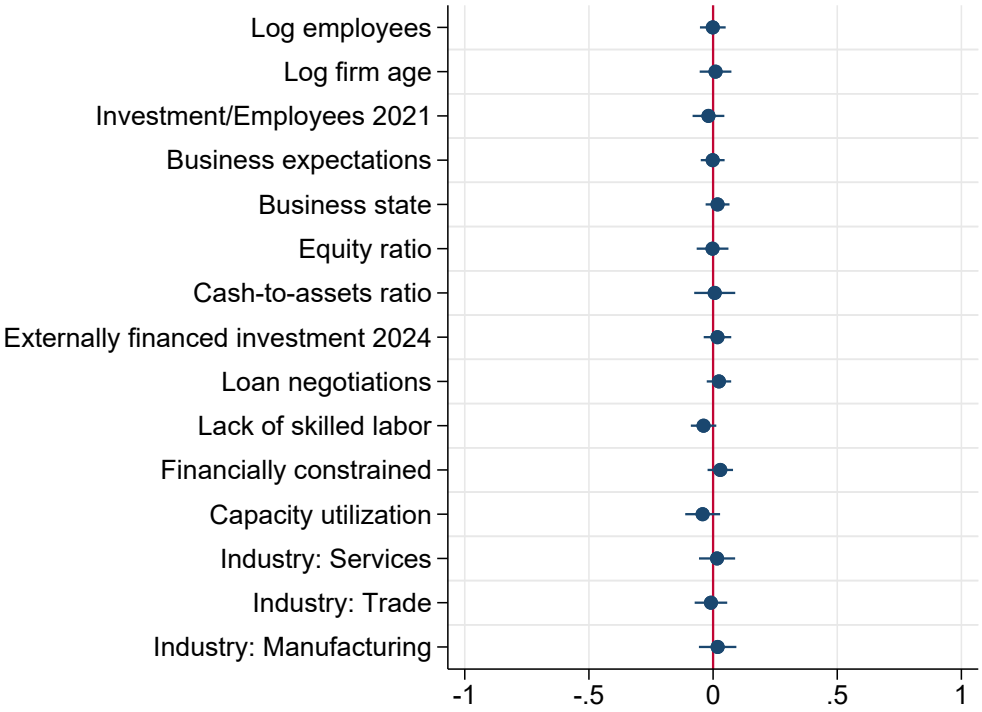
A Additional tables and figures

Table A.1: Sample Distribution by Industry and Size Compared to Population of German Firms

	ifo Business Survey				Distribution of German Firms by		
	Small	Medium	Large	Total	Count	Employees	Value Added
Industry	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Manufacturing	12.76	15.87	8.39	37.02	8.13	26.53	32.65
Energy, Water, & Waste	0.74	0.00	0.00	0.74	2.87	2.25	4.68
Construction	7.48	5.11	0.88	13.47	14.98	8.70	7.30
Retail, Wholesale, & Repair of Motor Vehicles	20.24	6.06	1.32	27.61	21.18	21.19	19.89
Transportation & Storage	3.25	0.00	0.00	3.25	3.96	7.62	6.39
Accommodation & Food Services	2.78	0.00	0.00	2.78	8.78	6.67	2.01
Information & Communication	3.49	0.00	0.00	3.49	5.08	5.14	7.05
Real Estate Activities	0.91	0.00	0.00	0.91	7.88	2.23	4.01
Professional, Scientific, & Technical Activities	7.85	0.00	0.00	7.85	18.56	8.79	9.25
Administrative & Support Services	2.84	0.03	0.00	2.88	8.58	10.88	6.77
Total	62.34	27.07	10.59	100.00	100.00	100.00	100.00
Distribution of German Firms by							
Count	96.79	2.57	0.64	100.00			
Employees	39.50	16.49	44.01	100.00			
Gross Value Added	27.83	15.43	56.74	100.00			

Notes: This table compares the distribution of firms in our sample to administrative data based on the 2021 Statistics on Small and Medium-sized Enterprises ("Statistik für kleine und mittlere Unternehmen") provided by the Federal Statistical Office (EVAS Code 48121). The firm size categories are: small: 0-49 employees; medium: 50-249 employees; large: 250+ employees.

Figure A.1: Random Group Assignment



Notes: OLS regression results from univariate regressions of the interest rate reduction in the vignette 0.5–4 p.p. (0.5, 1.0, 3.0, or 4.0) on firm characteristics. All variables are standardized. The sample is restricted to firms that have planned investments in 2024 and 2025. Bars represent the 95%-confidence band. Base category for industry is "Construction". See Appendix C for the wording of the corresponding survey questions.

Table A.2: Average Investment Adjustment in 2024 & 2025

	Mean	Std. Dev.	P10	P25	Median	P75	P90	N
Overall Adjustment								
0.5 p.p.	7	15	0	0	0	10	20	425
1 p.p.	7	14	0	0	0	10	23	422
3 p.p.	13	21	0	0	0	20	40	405
4 p.p.	14	21	0	0	0	20	50	424
Total	10	18	0	0	0	15	30	1676
Intensive Margin Adjustment								
0.5 p.p.	21	19	5	10	15	25	50	139
1 p.p.	19	18	5	8	15	25	50	150
3 p.p.	26	23	7	10	20	30	50	196
4 p.p.	28	23	5	10	20	38	50	208
Total	24	22	5	10	20	30	50	693
Extensive Margin Adjustment								
0.5 p.p.	33	47	–	–	–	–	–	425
1 p.p.	36	48	–	–	–	–	–	422
3 p.p.	48	50	–	–	–	–	–	405
4 p.p.	49	50	–	–	–	–	–	424
Total	41	49	–	–	–	–	–	1676

Notes: Distribution of merged investment adjustments in 2024 and 2025. Overall adjustment: Average adjustment in 2024 and 2025. Intensive Margin Adjustment: Average adjustment if the average adjustment is larger than zero. Extensive Margin Adjustment: Equal to 0 if firms do not adjust investment in either of the two years, and 1 if firms adjust in at least one year.

