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Subjective Uncertainty, Expectations, and Firm Behavior*

Abstract

Based on a new survey question in a large and representative panel of German firms, this paper introduces a novel measure of managers' subjective uncertainty. I compare this measure of business uncertainty to respondents' business expectations and document a strong negative relationship. However, the link is much weaker in bad times, since uncertainty is then persistently high – even when expectations are favorable. I continue by investigating the relative importance of uncertainty and expectations for corporate decisions. Exploiting information on firms' investment and labor reactions to the COVID-19 crisis, I do not find evidence that uncertainty induced "wait and see" behavior. However, a deterioration in managers' expectations and in their assessment of their firms' business situation predicts investment deferral and a reduction in employment.

JEL Code: C83, D22, D84, E32, E71
Keywords: Subjective uncertainty, expectations, firms, survey data, corporate decisions, business cycles

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1 Introduction

How does uncertainty affect business cycle fluctuations? The literature describes various theoretical channels through which uncertainty affects the behavior of households and firms. For instance, an increase in perceived uncertainty may impact individuals' forward-looking decisions about consumption, investment, and hiring.[1] On the other hand, changes in (mean) expectations are also likely to affect these decisions.[2] Since surveys have only recently started to measure the perceived uncertainty of households and firms, we still know little about the empirical relationship of uncertainty and expectations and their relative importance for household and firm behavior.

Focusing on firms, this paper introduces a new measure of managers' subjective uncertainty and relates it to their expectations and corporate decisions. All analyses are based on panel data from the ifo Business Survey, which is representative of the German economy and currently comprises roughly 9,000 respondents each month. To measure firms' subjective uncertainty, I use the results from a novel monthly survey question that asks top managers directly how uncertain they are about the future development of their business. Additional survey questions elicit managers' expectations about their own firms' business development and their assessment of their firms' current business situation.[3] Furthermore, a one-time special survey question in April 2020 provides information on firms' investment and employment responses to the COVID-19 crisis. The sample covers the three-year period from July 2017 to July 2020.

In addition to presenting new data on firms' subjective uncertainty, my contribution is twofold. First, both at the micro level and for the aggregate, I develop stylized facts about the relationship between managers' perceived uncertainty and their business expectations. By adding firms' assessment of their own current business situation as a third dimension to the analysis, I go on to characterize how subjective uncertainty typically changes with fluctuations in expectations and economic activity. Second, using the responses to a special survey question in April 2020 about corporate reactions to the COVID-19 crisis, I empirically examine the theoretical "real options" channel of uncertainty. In particular, I exploit the between-firm heterogeneity in uncertainty and expectations during this aggregate increase in uncertainty and simultaneous deterioration in expectations. It allows me to study whether firms that became more uncertain at this time were more likely to engage in "wait and see" behavior concerning their investment and employment decisions.

Using data at the firm level, my first result is that managers' perceived uncertainty is negatively related to business expectations and to their assessment of their firms' current business situation. Hence, the more pessimistic a respondent or the worse her assessment of the business situation, the more uncertain she is. This holds true both for the pooled sample and within firms.

Moreover, I find that the relationship between uncertainty and expectations is weaker in bad times. The reason is that perceived uncertainty is generally high when managers assess the current situation of their business as bad, regardless of their expectations.

[1] Bloom (2014) and Cascaldi-Garcia et al. (2020) provide an overview of theoretical mechanisms that link uncertainty to household and firm behavior.

[2] Besides a large body of theoretical literature, empirical evidence is provided, for instance, by Souleles (2004) for the impact of household expectations on consumption and by Gennaioli et al. (2016) for the effect of managers' expectations on investment.

[3] The responses to these two questions serve as input for constructing the ifo Business Climate Index, a highly-regarded business cycle indicator for the German economy.

It is perhaps particularly interesting that uncertainty in bad times is high also when expectations are favorable.

These results provide new insights about the relation between uncertainty and expectations for different activity levels of a firm over a stylized business cycle. In a good or normal situation, the average firm's uncertainty increases when expectations deteriorate. With a cyclical drop, uncertainty increases and remains at a high level during a phase of low economic activity. Uncertainty only decreases once the business situation improves. This stylized pattern derived from micro data is also visible in the aggregate. Average subjective uncertainty is strongly inversely correlated with average expectations in good times. Moreover, in line with the micro evidence, the relationship between aggregate uncertainty and expectations is weaker when many firms view their business situation as bad. In this case, aggregate uncertainty is generally elevated.

Business cycle models that incorporate endogenous feedback effects between uncertainty and growth, such as the ones proposed by Van Nieuwerburgh and Veldkamp (2006) and Fajgelbaum et al. (2017), can account for the empirically observed persistence of firms' uncertainty in bad times. Their key assumption is that the information available to firms differs between phases of high and low economic activity. This can serve as one explanation for the empirical pattern of perceived uncertainty in relation to expectations and the firms' business situation in my sample. If activity is weak, managers lack information about future production and are thus uncertain. In contrast, knowledge about future sales in good times, for instance, due to full order books, provides comparably rich information about future output and thus imply lower uncertainty. A second explanation rests on the asymmetry of growth rates over the business cycle (Berger et al., 2020). Since managers can expect the average negative shock to be larger than the average positive shock, uncertainty increases when expectations turn unfavorable. An exception occurs in a situation in which activity is far below normal. Positive shocks can then also be large, which helps rationalize the empirical finding of high uncertainty in bad times when expectations are favorable.

Regarding my second contribution, the question of the relative importance of changes in uncertainty and expectations for corporate decisions, I focus on the onset of the COVID-19 crisis. Based on a special survey question added to the ifo Business Survey in April 2020, I empirically examine the theoretical "real options" channel. The idea of this channel is that high uncertainty can make it rational for firms to delay (partially) irreversible investments and to "freeze" hiring. Decision makers "wait and see" until more information is available (Bernanke, 1983; Brennan and Schwartz, 1985; McDonald and Siegel, 1986). In the aggregate downturn in March 2020, uncertainty among German businesses increased sharply, while expectations plummeted. In addition to a "wait and see" effect on firm decisions induced by uncertainty, a drop in expectations may let firms defer investments and reduce employment.

To better understand the importance of uncertainty and expectations for firm behavior, I exploit the heterogeneity of these perceptions between firms during the COVID-19 shock, in combination with information on firm actions. I find that firms' decisions to postpone investment projects and to reduce their workforce are related to changes in their expectations and their perceived business situation, but not to changes in their uncertainty. Hence, I do not find evidence for "wait and see" behavior as predicted by the theoretical mechanism of "real options".

When analyzing the effect of uncertainty on outcomes, this analysis showcases two advantages of using micro data. First, it provides the opportunity to directly test theoretical

channels that work via the decision-making behavior of individuals. Second, in combination with aggregate fluctuations, differences in the cross section of perceived uncertainty can be exploited. In these ways, examining micro data can complement aggregate time series analyses, which are the source of most of the existing evidence to date.[4]

This paper contributes to several strands of the empirical literature about uncertainty, firms, and business cycles. First, it is part of the literature concerned with the measurement and analysis of perceived business uncertainty. Over the last decade, a handful of surveys have started to elicit the subjective uncertainty of businesses with respect to their own future development. For German manufacturing firms, Bachmann et al. (2020) present a quantitative measure of perceived uncertainty about quarterly sales growth rates.[5] For the US, Altig et al. (2020b) elicit quantitative one-year ahead expectations and uncertainty regarding a firm's growth of sales, investment, and employment.[6] Both studies relate uncertainty to past growth and forecast errors at the micro level. I extend this growing strand of literature in three ways. First, I present a new direct and holistic measure of managers' perceived uncertainty. Second, I focus on the relationship between uncertainty and expectations. Third, by considering the business situation, I add a new dimension to the analysis: the relative position of a firm in its cycle.

Due to the absence of survey-based measures of subjective uncertainty, almost all time-series studies in the literature on uncertainty shocks rely on proxy measures.[7] For a recent comprehensive overview, see Cascaldi-Garcia et al. (2020). A common finding from these time-series measures is that they are counter-cyclical. This paper differs from the literature on proxy measures by presenting aggregate time series of managers' subjective uncertainty about their firms' business development—jointly with their expectations and an assessment of their business situation.

This paper also contributes to the small survey-based micro-econometric literature that links the subjective uncertainty of economic decision makers to outcomes. The first contribution concerning firms stems from Guiso and Parigi (1999) who measure the uncertainty of managers about future sales growth. Based on a cross section of Italian firms, they find that businesses with similar expectations about sales growth, but higher

[4] Ludvigson et al. (2021) argues that the endogeneity of uncertainty and growth challenges identification schemes in vector-autoregressive frameworks, but also other time-series methods that attempt to causally link fluctuations of uncertainty to outcomes. The strong inverse co-movement of uncertainty with expectations and business activity in my data, especially in an economic downturn, supports this assessment.