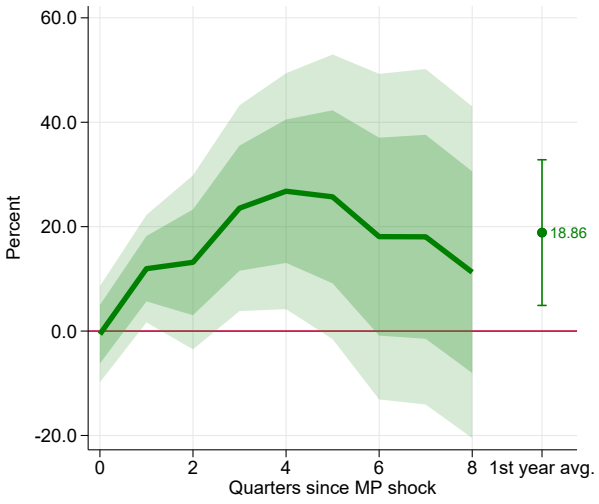
Table A.3: Investment Adjustment and Investment Plans

	Extensive Margin				Intensive Margin	
	2024	2025	2024	2025	2024	2025
Did not plan investments for 2024	-22.365***					
	(1.591)					
Did not plan investments for 2025		-22.262***				
		(1.778)				
Planned investments 2024 but not 2025			3.213		3.245	
			(3.259)		(2.557)	
Planned investments 2025 but not 2024				29.904***		1.615
				(3.265)		(2.055)
Business state: good	-5.600**	-11.993***	-3.343	-9.326***	-2.734	-1.895
	(2.310)	(2.477)	(3.261)	(3.255)	(2.515)	(2.340)
Business state: medium	-1.706	-4.773**	1.943	-2.431	-1.342	-1.793
	(1.964)	(2.145)	(2.955)	(2.893)	(2.191)	(1.918)
Constant	19.847***	-71.608***	39.175***	45.129***	25.607***	27.318***
	(1.700)	(1.933)	(2.571)	(2.535)	(1.916)	(1.690)
Observations	3147	2897	1922	1891	763	850

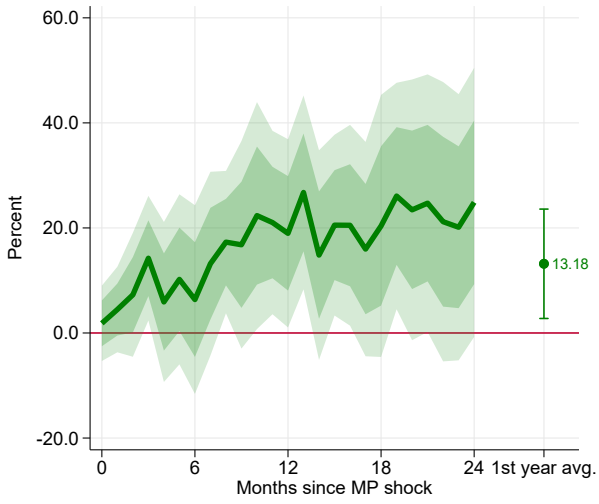
Notes: OLS regression results. "Extensive Margin": 0 for firms not adjusting investment in the vignettes and 100 for adjusting firms. "Intensive Margin": The sample is restricted to firms that adjust investment in response to the vignette. The investment adjustment in % is winsorized at 100%. Columns one and two: Unrestricted sample. Columns 3–5: Compare firms that have planned investments in only one year to firms that have planned investments for both, 2024 and 2025. All explaining variables are dummies. Base category for the business state is "bad". Robust standard errors in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.2: General-Equilibrium Response of Aggregate Investment to Monetary Policy

(a) Corporate Investment

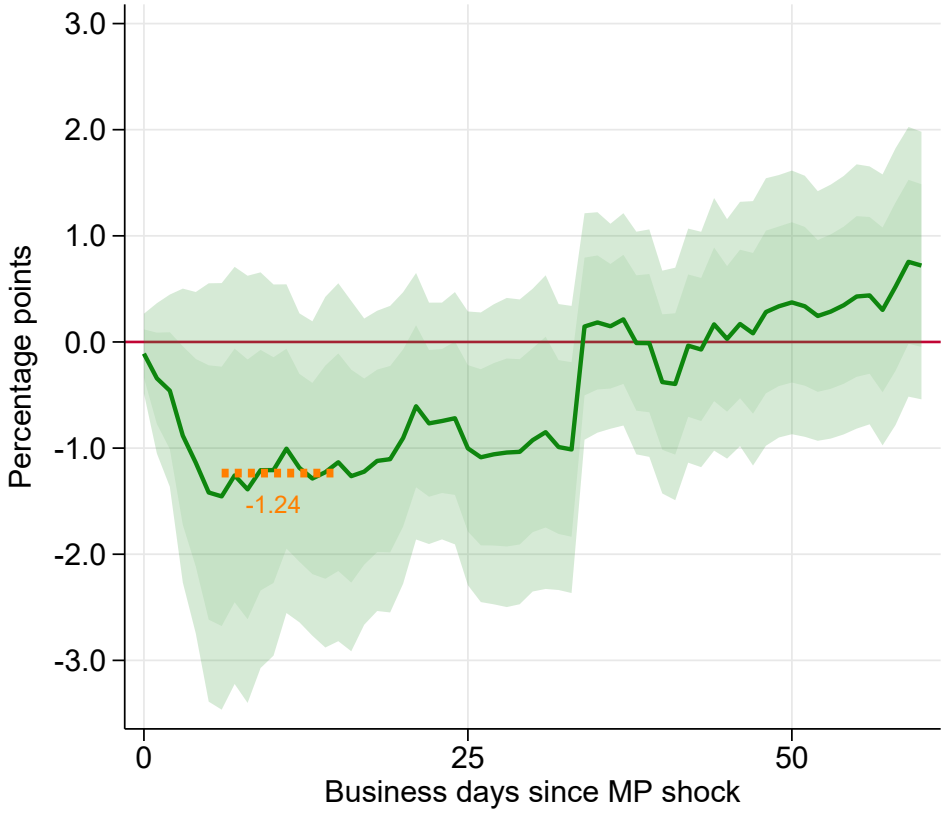


(b) Capital Goods Production



Notes: Impulse response functions to a 1 p.p. expansionary monetary policy shock. Estimated using a local projection in the following form: $log(y_{t+h}) - log(y_{t-1}) = \alpha^h + \beta_h \varepsilon_t^{MP} + \Omega_h' Z_{t-1} + \sum_{j=1}^{6} \Gamma_h^j Y_{t-j} + \upsilon_{i,t+h}$. Where y is aggregate corporate investment at quarterly frequency (Panel a) or aggregate capital goods production at monthly frequency (Panel b), Z_{t-1} is the monthly average of the firm-level controls and Y includes lags of the dependent variable, the inflation rate, and year-on-year industrial production growth (only Panel a). Dark and light shaded areas represent the 90% and 68% confidence levels, based on Newey-West standard errors using lag length $h + 1$.

Figure A.3: Monetary Policy Shock and Real Corporate Bond Yields



Notes: Impulse response function of daily real corporate bond yields following a 1 p.p. expansionary monetary policy shock, estimated using a local projection in the following form: $r_{t+h} - r_{t-1} = \alpha^h + \beta_h \varepsilon_t^{MP} + \Omega_h' Z_{m-1} + \sum_{j=1}^{6} \Gamma_h^j Y_{m-j} + \upsilon_{i,t+h}$. Where r is the real corporate bond yield at daily frequency. Z_{m-1} is the monthly average of the firm-level controls and Y includes the macro controls from Equation (1) at monthly frequency. Dark and light shaded areas represent the 90% and 68% confidence levels, based on Newey-West standard errors using lag length $h+1$. The orange-dashed line is the average effect over weeks 2–3, i.e. business days 6–15 after the shock.