[5] They measure subjective uncertainty as the difference between sales growth expectations in the best and in the worst case. Data comes from a quarterly supplement to the ifo Business Survey for Germany.

[6] Respondents are asked for five scenarios from best to worst of the outcome variable. Subsequently, the survey elicits probabilities for these scenarios. Uncertainty is then calculated as a measure of variance of these probability distributions. Similarly, Bloom et al. (2020) describe quantitative questions on sales growth uncertainty in the Management and Organizational Practices Survey administered by the Census in 2015. For the UK, the Decision Maker Panel also includes questions that follow this methodology (Bloom et al., 2018a).

[7] Popular approaches include indices of implied or realized volatility of stock market returns (Bloom, 2009; Barrero et al., 2017), the cross-sectional dispersion of firm-level outcomes, expectations, or forecast errors (Bachmann and Bayer, 2013, 2014; Bloom et al., 2018b; Bachmann et al., 2013), the conditional volatility of statistical forecast errors from macro time series (Jurado et al., 2015), counts of uncertainty-related keywords in news publications (Baker et al., 2016), and time devoted to uncertainty-related topics in quarterly earnings conference calls (Hassan et al., 2019).

uncertainty, invest less.[8] In a similar spirit, Dibiasi et al. (2018) study the investment response of a small share of firms that were exposed to an uncertainty-inducing referendum in Switzerland. Their result is that uncertain firms with a high degree of irreversibility lower investment. My analysis during the COVID-19 shock extends previous work due to the focus on corporate decisions on investment and employment and since I exploit the variation of uncertainty in an aggregate downturn.

Furthermore, this paper is part of the growing literature on uncertainty and expectations during the COVID-19 crisis. For the US and the UK, Altig et al. (2020a) and Baker et al. (2020) document large increases in both proxy measures of uncertainty and subjective business uncertainty. Using proxy measures, Baker et al. (2020) estimate that half of the aggregate drop in output can be related to second moment effects. Based on data of the ifo Business Survey, Buchheim et al. (2020a) highlight the relationship of corporate mitigation strategies in response to the COVID-19 shock with pre-existing business conditions and with expectations about the duration of the crisis. My analysis differs in that I focus on individual changes of uncertainty and expectations that constitute the aggregate variation at the onset of the COVID-19 recession.

My analysis of firms' "wait and see" behavior is also reminiscent of the literature that studies the impact of uncertainty shocks on the aggregate economy using real business cycle models. As a prominent example, Bloom et al. (2018b) generate drops of 2.5% of GDP with a model that uses nonconvex adjustment costs and the variance of firms' productivity shocks as a measure of risk. Bachmann and Bayer (2013) specifically study the impact of uncertainty on business cycle fluctuations through the "real options" channel. In line with the results from my analysis using data from the onset of the COVID-19 crisis, they find rather small effects.

The paper is structured as follows. Section 2 introduces the data, it explains the survey questions that elicit managers' perceptions, and it compares two measures of subjective uncertainty. Section 3 analyzes the relationship between subjective uncertainty, business expectations, and managers' assessment of their firms' business situation at the micro level. Section 4 presents aggregate time series of these variables. Section 5 analyses the theoretical "real options" mechanism at the onset of the COVID-19 crisis by relating uncertainty and expectations to corporate decisions about investment and employment.

2 Data

This paper is based on data from the monthly ifo Business Survey, which currently comprises roughly 9,000 German respondents. The survey is conducted by the Munich-based ifo Institute. Data in processible form is available since the German unification in 1990 (since 1980 for West Germany). The sample of firms is maintained to be representative of the German economy. To deal with attrition, ifo adds new respondents to the survey (see Sauer and Wohlrabe 2020). The survey covers firms in manufacturing (IBS-IND, 2020), construction (IBS-CON, 2020), retail and wholesale trade (IBS-TRA, 2020), and services (IBS-SERV, 2020). Its data on firms' business expectations and firms' assessment of their business situation forms the basis of the ifo Business Climate Index, a leading indicator of the German business cycle. As a widely respected measure of business senti-

[8] Bontempi et al. 2010 examine the same relationship for a panel of Italian firms from 1996 to 2004 and show that the relationship between uncertainty and investment varies over time and can become insignificant, which they attribute to changes in the competitive landscape.

ment, it attracts considerable attention from the general public, practitioners, and policy makers. Moreover, ifo Institute is responsible for collecting data according to a set of EU-harmonized business survey questions. It feeds into the EU-wide business sentiment index composed by the European Commission.[9]

A business participating in the survey can be a stand-alone firm or a division of a large conglomerate. The position of the personnel within the firms who fill out the questionnaire is high: Sauer and Wohlrabe (2019) find that more than 90% of the respondents are top-level managers, such as CEOs, CFOs, or department heads. Furthermore, the results from a meta survey from fall 2019 suggest that the respondents within a firm rarely change. Altogether, this ensures very high quality data.

The sample for all analyses starts with the introduction of the direct question for firms' subjective uncertainty in the online part of the survey in July 2017 and ranges until July 2020. I use data from all major sectors, namely, manufacturing, construction, retail and wholesale trade, and services.[10] The main analyses are based on the subsample of firms that respond to the online part of the survey, as opposed to paper-based participation. In the sample period, roughly two thirds of all survey participants respond online. This is equivalent to about 4,500 firms each month.[11] For the analysis that relates uncertainty and expectations to firm actions, I exploit a one-time special survey question from April 2020 that asks firms for measures that they have taken in response to the COVID-19 pandemic. Answer options include the postponement of investment projects and a reduction in the number of employees.

2.1 Survey Questions

This section explains the measurement of managers' perceptions using questions in the ifo Business Survey. As the central element for all further analyses, it introduces a novel direct survey question on managers' subjective business uncertainty. Moreover, it outlines questions on business expectations and the firms' cyclical business situation, as well as an additional uncertainty question.

In 2005, the ifo Institute introduced a new question design to capture firms' assessment of their current business situation and their expectations for the business development in the subsequent six months. Specifically, survey respondents of the online questionnaires are asked to provide their answer by clicking on a visual analogue scale with underlying

[9] Aggregate survey results for Germany are presented at www.ifo.de/w/3fvxPxj2P, the harmonized European results, including the European Economic Sentiment Indicator, can be found here: https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/business-and-consumer-surveys_en.

[10] I follow the data cleaning and harmonization procedure described in Link (2020). This involves the assignment of industry codes of the WZ08 classification to all observations and in some cases the aggregation of responses of subsidiaries to the entity level of firms. This leads to a sample of roughly 7,000 firms. The German WZ08 classification, short for "Klassifikation der Wirtschaftszweige 2008" is closely related to the European industry classification system NACE Rev. 2.

[11] Table 3 in Appendix A shows that there are almost no differences between the answers of online participants compared to those who participated paper-based. There is only one notable difference: online participants are more frequently representing large firms (250 or more employees), and somewhat less frequently small firms (less than 50 employees). However, there is no significant difference in the variables capturing the respondents' the assessment of the current business situation and business expectations, which form the core of the analysis in the subsequent sections.

values that range from 0 to 100.[12] In 2017, ifo started to elicit respondents' subjective business uncertainty using the same technology. Visual analogue scales are essentially continuous versions of the well-known Likert scales. As such, they are qualitative in nature, and are used, for instance, in medical research to assess feelings and pain intensity (Jensen et al., 2003). Visual analogue scales are easy to understand and, in contrast to trichotomous questions, allow for a differentiated assessment of a respondent's beliefs.

Figure 6 in Appendix A shows a screenshot of the original questions regarding the perceived business situation, expectations, and uncertainty from ifo's online questionnaire in the manufacturing survey. Translated into English, the questions are as follows:

1. We assess our current state of business as

   Respondents can click on a visual analogue scale that is labeled "bad" and "good" at its ends, respectively, and "satisfactory" at the center.

2. In the next 6 months, our state of business is likely to

   Respondents can click on a visual analogue scale that is labeled "become rather more unfavorable" and "become rather more favorable" at its ends, respectively, and "roughly stay the same" at the center.

3. We assess the uncertainty w.r.t. our business development in the next 6 months as:

   Respondents can click on a visual analogue scale that is labeled "low" and "high" at its ends, respectively, and "average" at the center.

In addition to eliciting firms' perceived business situation and expectations using visual analogue scales, ifo has continued to apply its more traditional trichotomous questions for these variables. In their English translation, they read: 1) We assess our current state of business as (a) good (b) satisfactory (c) bad, and 2) Our state of business is likely to (a) become more favourable (b) stay more or less unchanged (c) become less favorable. Question 1) appears in the section with headline "Current situation" and question 2) in the section with headline "Expectations for the next 6 months". I will occasionally use these responses in the subsequent analyses when categorization is helpful.[13]

In April 2019, ifo implemented a second question regarding uncertainty, following a proposal from the EU Commission's unit for "Economic Situation, Forecasts, Business and Consumer Surveys".[14] This question is part of the survey's section titled "Expectations for the next 6 months". It is asked both online and using paper questionnaires. Translated into English, the question reads:

4. The future development of our business situation is currently

   □ easy to predict

[12] See Stangl (2009) for details on the design and a comparison to the traditional trichotomous questions.

[13] The responses to the visual analogue scale questions seem to measure essentially the same as the trichotomous questions: the two unweighted aggregate monthly time series for the business situation and expectations from 2005 to 2020, respectively, are highly correlated with correlation coefficients of 99% and 86%.

[14] This question is going to become part of the set of EU-harmonized business survey questions in 2021. It is based on a similar question included in the business survey of the Austrian Institute of Economic Research, which has been asked in different versions since the 1980s (Glocker and Hölzl, 2019).

- ☐ rather easy to predict
- ☐ rather difficult to predict
- ☐ difficult to predict

The responses to questions 3 and 4 yield two separate measures of subjective uncertainty. Let *unc* denote the uncertainty measure based on the responses to question 3 and *diff_pred* be the variable that captures the responses to question 4.

In both uncertainty questions, respondents are asked about their business development. This broad expression can be understood as an umbrella term for all relevant firm-specific variables that affect the future path of the business. A meta survey conducted in the fall of 2019 sheds light on the variables that the respondents of the ifo Business Survey consider most important for their assessment of the business situation and expectations. The six most important factors are profits, turnover, demand, the stock of orders, costs, and liquidity (see Figure 7 in Appendix B).

Thus, *unc* and *diff_pred* are comprehensive uncertainty measures. They capture a wide range of aspects in managers' information set. This differentiates them from measures that focus on the uncertainty concerning the development of one particular firm variable, such as sales or employment, as in the surveys presented by Altig et al. (2020b) and Bachmann et al. (2020).

2.2 Summary statistics

How are the responses to questions 1, 2, 3, and 4 in Section 2.1 distributed over their respective domains? Tables 4 and 5 in Appendix B presents summary statistics of the variables capturing firms' assessment of their business situation, business expectations, and business uncertainty.

Most importantly, the responses to the first three questions in Section 2.1, given between July 2017 and July 2020, cover the entire range of the visual analogue scales between 0 and 100, respectively. As one would expect from scales reflecting cyclical variations, means and medians of the three variables lie at or somewhat above 50. The variables for the business situation and uncertainty are somewhat skewed to the right, with inter-quartile ranges of 42 to 72, and 44 to 70, respectively.

Regarding the uncertainty measure *diff_pred*, which is available from April 2019 to July 2020, 53% of the firm-time responses fall in the category "rather difficult to predict" and 19% in the category "difficult" to predict. Less than 1% choose the category "easy to predict". This suggests that managers permanently face a certain degree of uncertainty.

2.3 Comparing Two Measures of Subjective Uncertainty

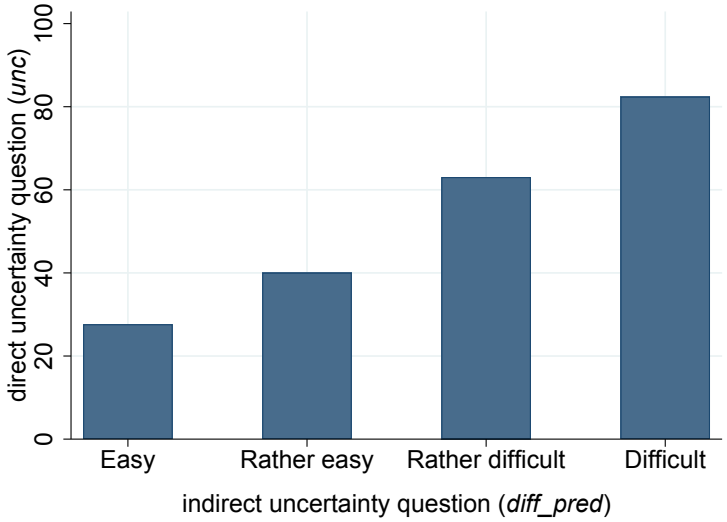
How do managers' understand the term "uncertainty" when directly asked about it? To shed light on this, this section compares the two survey-based uncertainty measures *unc* and *diff_pred* from question 3 and 4 in Section 2.1 conceptually and empirically.

I note similarities and differences in the underlying questions. Both *unc* and *diff_pred* have essentially the same object and the same time horizon of uncertainty: the "business development" and the "development of the business situation" over the subsequent six months. The main difference between *unc* and *diff_pred*, in addition to the mode of delivery, is the way they ask for uncertainty. Question 3 asks respondents *directly* how uncertain they are, while question 4 asks *indirectly* by inquiring about the degree of

difficulty that respondents perceive in predicting the future business development. The responses to the indirect question 4 may either reflect uncertainty as risk, that is, a second moment, or as Knightian uncertainty.[15] In the direct question, it may be less clear a priori what respondents think when they are asked for their "uncertainty". Thus, by comparing *unc* and *diff_pred*, I analyze the influence that the type of question has on the responses, and whether managers in firms have a good understanding of the term "uncertainty".

Figure 1 presents the mean values of the responses from the direct uncertainty question 3 in Section 2.1 (*unc*), for each of the categories of the indirect uncertainty question 4 (*diff_pred*). The bar chart is based on the subsample covering the period from April 2019 to July 2020, for which both variables are available.

Figure 1: Comparison of two measures of subjective uncertainty



Notes: The height of the bars illustrate the mean values of subjective uncertainty (*unc*), the responses to the direct uncertainty question 3 in Section 2.1, for each of the categorical answer options of the indirect uncertainty question 4 (*diff_pred*) in Section 2.1. The figure is based on 73,413 firm-time observations.

The main result is that the two variables are almost perfectly aligned. For the categories "rather easy to predict", "rather difficult to predict", and "difficult to predict", which combine more than 99% of the responses, advancement by one category in the perceived difficulty of predicting the future development of the firms' business situation corresponds to a mean of *unc* that is roughly 20 points higher on the visual analogue scale. In other words, the more difficult respondents perceive the prediction of the future development of their business situation, the more uncertain they report to be. Figure 8 in Appendix B presents a box plot instead of the bar chart and demonstrates that this finding is robust to using medians instead of means. Moreover, Figure 9 in Appendix B shows that unweighted averages of the responses to the two uncertainty questions co-vary almost perfectly in the time series from April 2019 to July 2020 for which both measures are available.

The result that the information contained in *unc* and *diff_pred* is very similar suggests that respondents have a good understanding of the term "uncertainty"—in the sense of

[15]The categorization of uncertainty in risk and Knightian uncertainty dates back to Knight (1921). In today's understanding, risk refers to a situation in which individuals can assign probabilities to a set of future events, while this is not possible in the case of Knightian uncertainty.

"difficult to predict"—when they are directly asked for it. Hence, a direct question for managers' uncertainty seems to be an easy and sensible way to elicit firms' subjective beliefs. The remainder of the paper focuses on the direct uncertainty measure *unc*. It is available for a longer period of time than *diff_pred*, and it has the advantage of being a near-continuous variable. However, I replicate most results using *diff_pred* for robustness.

3 Subjective Uncertainty at the Micro Level

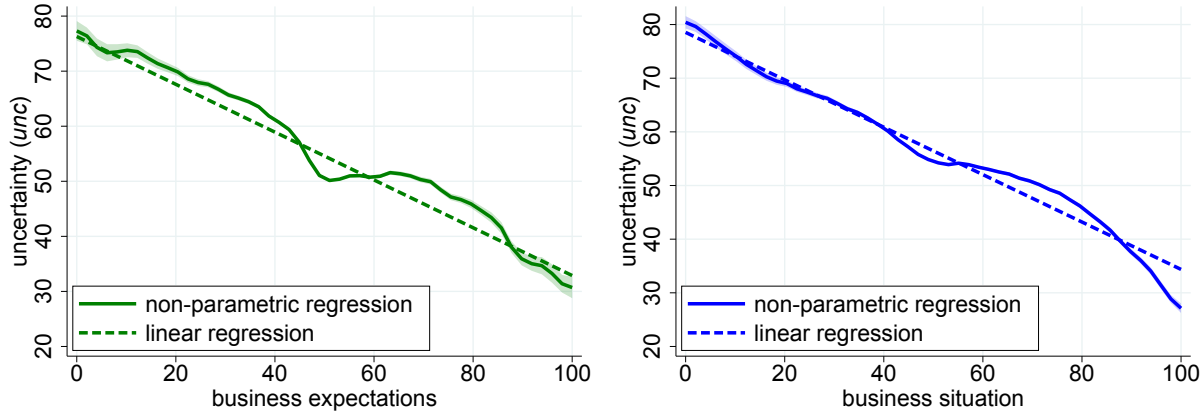
Using survey data from businesses allows me to study properties of uncertainty at the micro level. Specifically, it enables me to study the relationship between perceived uncertainty and expectations from the same firm. In addition, I can relate subjective uncertainty to the self-assessed business situation of a respondent. The panel dimension of the sample offers ample variation in the cross section and the time series.