Table A.4: Investment Responses to Monetary Policy Shocks in the Literature

Reference	Dependent variable	Original estimate	Transformed estimate	Notes
Ottonello and Winberry (2020) Footnote 5	$\log(k_{t+h})-\log(k_{t-1})$	–	20%	Transformed the estimate themselves assuming $\frac{I}{K} = \delta = 0.1$. Based on the estimate for the first quarter after the shock.
González et al. (2024) Footnote 35	$\log(k_{t+h})-\log(k_{t-1})$	–	19%	Transformed the estimate themselves assuming $\frac{I}{K} = \delta = 0.1$.
Cao et al. (2023) Figure 3, Panel (b)	$\frac{k_{t+h}-k_{t-1}}{k_{t-1}}$	∼1.3%	∼13%	Transformed assuming $\frac{I}{K} = \delta = 0.1$. The effect is further increasing until ∼3% in year 4.
Jungherr et al. (2022) Appendix Figure B.1	$\log(k_{t+h})-\log(k_{t-1})$	∼0.9%	∼30%	The effect is in response to a 1 sd monetary policy shock. As noted on page 7, a 1 sd shock translates into a 30 bp change in the Fed Funds Rate. Thus the estimate is multiplied by ten thirds first, before transforming it assuming $\frac{I}{K} = \delta = 0.1$.
Durante et al. (2022) Appendix Figure, Panel (a)	$\log(I_{t+h})-\log(I_{t-1})$	∼0.25%	∼25%	The effect is in response to a 1 basis point shock and thus multiplied by 100.

Notes: Comparison of estimates for the effect of identified monetary policy shocks on the capital stock or investment rate. Because the capital stock in periods before $t = 0$ is orthogonal to the shock, the estimates in rows 1–4 give the percentage change in the capital stock. The original estimate is the estimate for the one-year horizon. The transformed estimate is a transformation of the original estimate as described in the Notes and represents a percentage change in investment. "∼" indicates the estimates are taken from figures and are therefore imprecise.

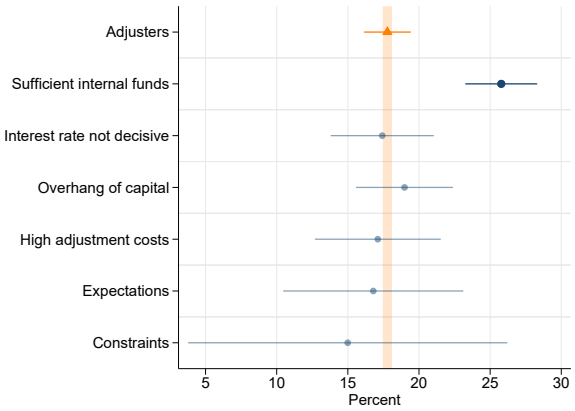
Table A.5: Codebook

Category	Explanation	Translated examples
Sufficient internal funds		
no financing needs	No need for external funds, enough internal funds to finance investment.	"We have sufficient funds to finance investments from liquidity." "sufficient own liquidity" "Liquidity available, loans are not necessary", "no financing needed"
always internally financed	Financing investment only internally.	"Cash payer" "Because I don't want to take out a loan for investments." "Internally financed 100%" "We only spent earned money"
High return to capital – Interest rate not decisive		
interest rate not decisive	Interest rate is not a decisive criterion in investment decisions.	"Interest costs do not play a role in our investment decisions, as the returns are sufficiently high." "Interest rates do not play a decisive role in investment decisions" "We invest when it is necessary"
Low return to capital – Overhang of capital		
no opportunities	No additional investment opportunities beyond plans.	"The planned investments should be amortized in any case, regardless of a 4% reduction in interest rates. However, higher investments than planned would probably not result in significantly higher returns despite the more favorable interest rate." "No need" "Because additional investments are not necessary"
necessary	Focus on necessary/replacement investment.	"since only planned replacements/rationaliztations" "Only absolutely necessary investments are made" "Due to the tense economic situation, we would still only invest what is absolutely necessary."
High adjustment costs		
adjustment costs	Fixed investment plan, long-term plan.	"Planning already completed" "Building permits not possible on short notice" "Long-term orders, fixed roadmap" "There is budget planning over several years"
non linear	Not reacting because lending rate change is too small.	"the impact of 1% is too low" "Too little adjustment of the interest rate level" "1% less interest too little incentive"
Expectations		
demand	Investment depends on demand situation.	"no demand" "Depending on the development of orders" "First observe the overall economic development" "The planned investments are mainly replacement investments; with the current order intake and order backlog, no further capacity investments are necessary."
uncertainty	Uncertain economic environment hinders additional investment.	"Lack of investment certainty" "Overall situation too uncertain" "political uncertainties"
Constraints		
constraints	Labor, financial or capacity constraints hinder additional investment.	"No personnel resources for further projects/investments in 2024." "We are already working to capacity with the planned necessary investments." "Reduction of liabilities has priority" "Fixed debt limits defined"
Other		
other	Giving a reason that does not match the other groups.	"Corporate group target" "other reasons"

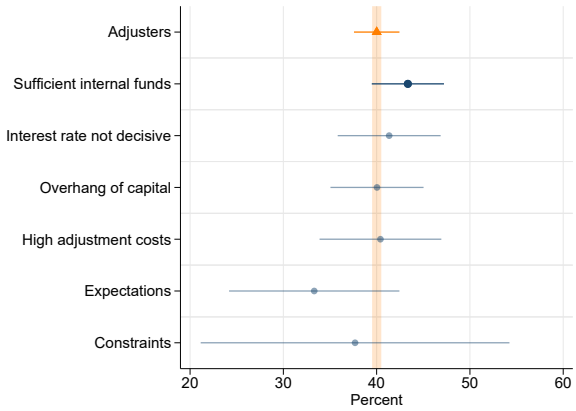
Notes: Codebook and example responses for hand-coding the open-ended text questions.