This section has three parts. I start by examining the bivariate relationships between perceived uncertainty vis-à-vis expectations and the business situation, respectively. Second, I study the uncertainty respondents perceive for different combinations of the business situation and expectations. Third, based on these results, I describe how uncertainty fluctuates over a stylized cycle and discuss explanations for my empirical findings.

3.1 Uncertainty vs. Expectations and the Business Situation

How is managers' subjective uncertainty related to their business expectations and their assessment of their firms' cyclical business situation? Figure 2 illustrates these two bivariate relationships using non-parametric regression lines and linear fitted lines. I present the relationship between uncertainty and expectations and between uncertainty and the business situation for the pooled sample of roughly 160,000 firm-time observations.

Figure 2: Relation of subjective uncertainty to expectations and the business situation



Notes: This figure shows non-parametric kernel regression lines of degree zero with shaded 95% confidence bands as well as fitted linear regression lines for the relationship between subjective uncertainty (*unc*) and business expectations in the left plot, and between subjective uncertainty (*unc*) and the business situation in the right plot. The non-parametric lines use an epanechnikov kernel and the "rule-of-thumb" bandwidth (Fan and Gijbels, 1996). The assessment of the business situation, expectations, and uncertainty are based on questions 1, 2, and 3 in Section 2.1. Responses are elicited using visual analogue scales that range from 0 to 100, respectively.

From the left plot, I observe a strong negative and near-linear relationship between subjective uncertainty and expectations. Hence, the more pessimistic respondents are about the development of their business situation over the next six months, the more uncertain they are about it. The right plot shows that subjective uncertainty is also strongly negatively related to the respondents' assessment of their business situation, which indicates the position of a firm in its cycle. Managers perceive higher uncertainty the worse they assess the current cyclical business situation of their firm.

I formalize this graphical evidence by means of regressions. This adds magnitudes and significance levels of the slope coefficients and allows me to examine the within-firm time variation.[16] It can lead to a better understanding of the time variation in aggregate uncertainty, which is at the center of a large body of the literature on uncertainty and business cycle fluctuations.

Table 1 presents regressions of subjective uncertainty (*unc*) on expectations and the business situation. Columns 1 and 2 display the results from pooled OLS estimations, which correspond to the slopes of the linear predicted lines of Figure 2. The coefficients for both bivariate relationships are negative and highly significant. If expectations are 10 points lower on the visual analogue scale, uncertainty is 4.3 points higher on average. For a 10 point lower situation, on average, the uncertainty differential is 4.4 points. This captures both the variation between and within firms. The R-squared values of 0.12 and 0.20 in columns 1 and 2, respectively, indicate the presence of ample variation that is not captured by the bivariate relationships.

Table 1: Relation of subjective uncertainty to expectations and the business situation

Dependent variable: Subjective uncertainty (*unc*)	(1) OLS	(2) OLS	(3) FE	(4) FE
Business expectations	-0.434***		-0.362***	
	(0.0112)		(0.00743)	
Business situation		-0.442***		-0.423***
		(0.00919)		(0.00630)
Constant	76.30***	78.54***	72.85***	77.59***
	(0.580)	(0.506)	(0.416)	(0.367)
No. of obs.	157965	158366	149086	149453
R-sq.	0.12	0.20	0.081	0.15

Notes: Results from pooled OLS and fixed effects (FE) regressions with firm-time observations. The dependent variable is subjective uncertainty (*unc*). The FE regression are based on the subsample of firms with at least 10 responses of the variables used in the regressions, respectively. The R-squared values in columns 3 and 4 show the R-squared within firms. Standard errors in parentheses, clustered by firm; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

For the subsample of firms with at least ten observations, I isolate the within-firm variation in the panel using fixed effect regressions. More than 93% of the original sample remains. Columns 3 and 4 show the results. The coefficients of the fixed effect regressions

[16] I note that the visual analogue scale is identical for all firms and, hence, is designed to show time-variation within businesses. However, due to the rather short period of time of the sample of three years, some firms might be above or below their longer-run average expectations or their "normal" business situation in most or all of the sample horizon.

are similar in magnitude to the coefficients from the OLS regressions. Hence, the average firm is more uncertain if its business expectations or the assessment of its business situation is lower. However, the coefficient in column 3 that isolates the correlation of uncertainty and expectations in the time series is somewhat smaller than the coefficient in column 1 of the total variation. To sum up, the estimates in columns 1 and 2 do not capture merely cross-sectional differences between firms. The negative relationship of uncertainty vis-à-vis expectations and the cyclical situation is also present within firms.

Are these results driven by the impact of the COVID-19 crisis in the end of the sample period? Figure 10 and Table 6 in Appendix C replicate Figure 2 and Table 1 for the subsample from July 2017 to February 2020, which excludes the five survey waves affected by the COVID-19 crisis. Results are overall very similar. One small difference is that the coefficients of the fixed effect regressions are somewhat larger in the full sample. This seems natural, as one would expect the COVID-19 crisis to induce additional time variation in firms' perceptions.

Moreover, Figure 11 in Appendix C shows that the stylized facts concerning the negative bivariate relationships between uncertainty and expectations, and between uncertainty and the business situation, also hold for the indirect uncertainty measure *diff_pred* in the pooled sample. I conclude that, first, uncertainty is negatively correlated to a firms' cyclical position, which is measured by the business situation. Second, business expectations and the perceived uncertainty regarding these expectations are clearly dependent with a negative relationship at the micro level.

My results may recall the stylized fact from the finance literature that conditional volatility is negatively correlated with expected returns at stock markets (see, for instance, Bekaert and Wu 2000). However, it is unclear a priori whether managers' subjective uncertainty and expectations about their future business behave similarly to financial market outcomes. The new survey evidence suggests that this it indeed the case.

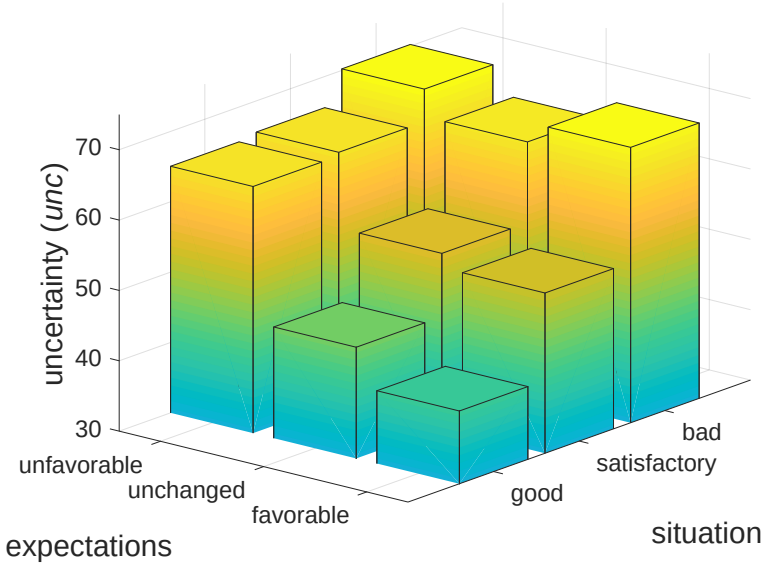
3.2 Uncertainty and Combinations of Situation and Expectations

Section 3.1 establishes negative bivariate relationships between uncertainty and business expectations as well as between uncertainty and the respondents' assessment of their business situation. I now take this analysis one step further by asking what degree of uncertainty respondents perceive for combinations of their business situation and expectations. In other words, I examine the relationship between uncertainty and expectations conditional on the cyclical position of the firm.

Overall, respondents' expectations and their assessment of the current business situation are positively related. The correlation coefficient is 0.55 in the pooled sample. However, there are numerous cases in which they differ. These cases are interesting to study, since they may offer new insights about the typical evolution of uncertainty over the business cycle.

Two cases are of particular interest: on the one hand, a firm can be in a good business situation, but its expectations are unfavorable. Is the uncertainty of such a business high, as the negative relationship between the uncertainty and expectations would suggest, or is its uncertainty low, since the business is still in a good situation? On the other hand, a business can be in a bad condition but have favorable expectations. Does this go along with high or low subjective uncertainty?

Figure 3: Uncertainty by combinations of business situation and expectations



Notes: The bar chart illustrates the mean values of uncertainty (*unc*) by the nine combinations of the categorical responses to the trichotomous questions about the business situation and business expectations outlined in Section 2.1. Each mean is based on at least 5,000 firm-time observations.

Figure 3 presents the relationship between subjective uncertainty (*unc*) and combinations of expectations and the business situation for the pooled sample. To facilitate the comprehension of this trivariate relationship, I draw on the categorical responses to the trichotomous questions about expectations and the state of business in ifo's business cycle survey. The height of the bars illustrate the mean values of uncertainty for the nine combinations of the business situation assessed as good, satisfactory, or bad, and expectations reported as favorable, unchanged, or unfavorable. Each combination is based on more than 5,000 firm-time observations.

The main result is that the respondents perceive high uncertainty if either their expectations are unfavorable or the assessment of their business situation is bad, or both. This implies that in a good business situation, when uncertainty is typically low, respondents perceive high uncertainty if expectations are unfavorable. If the situation is assessed as bad, uncertainty is high despite favorable expectations. Generally, the relationship between uncertainty and expectations is state-dependent: it is weaker in bad times, since then uncertainty is always high—almost independently of expectations. Given the bivariate relationships in Figure 2, it does not come as a surprise that uncertainty is at its lowest if the business situation is good and expectations are favorable.

Figure 12 in Appendix C demonstrates that the stylized facts regarding the trivariate relationship between uncertainty, expectations, and the business situation also hold true for a subsample that excludes the COVID-19 crisis. Moreover, results are qualitatively the same for the uncertainty measure *diff_pred* (see Figure 13 in Appendix C). As an alternative to the three-dimensional bar chart in Figure 3, Figure 14 in Appendix C further presents the trivariate relationship between uncertainty, expectations, and the business situation for the variables elicited using visual analogue scales, similar to Figure 2. Instead of *one* non-parametric regression line, which illustrates the relationship between uncertainty and expectations, *three* lines represent subsamples by the answer categories

to the question on the business situation. Again, it becomes clear that uncertainty is high if respondents assess their business situation as bad, irrespective of their expectations. If the business situation is good or normal, uncertainty is lower the better the expectations. An analogous continuous illustration for *diff_pred* instead of *unc* in Figure 14 of Appendix C confirms this pattern.

Using the more continuous visualization technique, Figure 15 in Appendix C additionally provides evidence that the new stylized facts also hold true for the within-firm variation in uncertainty, expectations, and the business situation.[17] Hence, it is not a mere artifact of the variation in the cross section.

3.3 Uncertainty Over the Firm and Business Cycle

The firm-level data on subjective uncertainty coupled with data on expectations and the cyclical business situation allows me to characterize how uncertainty fluctuates over a stylized cycle. Moreover, I provide an overview of theoretical mechanisms that can explain the empirical findings from Section 3.2.

How does uncertainty fluctuate with a firm's activity level and its manager's expectations? The findings from Section 3.2 suggest that the typical firm in a normal or good business situation reports an increase in uncertainty if expectations become unfavorable. If subsequently the firm's performance drops, uncertainty remains high as long as managers perceive the situation as bad—even if expectations become favorable again. This implies that uncertainty is persistently high in a period of low economic activity. Only once the firm's situation improves, uncertainty decreases back to the initial level. Since in economy-wide business cycle fluctuations many firms experience cyclical swings, uncertainty is likely to behave in a similar way in the aggregate.

What may be reasons for such fluctuations in uncertainty? One starting point can be the asymmetry of the business cycle, which implies that the distribution of a firms' growth rates is typically negatively skewed.[18] As a consequence, firms can expect the average negative shock to be larger than the average positive shock in absolute terms. Suppose a firm is in a good business situation and holds unfavorable expectations. Uncertainty perceived as risk then concerns the magnitude of the negative shock. It can potentially be large due to the fat left tail of the shock distribution. This could explain why managers are typically highly uncertainty in such instances. Orlik and Veldkamp (2014) provide a similar reasoning. They show how tail risks arising from negatively skewed growth rates can explain an increase of a forecasters' macroeconomic uncertainty in recessions.

A second intuition for the negative relationship between managers' uncertainty and the cyclical business situation of their firm rests on differences in the availability of information between good and bad times (see, for instance, Van Nieuwerburgh and Veldkamp (2006) for a theoretical mechanism). In a good business situation with favorable expectations, managers can receive strong signals of high demand. Knowledge about orders and being (temporarily) constrained by fixed capacities can make it relatively easy for executives to predict future sales and profits. Conversely, in case demand is perceived

[17] To show this, I focus on the subsample of firms for which at least ten observations are available. More than 93% of the original firm-time observations remain. I then create variables capturing the within variation by subtracting the firm-specific means from the firm-time values of the variables for uncertainty (*unc*), business expectations, and the business situation.

[18] Evidence for asymmetry in aggregate and firm-level growth is presented, for instance, by Salgado et al. (2020) and Ilut et al. (2018).

as weak, decision makers lack knowledge about the future growth path. As a result, uncertainty is high in the case in a bad business situation, but also if expectations are unfavorable.

If weak demand is a rather rare event for a firm, managers may also be uncertain since they are unfamiliar with that situation. Uncertainty in a bad cyclical state of a firm may also originate from the question whether a realized negative shock is temporary or permanent (Bernanke, 1983). In case of a temporary shock, expectations eventually turn favorable. However, then again the potential magnitude of the expected positive change is large. This can make forecasts quantitatively difficult. High upward risk could explain the empirical finding of high perceived uncertainty in an unfavorable situation with positive expectations. Noisy estimates of the recovery can have the same effect (Van Nieuwerburgh and Veldkamp, 2006).

4 Subjective Uncertainty in the Aggregate

In this section, I exploit the time series dimension of my panel. This allows me to construct one of the first aggregate series of subjective uncertainty that provides information on the uncertainty perceived by managers about the future development of their own business. This micro-foundation has the advantage that I can construct a time series of business expectations from the same respondents. In addition, I relate these series to respondents' assessment of their business situation. Given the micro evidence presented in Section 3, I ask whether subjective business uncertainty is negatively related to expectations also in the aggregate, and whether this link is weaker in bad times.

Figure 4 presents time series of subjective uncertainty, business expectations, and the assessment of the current business situation from July 2017 to November 2020.[19] I aggregate the firm-level survey data using firm size and sector weights as described by Sauer and Wohlrabe (2020).[20] This makes the series representative for the German economy.

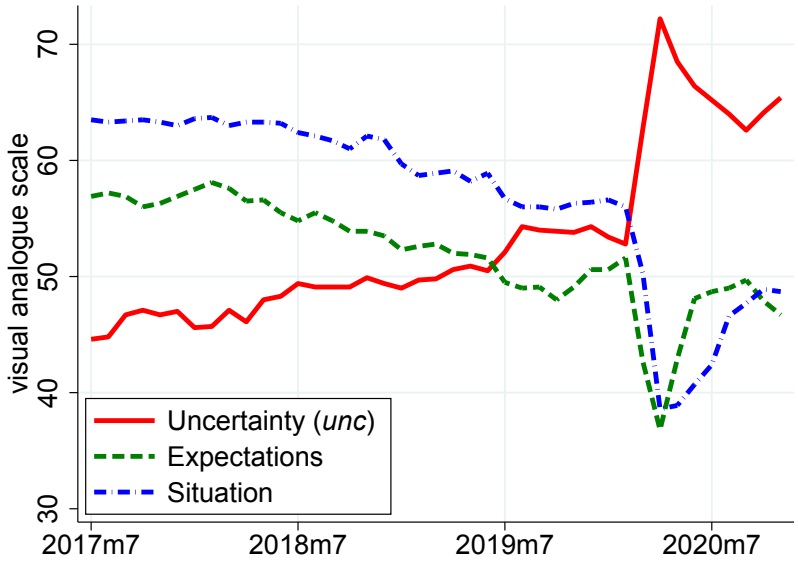
The first observation from Figure 4 is that firms' subjective uncertainty is almost perfectly inversely related to both business expectations and the business situation. Indeed, over the 41 months of the sample, uncertainty is highly negatively correlated with expectations and the business situation, with correlation coefficients of -0.90 and -0.98, respectively. After the boom in 2017, uncertainty slowly increases as expectations and the assessment of the business situation gradually deteriorate. The V-shaped pattern of expectations and the business situation in the beginning of the COVID-19 crisis is then likewise mirrored by a sharp increase and subsequent decrease of uncertainty in the first half of 2020.