Figure A.4: Additional firm characteristics by reasons for not adjusting investment

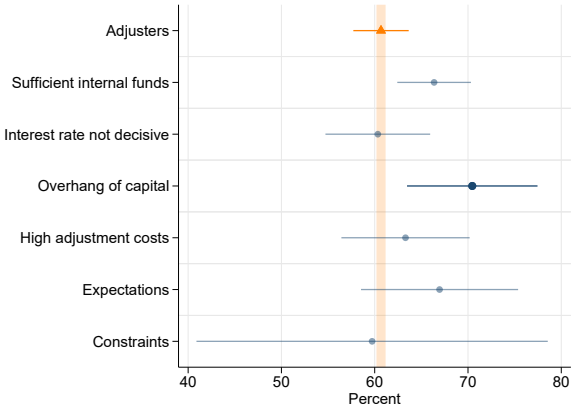
(a) Average cash to total assets 2021-2023



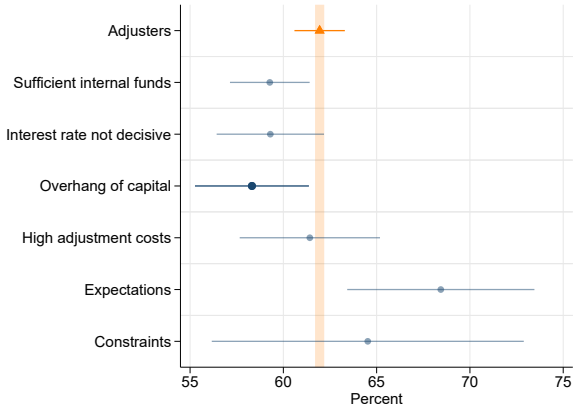
(b) Average equity ratio 2021-2023



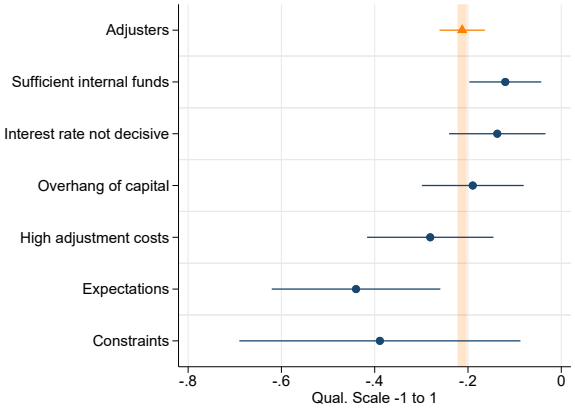
(c) Average share of stagnating products



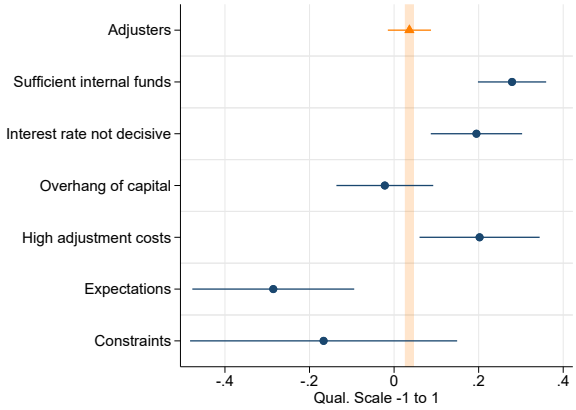
(d) Average uncertainty 2021-2023



(e) Business expectations



(f) Business state



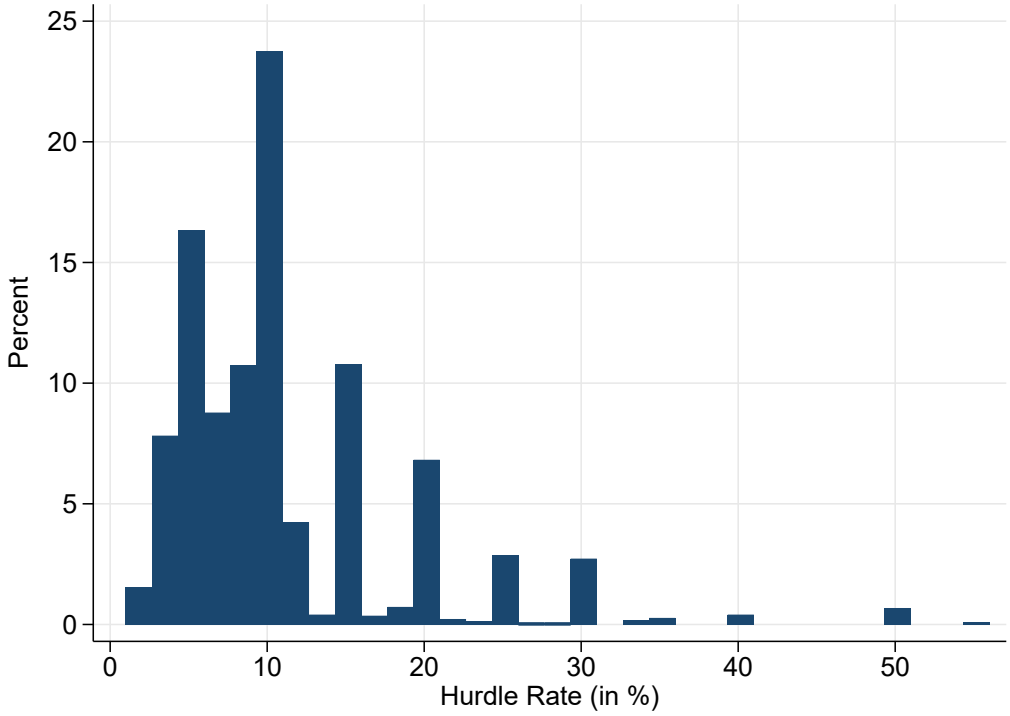
Notes: This figure shows average values of different firm characteristics for the classified non-adjustment narratives. The average values for the group that adjusts investment plans in the vignette is shown in orange. Panel (a): average cash-to-asset ratio in 2021–23 from the Orbis database. Panel (b): average equity ratio in 2021–23 from the Orbis database. Panel (c): sample average of the revenue share of stagnating and shrinking products. Panel (d): average uncertainty 01/2021 – 12/2023. Averages are calculated after absorbing month fixed effects to account for non-balancedness of the panel. Panel (e): business expectations (−1/0/1) in 12/2023. Panel (f) business state (−1/0/1) in 12/2023. minus long-run firm-average. See Appendix C for wording of the survey questions. Bars represent 95% confidence intervals.