The second observation from Figure 4 is that uncertainty comoves less with expectations in times of low economic activity. In the good business situation between July 2017 and February 2020, uncertainty closely mirrors expectations. During the bad business situation of the first wave of the COVID-19 crisis, expectations recover quickly. However,

[19]While the micro data collected by ifo Institute can only be accessed with a lag, the aggregated data is readily available. This allows me to present a time series that uses more survey months than the sample that I use for the micro analysis.

[20]Firm-level responses are first aggregated to the 2-digit level of the WZ08 sector classification (comparable to the classification scheme NACE Rev. 2) using firm size weights, and then aggregated to the level of the total economy by using sectoral value added weights from the German Federal Statistical Office.

Figure 4: Time series of subjective uncertainty, expectations, and the business situation



Notes: The figure presents time series of subjective uncertainty (*unc*), business expectations and an assessment of the respondents' current business situation. These measures are based on the firm-level answers to questions 1, 2, and 3 in Section 2.1, which are aggregated using firm size and sector weights as described in Sauer and Wohlrabe (2020). The labels at the vertical axis are numbers from a visual analogue scale that ranges from 0 to 100. The series are based on data from July 2017 to November 2020.

despite a decrease after April 2020, uncertainty remains on a high level. In this phase, uncertainty seems to be less correlated with expectations and to more closely track the business situation. In the end of the sample period, after the situation has somewhat normalized, expectations worsen again and uncertainty simultaneously increases. In sum, these developments are in line with the micro evidence from Section 3.2 and the resulting characterization of how uncertainty fluctuates over a stylized cycle in Section 3.3.

A third observation is that in two instances expectations decline and uncertainty simultaneously increases, but the business situation stays either constant or improves. This is evident in the first half of 2018 and between September and November 2020. It suggests that uncertainty is not only counter-cyclical with respect to realized business activity. Uncertainty can also co-move with expectations alone while activity is unchanged. Overall, it seems that uncertainty increases whenever either expectations deteriorate or the business situation worsens, or both. This is again consistent with the evidence from the micro data in Section 3.2.

An implication of all of these observations is that, when using time series econometric analyses, it may be difficult to disentangle effects of subjective business uncertainty on macroeconomic variables, such as production, investment, and employment, from the effects of expectations and current economic activity. Ludvigson et al. (2021) arrive at a similar conclusion. They highlight the difficulty to causally identify uncertainty shocks in vector autoregression frameworks.

In the next section, I propose an alternative approach to learn about the effect of uncertainty on decision making and outcomes. In particular, I use the cross-sectional variation in the micro data of my sample to empirically examine the relationship of managers' uncertainty and expectations to their investment and employment decisions.

This allows me to directly study the predictions of a theoretical mechanism that links uncertainty to firm behavior.

5 Uncertainty, Expectations, and Corporate Decisions

When examining the effect of uncertainty on firms' economic decisions, one prominent theoretical channel is centered around "real options" (Bernanke, 1983; Brennan and Schwartz, 1985; McDonald and Siegel, 1986).[21] When decisions in firms cannot be easily reversed (or it is costly to do so) and when they affect the profitability of actions taken later, managers confronted with high uncertainty may prefer to "wait and see". More specifically, in such a case, it can be optimal for a business to postpone investment projects and to stop hiring and firing until the outlook becomes clearer. Due to the lack of suitable measures of subjective uncertainty at the firm level, empirical evidence on such behavior is scarce.

Perceived uncertainty seems to fluctuate most around recessions. Section 4 has provided evidence that the onset of the COVID-19 crisis was accompanied by a large increase in uncertainty, while expectations plummeted. Based on the theoretical considerations above, in the presence of an uncertainty shock alone I would expect firms to postpone (partially) irreversible investments and to leave the number of their employees largely unchanged. A negative shock to expectations is also likely to make firms defer investments. However, I would expect them to reduce employment as a consequence. The actual effect of each of the two shocks is unclear. Therefore, it is interesting to use micro data to study the relationship between uncertainty and firms' actions while the aggregate economy simultaneously experiences a sharp drop in expectations and a stark increase in uncertainty.

For firms to postpone investments in times of high uncertainty according to "real options" theory, they must view them as partially or completely irreversible. A special question in the ifo Business Survey from November 2020 provides evidence on managers' beliefs about the irreversibility of their investments. Respondents are asked to assess the resalability of their investment goods on a scale from 1 (bad) to 6 (good). Appendix D presents the exact wording of the question and Figure 16 in this Appendix the answer distribution. Roughly 80% of the managers responded with a number smaller or equal to 3, with the mode of the distribution being at 2. Hence, a large majority of firms view it as costly or difficult to reverse their investments.[22] If uncertainty is high, "real options" theory would thus predict that most managers defer investments.

In this section, I exploit the cross-sectional heterogeneity in changes of subjective uncertainty and expectations between German firms at the onset of the COVID-19 crisis. I use the aggregate variation to find out whether differences in the impact of this shock on the subjective uncertainty of managers relates to differences in their investment and employment decisions.

[21] Other possible theoretical channels include precautionary behavior, borrowing constraints due to higher risk premia, and a loss in confidence caused by ambiguity aversion. Growth options and the Oi-Hartman-Abel effect constitute theoretical mechanisms that can explain positive investment and growth effects from (upward) uncertainty. Bloom (2014) provides an overview of these channels.

[22] These results are in line with previous evidence from Dibiasi et al. (2018). Surveying Swiss firms, they present evidence that 70% of the respondents consider their investments to be highly or fully irreversible; 94% view them as at least somewhat irreversible.

5.1 Sample

To address this question, I use the micro data from the February, March, and April waves of the ifo Business Survey from 2020. I then relate changes of subjective uncertainty (*unc*) and business expectations between February and March to subsequent self-reported information in April about whether firms have postponed investment projects and whether they have reduced employment, respectively, because of the COVID-19 crisis. Appendix D contains the English translation of the corresponding special question in the April wave of the ifo Business Survey.[23]

While the March wave of the ifo Business Survey was conducted from March 2 to March 24, I base my analysis on the subsample of firms that submitted their questionnaires in the nine days from March 16 to March 24. Figure 17 in Appendix D presents a histogram of the submission dates in March. Information on the date is missing for 12% of all participants. I exclude these observations from all further analyses. Table 8 in Appendix D shows that the group of firms that responded from March 16 to March 24 is representative for the entire sample of firms that responded in March.

Focusing on the firms that responded from March 16 to March 24 ensures that managers are well-informed about the gravity of the crisis, and especially about the shutdown. As a result, I can exploit the full aggregate variation of the shock to uncertainty and expectations. Using data from the beginning of March would blur the within-variation of the aggregate shock as idiosyncratic changes in uncertainty and expectations are likely to dominate changes in beliefs due to the COVID-19 crisis. I do not use data on firms' uncertainty and expectations from April, since these perceptions would be captured after the firms have taken measures in response to the pandemic.

Of the participants for which a submission date in March is available, 1,269 responded between March 16 and 24. This includes answers from both the online and the paper-based parts of the survey. For the baseline analysis, I use firms that answered in both February and March of 2020 to the online survey questions 1, 2, and 3 regarding the business situation, expectations, and uncertainty, as described in Section 2.1. Moreover, I require answers from these firms to the special survey question from April 2020 about their reactions to the COVID-19 pandemic. This leaves me with a baseline sample of 654 firms for the main analysis.