Table A.6: Reasons for not adjusting investment by year

	2024		2025		Difference	
	N	%	N	%	p.p.	SE
Sufficient internal funds						
no financing needs	219	28	215	29	-1.07	0.45
always internally financed	57	7	58	8	-0.28	1.39
High return to capital – Interest rate not decisive						
interest rate not decisive	153	19	147	20	-0.32	0.41
Low return to capital – At the optimal capital stock						
no opportunities	102	13	99	13	-0.35	0.48
necessary	41	5	38	5	0.10	0.29
High adjustment costs						
non linear	28	4	27	4	-0.07	0.29
adjustment costs	72	9	56	8	1.35	1.48
Expectations						
demand	37	5	30	4	0.00	1.07
uncertainty	21	3	22	3	-0.29	0.39
Constraints						
constraints	20	3	17	2	0.26	0.29
Other						
other	37	5	35	5	0.67	1.07
Total	787	100	744	100	–	–

Notes: Distribution of the answers to the open-ended question across the hand-coded categories. Column 1–2: Reasons for non-adjustment in 2024. Column 5–6: Reasons for non-adjustment in 2025. Column 7-8: Difference between share of answers in each category for 2024 and 2025 with corresponding standard errors.

Figure A.5: Distribution Hurdle Rates



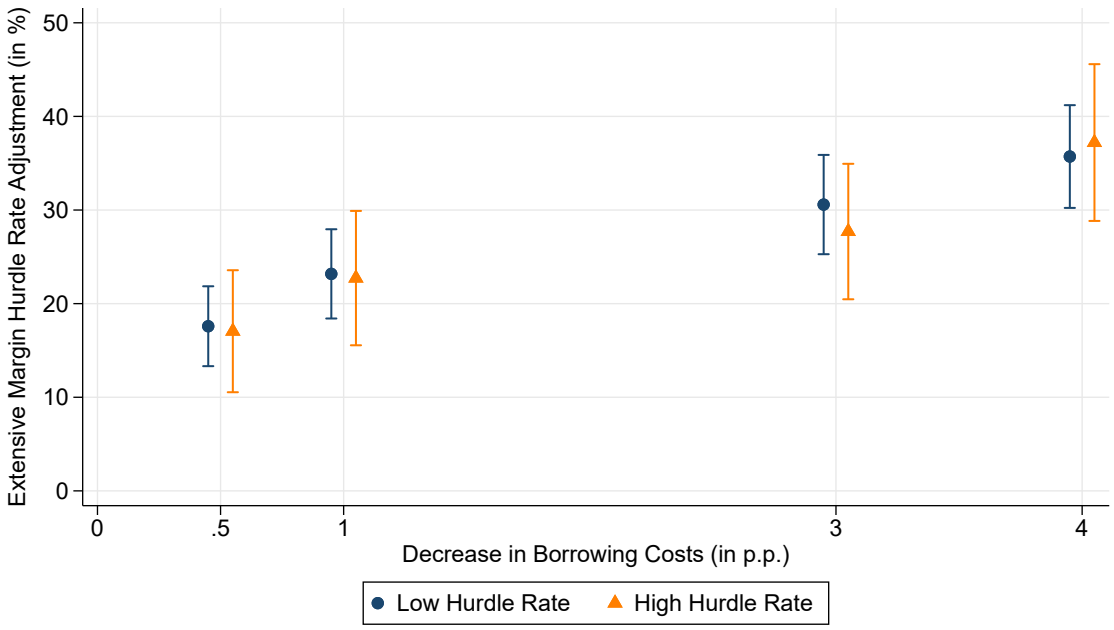
Notes: Distribution of hurdle rates elicited in 01/2024, trimmed at the 1%-level.

Table A.7: What explains not knowing and not adjusting HR?

	Don't know HR	Adjusting Inv. but not HR	
	(1)	(2)	(3)
Family-owned firm	-0.029	-0.052	-0.034
	(0.046)	(0.102)	(0.091)
Answered by CEO or owner	-0.151***	0.041	0.030
	(0.047)	(0.081)	(0.095)
Log employees	-0.019	-0.023	-0.008
	(0.014)	(0.029)	(0.033)
Respondents' education: at least college	-0.107***	0.104	0.069
	(0.033)	(0.095)	(0.137)
Share of externally financed investment 2024	-0.001***	0.001	0.002*
	(0.000)	(0.001)	(0.001)
Investment/Employees 2021	-0.003**	-0.003	-0.002
	(0.001)	(0.002)	(0.003)
Extensive margin investment adjustment real world			0.207***
			(0.073)
Constant	0.940***	0.381*	0.312
	(0.067)	(0.215)	(0.258)
Observations	1169	202	173
R^2	0.038	0.056	0.113
2-digit industry FE	✓	✓	✓

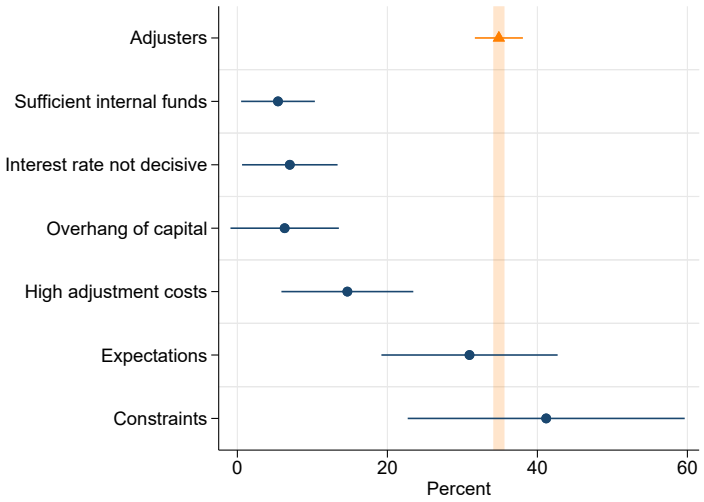
Notes: OLS regression results. Column 1: dependent variable is a dummy for not knowing the hurdle rate. Columns 2–3: dependent variable is a dummy for not adjusting the hurdle rate conditional on adjusting investment. Robust standard errors in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.6: Semi Elasticity – Extensive Margin by Hurdle Rate Level



Notes: Share of firms adjusting their hurdle rate in the vignette for firms with hurdle rate level $\leq$ p50 (blue dot) and firms with hurdle rate level $>$ p50 (orange triangle). The sample is restricted to firms knowing their hurdle rate and firms with a hurdle rate within p1/p99.

Figure A.7: Real-World Investment Adjustment by Narratives



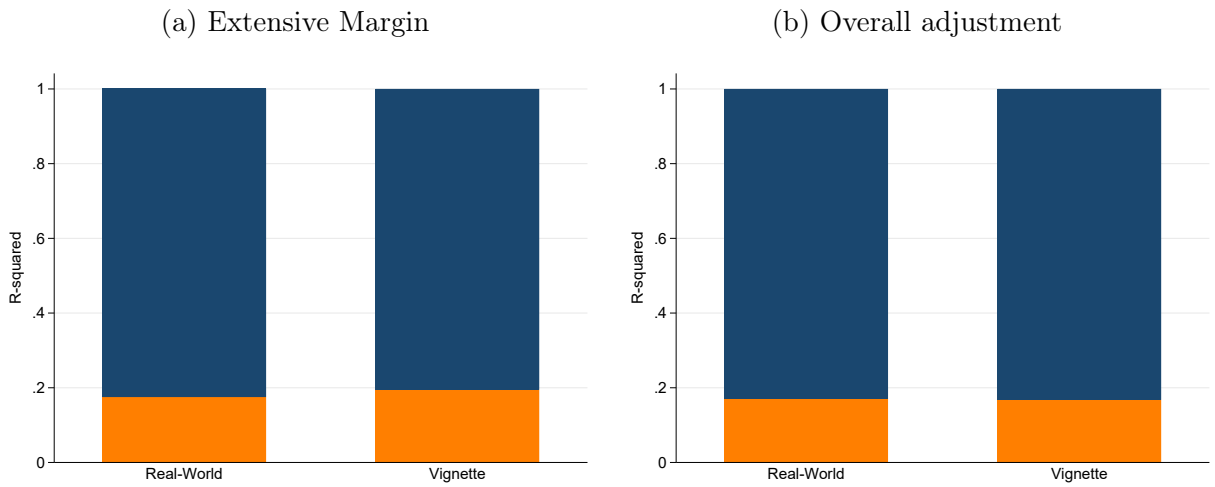
Notes: Share of firms adjusting investment in response to the 2022-23 interest rate hikes by the classified non-adjustment narratives. The share for the group that adjust investment plans in the vignette is shown in orange. Bars represent 95% confidence intervals.

Table A.8: Explaining Differences Between Vignette and Real-World Investment Adjustment

	$\mathbb{1}[\Delta I_i^{real\ world} = 0 \mid \Delta I_i^{vignette} > 0]$					
	(1)	(2)	(3)	(4)	(5)	(6)
Business state 12/2023: good	0.181***			0.182**		
	(0.066)			(0.071)		
Business state 12/2023: medium	0.116***			0.144***		
	(0.042)			(0.043)		
Loan negotiations past 3 months		-0.154**			-0.165**	
		(0.060)			(0.063)	
Loan negotiations past 3 months × Bank acted restrictive		0.064			0.065	
		(0.076)			(0.077)	
Financially constrained 10/2023			-0.165*			-0.205**
			(0.096)			(0.093)
Avg. business state past 2 years	0.150**	0.244***	0.246***	0.123	0.214***	0.200***
	(0.069)	(0.057)	(0.056)	(0.084)	(0.067)	(0.071)
Log employees	0.026**	0.025**	0.023*	0.048	0.057*	0.055*
	(0.012)	(0.012)	(0.014)	(0.030)	(0.029)	(0.031)
Constant	0.344***	0.490***	0.476***	0.232	0.351***	0.333**
	(0.066)	(0.054)	(0.067)	(0.139)	(0.126)	(0.131)
Observations	480	462	438	467	449	427
R^2	0.059	0.073	0.072	0.144	0.152	0.157
2-digit Sector FE	–	–	–	✓	✓	✓

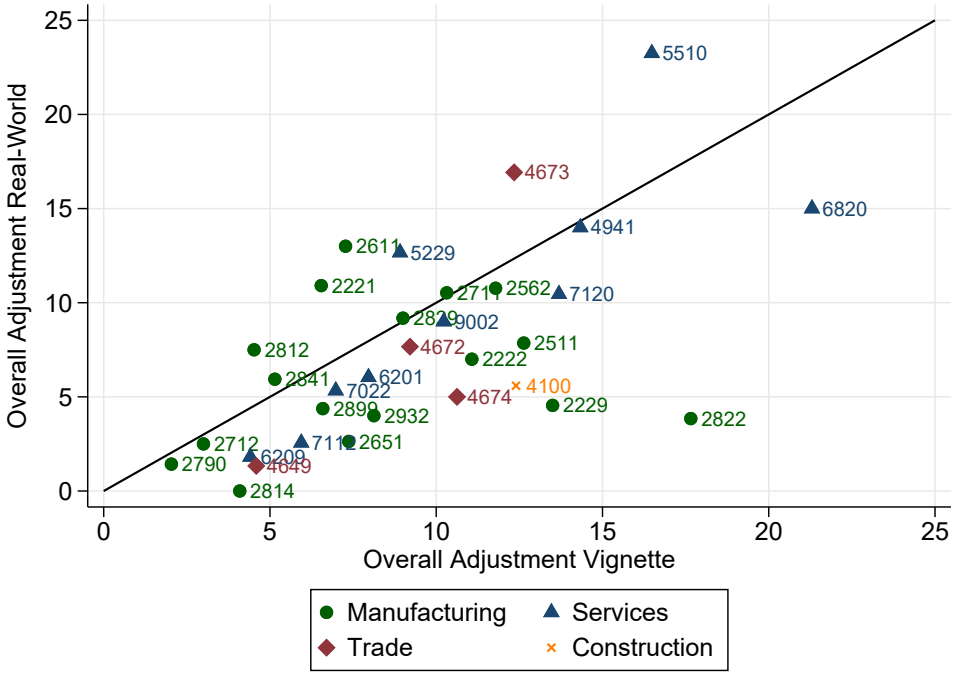
Notes: OLS regression results. The dependent variable is 1 for firms that adjusted investment in the vignettes but not in response to the increasing interest rates in the real world and 0 for firms that adjusted investment in both cases. The sample is restricted to firms that have planned investments in 2024 and 2025. Base category for the business state is "bad". Standard errors clustered at the 2-digit industry level in parentheses. Level of significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.8: Variation in Extensive Margin Explained by 4-Digit Industry FE



Notes: The figure shows in orange the R-squared from a regression of the extensive margin investment adjustment (Panel a) and the overall adjustment (Panel b) on 4 digit-industry fixed effects, each for the adjustment in the vignette and the real world. The sample is restricted to firms that have planned to invest in 2024 and 2025.