5.2 Descriptive Evidence

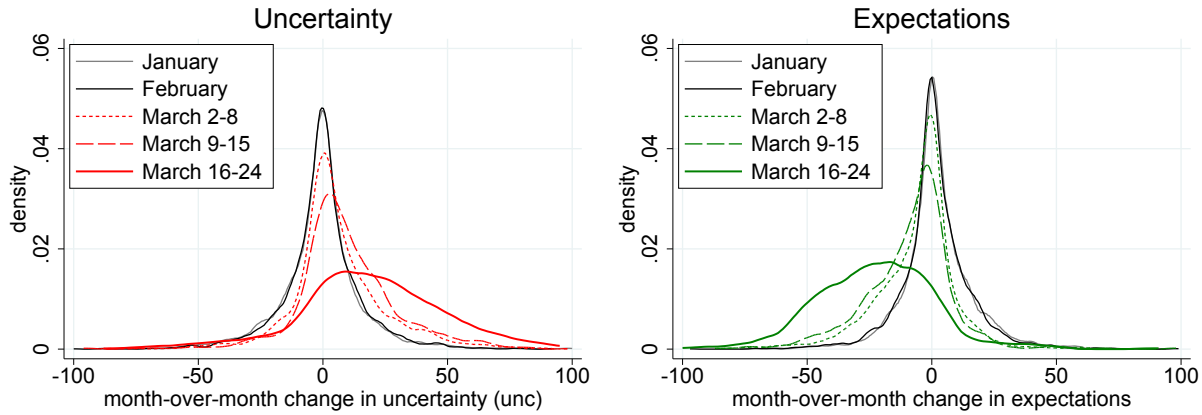
Table 7 in Appendix D presents a short time line of events during the onset of the COVID-19 crisis in Germany. Due to the unprecedented character of the crisis, the negative consequences of the pandemic for the economy only became apparent gradually: on March 10, many federal states canceled mass events with more than 1,000 participants. On March 13, schools and childcare facilities were closed in most federal states. On March 16, the first day of the subsample period for the analysis, Germany closed its federal borders and the government announced the closing of shops and public facilities.

In the analysis, I use the variation between firms with respect to changes in their perceived uncertainty and expectations between February and March. The aim is to capture the variation that is due to the aggregate shock of the COVID-19 crisis, as opposed to idiosyncratic changes. Figure 5 presents distributions of changes in subjective uncertainty (*unc*) and expectations, respectively, between February and March. In particular, I split

[23] The responses of the April survey were collected between April 1 and April 23.

the sample into three groups by the week in which the firms responded in March. The changes for all firms in January and February compared to the previous month, respectively, are also displayed as a reference. They are centered around zero. Thus, these changes are not driven by a common aggregate shock but reflect idiosyncratic variation at a lower level.

Figure 5: Distribution of changes in uncertainty and expectations



Notes: The figure shows kernel density estimates for month-over-month changes in subjective uncertainty (*unc*) in the left plot and month-over-month changes of expectations in the right plot for all firms in January and February, respectively, as well as for three groups of firms in March, split by the date of submission of their questionnaire. The density estimates are obtained using an epanechnikov kernel and the "rule-of-thumb" bandwidth (Fan and Gijbels, 1996). The measures for uncertainty and expectations are based on the responses to questions 1, 2, and 3 in Section 2.1. The horizontal axes depict changes based on numbers from visual analogue scales that range from 0 to 100.

While the kernel density estimate for the first group of firms that responded between March 2 and 8 shows only minor deviations from the distributions of the changes in January and February, the kernel density estimates for the second group of firms (March 9-15) differ more. For the third group (March 16-24), the distribution is much wider and clearly positively skewed in case of the changes in uncertainty and negatively skewed for changes in expectations. This reflects the aggregate shock to uncertainty and expectations triggered by the events at the beginning of the COVID-19 crisis.[24] Considering only the third group of firms, that responds between March 16 and 24, allows me to mostly capture this variation. Moreover, I observe ample heterogeneity between firms: while on average, respondents become more uncertain and more pessimistic, these changes in beliefs are more pronounced among some managers compared to others.

5.3 Econometric Model and Estimation

I exploit this between-firm variation to estimate the relationship between uncertainty and corporate decisions. As the baseline econometric specification, I choose a linear probability model of the form:

$$y_{it} = \beta_0 + \beta_1 \Delta u_{i,t-1} + \beta_2 u_{i,t-2} + \beta_3 \Delta e_{i,t-1} + \beta_4 e_{i,t-2} + \beta_5 \Delta s_{i,t-1} + \beta_6 s_{i,t-2} + \gamma' x_i + \epsilon_{it}$$

[24]The bar chart in Figure 18 of Appendix D displays means of the month-over-month changes in uncertainty, expectations, and the business situation for each of the three groups of firms in March.

where y_{it} denotes a dummy variable for firm i's decision at time t, which can be either to postpone investments or to reduce employment. $\Delta u_{i,t-1}$, $\Delta e_{i,t-1}$, and $\Delta s_{i,t-1}$ are changes in uncertainty, expectations, and the business situation between periods $t-2$ and $t-1$. $u_{i,t-2}$, $e_{i,t-2}$, and $s_{i,t-2}$ are the levels of these variables in period $t-2$, respectively. x_i captures time-invariant firm characteristics, namely size and sector, and ϵ_{it} is an error term.

For the estimation, I use survey data from February, March, and April 2020, which refer to $t-2$, $t-1$, and t above. Unconditionally, 43% of the firms that responded between March 16 and 24 report in April that they have postponed investment projects and 16% state that they have reduced employment because of the COVID-19 crisis. For the baseline regressions, I use the uncertainty measure *unc*, as well as business expectations and situation elicited with a visual analogue scale. These variables are based on questions 1, 2, and 3 in Section 2.1. To control for the size of the firms, I define dummy variables for three size classes based on the number of employees: small firms have less than 50 employees, medium-sized firms have between 50 and 249 employees, and large firms have 250 or more employees. This categorization is in line with the official definition of the German Federal Statistical Office. To take out sector-specific effects, I include dummies for sectors at the two-digit level of the German WZ08 classification, which is closely related to the European industry classification system NACE Rev. 2.

The econometric model contains both *levels* in period $t-2$ as well as *changes* in uncertainty, expectations, and the business situation between $t-2$ and $t-1$. The levels in February control for heterogeneity between firms before the aggregate shock. This is especially advantageous in view of the boundedness of the visual analogue scale. It allows me to compare changes between firms with the same level in February. Since I want to relate changes of uncertainty caused by the aggregate shock of the COVID-19 crisis to managers' investment and employment decisions, my primary focus is on the coefficient of the change in uncertainty, β_1.[25]

5.4 Results

Table 11 presents regression results from ten linear probability models. The dependent variable in columns 1 to 5 is a dummy for firms' decisions to postpone investments, in columns 6 to 10 the dependent variable is a dummy for the decision to reduce employment.

The main result from columns 1 to 5 is that changes in uncertainty are unrelated to the decision to postpone investment once I control for expectations and other variables. In column 1, I regress the dummy for the decision to postpone investment projects on the month-over-change in uncertainty in March and the base level of uncertainty in February. I find that there is a weak positive relationship between changes in uncertainty and the probability that firms postpone investments. The level of uncertainty before the aggregate shock of the COVID-19 crisis has a stronger positive association with firms' decisions to postpone investments. In column 2 I replace the uncertainty variables with the change

[25]Given the negative relationships of uncertainty and expectations as well as uncertainty and the business situation documented in Section 3.1, there might be a concern of multicollinearity. Table 9 in Appendix D shows that the main regressors in levels and changes are indeed correlated. However, none of the pairwise correlation coefficients exceeds 0.53. The R-squared from an OLS regression of $\Delta u_{i,t-1}$ on the level of uncertainty in $t-2$, as well as level and change variables of expectations and the business situation is 0.33. This leaves room for independent contributions of the regressors. Table 9 also shows that individual firms seem to experience the aggregate uncertainty and expectation shocks quite differently: the correlation between changes in uncertainty and changes in expectations is merely -0.21.

and base level of expectations. Unconditionally, both expectation variables are strongly negatively related to the dependent variable. The coefficients are economically relevant: a decrease in expectations by ten points on the visual analogue scale goes along with an increase of the likelihood to postpone investments by roughly five percentage points. Column 3 displays the outcome of a joint regression of the uncertainty and expectation variables in levels and changes from columns 1 and 2. Most importantly, the coefficient on the change of uncertainty shrinks in size and becomes insignificant, while the coefficient of the change in expectations remains highly significant. This result remains unchanged in column 4, in which I add variables for the level and change of the business situation. Of the two only the change in the situation significantly predicts firms' investment deferral. The results of column 4 are robust to including firm size and sector dummies, as indicated by column 5. To sum up, changes in expectations and the business situation triggered by the COVID-19 crisis are related to a higher likelihood to postpone investments, while changes in uncertainty are not. Moreover, firms with a higher level of uncertainty before the aggregate shock more often defer investments because of the crisis.

Replicating the model structure of columns 1 to 5, the regressions in columns 6 to 10 use the dummy for a reduction in employment as dependent variable. They show that changes in uncertainty are not related to the decision to lay off employees. In case of a "freeze" of employment according to "wait and see" behavior, I would have expected a significant negative coefficient: with higher uncertainty, firms would be less likely to lay off personnel. However, the coefficients in columns 6 to 10 are quantitatively small and statistically not significant. Column 6 shows that unconditionally changes in uncertainty are unrelated to the decision to reduce the number of employees. The results in column 7 say that the relationship between changes in expectations and the decision to reduce employment is strong. The more pronounced the deterioration in expectations, the more likely respondents downsize their workforce. The base levels of uncertainty and expectations from February in columns 6 and 7 are also connected to a higher probability to lay off employees. In the joint regression in column 8, the level and change in expectations "drive out" the level of uncertainty: its coefficient becomes small and statistically insignificant. In column 9, I include levels and changes of the business situation as additional regressors. Changes in current activity as well as pre-existing differences between firms are strongly related to the dependent variable. This is also true when adding size and sector dummies in column 10. Changes in the business situation as indicator for firms' current economic activity emerge as the most important transmission channel from the aggregate shock to firms' decision to reduce employment.