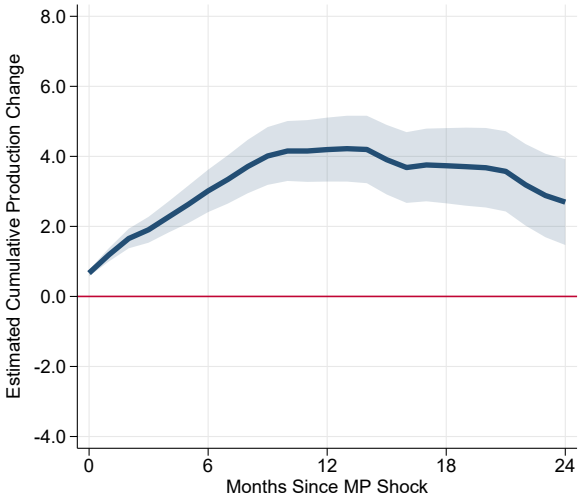
Figure A.9: Investment Adjustment in real-world and vignette: industry level



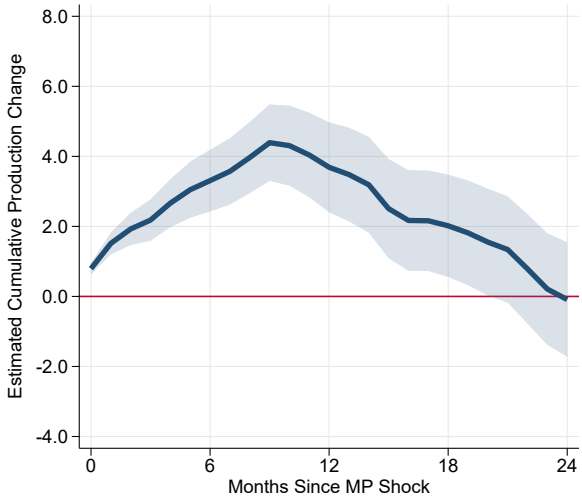
Scatterplot of the investment adjustment in the real-world and investment adjustment in the hypothetical vignette at the four-digit industry level. 45-degree line in black. Investment adjustment is winsorized at 100%. The sample is restricted to firms that planned to invest in 2024 and 2025, displaying only industries with more than 15 observations.

Figure A.10: Average Production Response to a Monetary Policy Shock

(a) Full Manufacturing Sample

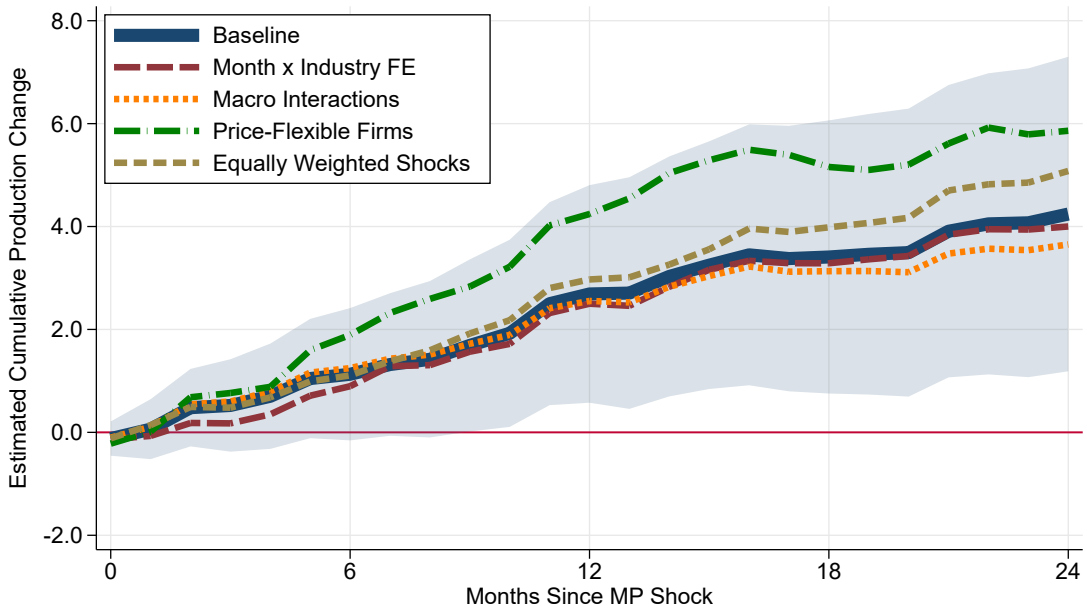


(b) Vignette Sample



Notes: Impulse response functions at monthly frequency of cumulative production to a 1 p.p. monetary policy shock. The sample is balanced over the horizons. Panel (a): all manufacturing firms. Panel (b): only firms answering the vignette question and having planned investments for 2024 & 2025. Shaded areas represent the 90% confidence level. Standard errors are two-way clustered at the firm and the 2-digit-industry-by-month level.

Figure A.11: Differential Production Effect of Monetary Policy for Adjusting Firms



Notes: Differential effect of a 1 p.p. expansionary monetary policy shock on cumulative production for firms adjusting investment in the vignettes. Baseline: estimated using Equation 1 and adding a non-interacted monetary policy shock ε_t^{MP}. The shaded area represents the corresponding 90% confidence band. Standard errors are two-way clustered at the firm and 2-digit industry-by-month level. "Month x Industry FE" adds the respective fixed effects to Equation (1). "Macro interactions" adds interactions between an indicator for adjusting investment in the vignettes and the first lag of Y_t. "Price-flexible firms": sample is restricted to firms that adjusted prices more often than the median firm in the two years prior to the shock. "Equally weighted shocks": reweighting shocks in the regression such that each shock enters with the same weight. The sample is always restricted to firms that have planned investment for 2024 and 2025.

B Transformation to user cost elasticity

This appendix illustrates how our interest rate semi-elasticity of investment translates into an investment elasticity with respect to the (user) cost of capital.

The user cost of capital according to Hall and Jorgenson (1967) is given by:

$$c = q(r + \delta)\frac{1 - \tau * z}{1 - \tau} \ , \tag{2}$$

where q is the price of the capital good relative to the output price, r is the real interest rate, δ is the discount factor, τ is the corporate tax rate, and z is the present discounted value of the depreciation deduction. The user cost of capital represents the shadow price for a marginal unit of capital.

We make the following assumptions: $\tau = 0.3$, $\delta = 0.1$, and there is straight-line depreciation over a period T of 10 years such that for z follows:

$$z = \sum_{t=1}^{T} \frac{1}{(1+i)^t} * \frac{1}{T} \ . \tag{3}$$

Each of these assumptions is based on information from the CBT Tax Database for equipment in Germany in 2017. i, the nominal discount rate is set to 7% following Link et al. (2023a). The SPF forecast in 2023Q4 for the 5-year inflation rate was 2.1%, so we set the real interest rate $r = 0.05$. Furthermore, we set $q = 1$.

As we shift the interest rate on loans, the loan rate should be the relevant interest rate for deciding on investing in a marginal unit of capital. Since the loan interest rate is tax deductible, we rewrite the user cost in the following way:

$$c = q(i_b(1 - \tau) - \pi^e + \delta)\frac{1 - \tau * z}{1 - \tau} \ , \tag{4}$$

where i_b is the tax-deductible nominal loan interest rate, and π^e is the 5-year expected inflation rate, which we set to 2.1% according to the SPF forecast in 2023Q4. We assume that firms' nominal discount rate used to calculate z remains unchanged by the vignette, because it is unclear how the discount rate changes with the change in the loan rate. Allowing the discount rate to change does not significantly impact the result. Using the cost of capital formulation in Equation (4) and calculating the percentage change in c for a 1 p.p. change in i_b from 5% to 4% we get: $\frac{\partial log(c)}{\partial i_b}\Big|_{i_b=0.05} = 0.053$. Thus, our semi-elasticity of 7% translates into an elasticity of investment with respect to the user cost of 1.3, which aligns with the estimate of Curtis et al. (2021), even though the precise number is of course sensitive to the assumptions made.

C Survey questions

Standard Questions of the ifo Business Survey (translated to English)

Business state:

Current situation: We evaluate our current business situation as [1] good, [0] satisfactory, or [-1] bad.

Business expectations:

Expectations for the next six months: We expect our business state, in economic terms, to [1] improve, [0] stay the same, or [-1] deteriorate.

Uncertainty:

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)] ___ %

Production activity:

Trends in [last month]: Compared to [two months ago] our production activity has [1] increased, [0] remained the same, or [-1] decreased.

Production expectations:

Expectations for the next three months: We expect our production activity to [1] increase, [0] remain the same, or [-1] decrease.

Demand situation:

Trends in [last month]: Compared to [two months ago] our demand situation has [1] improved, [0] remained the same, or [-1] deteriorated.

Price adjustments:

Trends in [last month]: Compared to [two months ago] our prices–taking into account changes in conditions–[1] increased, [0] remained the same, or [-1] decreased.

Loan negotiations [quarterly frequency]:

We have conducted loan negotiations with banks in the past 3 months: ☐ yes ☐ no
If yes, the banks behaved: ☐ accommodating ☐ normal ☐ restrictive

Capacity utilization [quarterly frequency]:

The utilization of our machines (full utilization = 100%) is currently: ___ % [tick box from 30% to 100% in 5/10 p.p. steps, or enter value manually if larger than 100%]

Business constraints [quarterly frequency]:

Our [production/business] activities are currently being constrained: ☐ yes ☐ no
If yes, they are being constrained by the following factors:
☐ Lack of skilled labor
☐ Financing constraints
☐ ...

Externally financed investment [annual frequency, November]:

To what extent will you finance your investments in [the following year] externally?

R&D activity [annual frequency, December]:

Did you carry out R&D activities in [the last year]? ☐ yes ☐ no

Product stages [annual frequency, November]:

[This year] our products–measured in terms of their total turnover–were in the following phases (estimates are sufficient):
___ % Market entry (innovation)
___ % Growth
___ % Stagnation
___ % Shrinking

Investment focus [annual frequency, November]:

Our investment activity (this year) is focused on:
☐ Capacity increases
☐ Rationalization (efficiency increases)
☐ Replacements
☐ Others

Planned investment focus [annual frequency, November]:

Our investment activity (next year) is focused on:
☐ Capacity increases
☐ Rationalization (efficiency increases)
☐ Replacements
☐ Others

Determinants of investment [annual frequency, November]:

Decisive factors for our investment activity (next year):
☐ No investment

☐ Demand
☐ Financial conditions
☐ Technological factors
☐ Taxes/subsidies
☐ Other factors

Revenues [annual frequency, March]:

What was your total revenues [two years ago]: ___ thousands/million/billion

Investment [annual frequency, March]:

What was your total investment [two years ago]: ___ thousands/million/billion

Firm age [one-off question, September 2018]:

In which year was your business founded?

Family business [one-off question, February 2014/2023]:

Do you consider yourself a family business? (Meaning the majority of the voting capital is held by one or more families who are related to each other): ☐ yes ☐ no

Respondents' education [one-off question, February 2020]:

What is the highest degree you have obtained?
☐ Secondary school diploma
☐ High school diploma
☐ Completed vocational training
☐ Bachelor degree or Bachelor Professional
☐ Master degree or diploma
☐ Doctoral degree
☐ Other

Equity ratio [one-off question, September 2020]:

What was your company's equity ratio at the end of 2019? ___ %

Cash-to-total assets [one-off question, September 2020]:

What was your company's "cash and cash equivalents" as a percentage of total assets in March 2020? ___ %

Risk preference [one-off question, March 2022]:

In general, are you willing to take risks or do avoid risk? You can answer on a scale of 0 to 10 (0 = not at all willing to take risks, 10 = very willing to take risks).

Energy intensity [one-off question, April 2022]:

What share of your revenues did you approximately spend on energy costs in 2021 (energy intensity)? ___ %

Patience [one-off question, August 2022]:

How do you assess your willingness to give up something today in order to gain a greater advantage in the future? (Answer scale from 0 to 10)

Respondents' position [one-off question, May 2023]:

Which term best describes the position of the person who usually answers the survey?
☐ Owner
☐ CEO/ board member/ authorized signatory
☐ Department head
☐ Team head
☐ Clerk
☐ Other

Additional questions in December 2023 (translated to English)

Investment adjustment in real world:

Have you reduced planned investments in the last 1.5 years due to the rise in interest rates and tighter credit conditions?
Total investments:
☐ no, no investments planned ☐ no, not reduced ☐ yes, reduced by ___ %

Investment in energy efficiency and usage of renewable energies:
☐ no, no investments planned ☐ no, not reduced ☐ yes, reduced by ___ %

Investment in research and development:
☐ no, no investments planned ☐ no, not reduced ☐ yes, reduced by ___ %

Investment plans:

Have you planned investments for the years 2024 and 2025?
2024: ☐ yes ☐ no 2025: ☐ yes ☐ no

Vignette:

For the following questions, please imagine that the **financing conditions improve** for you and your competitors. For the next 2 years, **loan interest rates** for all maturities are **[0.5/1/3/4] p.p. lower** than currently expected. Assume that nothing else changes in terms of credit conditions, firm-specific or macroeconomic conditions.

If investments were planned in 2024/2025:

To what extent would you adjust the amount of the planned total investments for 2024 and 2025 as a result (in %)? (A rough estimate is sufficient) 2024:___ / 2025:___

If investments were not planned:

In this case, would you plan investments for [2024/2025]? ☐ yes ☐ no ☐ I don't know

If answering "no" or "0%" in previous question:

Why would you not adjust the amount of the planned total investments for 2025 despite lower interest rates? ___ [open text field]

Additional questions in January 2024 (translated to English)

Hurdle rate:

What is your current minimum required return for an investment (hurdle rate)? ___ %

☐ don't know

Vignette:

For the following questions, please imagine that the **financing conditions improve** for you and your competitors. For the next 2 years, **loan interest rates** for all maturities are **[0.5/1/3/4] p.p. lower** than currently expected. Assume that nothing else changes in terms of credit conditions, firm-specific or macroeconomic conditions.

In this case, would you adjust your hurdle rate? ☐ yes ☐ no ☐ I don't know

Comment: ___ [open text field]