To sum up, the results from Table 11 suggest that the shock to expectations and business conditions at the onset of the COVID-19 crisis dominates the effects that we would have expected from a pure uncertainty shock and the theory of "real options". I do not find evidence that firms postpone investments or "freeze" employment following changes in uncertainty. In contrast, negative changes of expectations and of the assessment of the business situation are significantly related to these corporate decisions. Perceptions and the business situation before the aggregate shock also predict firms' reactions to the crisis. This is in line with previous findings by Buchheim et al. (2020a).

Table 2: Relationship between corporate investment and employment decisions and past uncertainty, expectations, and situation

Dependent variable:	decision: postponement of investment					decision: reduction of the number of employees				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔUncertainty in $t-1$	0.00171**		0.000738	0.000682	0.000660	0.000352		-0.000196	-0.000237	0.000215
	(2.13)		(0.91)	(0.83)	(0.75)	(0.52)		(-0.29)	(-0.36)	(0.36)
Uncertainty in $t-2$	0.00562***		0.00462***	0.00452***	0.00394***	0.00222***		0.000663	0.000474	0.000719
	(5.95)		(4.65)	(4.28)	(3.41)	(2.73)		(0.81)	(0.56)	(0.90)
ΔExpectations in $t-1$		-0.00530***	-0.00457***	-0.00312***	-0.00317***		-0.00282***	-0.00278***	-0.00133*	-0.000779
		(-5.93)	(-4.92)	(-3.00)	(-2.91)		(-4.25)	(-4.02)	(-1.80)	(-1.05)
Expectations in $t-2$		-0.00460***	-0.00240*	-0.00127	-0.00105		-0.00572***	-0.00535***	-0.00408***	-0.00402***
		(-3.61)	(-1.81)	(-0.89)	(-0.70)		(-5.48)	(-4.79)	(-3.68)	(-3.58)
ΔSituation in $t-1$				-0.00327***	-0.00324***				-0.00324***	-0.00271***
				(-3.19)	(-2.84)				(-3.93)	(-3.27)
Situation in $t-2$				-0.00194*	-0.00141				-0.00222***	-0.00156*
				(-1.70)	(-1.08)				(-2.89)	(-1.93)
Dummy medium sized firms					0.0339					0.0302
					(0.74)					(0.85)
Dummy large firms					0.0289					0.0222
					(0.47)					(0.51)
Constant	0.0705	0.534***	0.168*	0.210*	-0.195	0.0234	0.387***	0.336***	0.390***	0.195*
	(1.12)	(8.67)	(1.73)	(1.87)	(-1.37)	(0.44)	(7.17)	(3.94)	(4.10)	(1.87)
Sector dummies					YES					YES
No. of firms.	653	653	653	653	653	653	653	653	653	653
R-sq.	0.049	0.052	0.085	0.100	0.21	0.016	0.063	0.065	0.094	0.24

Notes: Results from OLS regressions. The dependent variable in columns 1 to 5 is a dummy for the decision to postpone investment projects because of the COVID-19 crisis, in columns 6 to 10 it is a dummy for the decision to reduce employment because of the COVID-19 crisis. Information on firms' decisions stems from the ifo Business Survey in April 2020. The regressors are levels of uncertainty (*unc)*, expectations, and business situation from February 2020, and month-over-month changes from March 2020. These measures are based on the responses to the questions 1, 2, and 3 in Section 2.1. t-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10 in Appendix D presents additional regressions for two related managerial decisions: the cancellation of investment projects and the implementation of short-time work. I use dummies for these actions as dependent variables in otherwise unchanged regressions. The data stems from the same special question in April as the data on the decisions to postpone investments and to reduce employment. Unconditionally, 19% of the firms that responded between March 16 and 24 report to have canceled investment projects, and 49% indicate to have introduced short-time work. In principal, uncertainty could also affect these decisions via precautionary behavior. However, this does not seem to be the case. Once expectations are controlled for, again I find that—besides pre-existing business conditions before the aggregate shock—only changes in expectations and in current economic activity are related to these investment and employment decisions.

5.5 Robustness

Did managers anticipate the economic consequences of the COVID-19 crisis before March 2020? News about the COVID-19 epidemic in Asia could have affected uncertainty and expectations of respondents in February. However, Buchheim et al. (2020b) show that there was basically no such effect. Instead, respondents of the ifo Business Survey only changed their beliefs once domestic policy imposed measures to contain the epidemic in March. The spread of the disease in Italy only became known on February 21, the last day of this month's survey wave. Hence, information about the outbreak in Europe is also unlikely to affect the results.

Appendix D presents robustness checks for the baseline regression results above. First, instead of estimating linear probability models, I compute average marginal effects from probit regressions. The results, displayed in Table 2, are almost exactly the same.[26]

Second, to account for possible measurement error in the variables for uncertainty, expectations, and the business situation, I apply the Obviously Related Instrumental Variable (ORIV) approach proposed by Gillen et al. (2019). To this end, in the sample from February to April 2020, I first regress the uncertainty variable *unc* on *diff_pred* and use the predicted values, as well as changes of the predicted values, as alternative regressors $\Delta u_{i,t-1}*$ and $u_{i,t-2}*$. These new variables capture the common variation in *unc* and *diff_pred* and are free of independent and identically distributed measurement error. By regressing expectations and the business situation measured using visual analogue scales on their categorical counter-parts, I analogously obtain predicted values for these variables, in levels and in changes.[27] Table 12 in Appendix D shows that the main results are robust to re-estimating the baseline regressions with these modified variables. A difference is that the coefficients of expectations and the business situation are substantially larger using the ORIV approach. This suggests the presence of an attenuation bias in the baseline regressions. As a consequence, in the regressions with the modified variables, uncertainty in February is "driven out" by expectations and the situation. In contrast to the baseline regressions, using the ORIV approach the level of uncertainty before the aggregate shock does not predict firms' investment and employment decisions.

[26]Note that in the probit regressions of columns 5 and 10 instead of two-digit sector dummies I use dummies for the more aggregate manufacturing, construction, trade, and services sectors. The reason is that at the 2-digit WZ08 sector level, I would not be able to use a small fraction of observations, as too few observations in some of 2-digit sectors do not allow for the computation of marginal effects.

[27]Since not for all observations in the baseline sample values from the categorical variables on the business situation, expectations, and uncertainty (*diff_pred*) are available, the sample for the regressions is slightly reduced from 656 to 629 firms.

As another robustness test, Table 13 replicates the baseline regressions in Table 11 using the uncertainty measure *diff_pred* as well as the categorical variables for expectations and the business situation. This requires the definition of several dummy variables. Regarding *diff_pred*, I join the sparsely populated category "Easy" with the category "Rather easy" and create indicator variables for the resulting three levels of the difficulty to predict the future business development in periods $t-2$ and $t-1$. Based on these uncertainty states, I define dummy variables for positive and negative changes from $t-2$ to $t-1$. Moreover, I use the trichotomous variables on expectations and the business situation to create dummies for the levels in $t-2$ as well as positive and negative changes between $t-2$ and $t-1$, respectively. In the regressions, I define the lowest uncertainty level as well as the middle categories of expectations and the business situation as the baseline. The baseline for the variables in changes are the cases of no change, respectively.

The regression results in Table 13 confirm the main findings from above. Unfavorable expectations in the level as well as negative changes in expectations "drive out" the effect captured by the dummy for increases in uncertainty. This holds true for both the decision to postpone investments and the decision to reduce the number of employees. In regressions with only uncertainty and expectation variables, the level of uncertainty in February is also significantly related to the outcome dummies. However, it becomes insignificant once I control for levels and changes of the business situation.

6 Conclusion

Based on data from a large and representative German business survey, this paper analyzes the relationship of a novel measure of firms' subjective uncertainty to business expectations and corporate decisions. I establish stylized facts and empirically examine the prediction of a prominent theoretical channel that links uncertainty to firm behavior.

Contrasting managers' subjective business uncertainty with their business expectations and their assessment of their business situation, I find negative relations at the micro level and strongly inverse relationships in the time series. Moreover, the relationship between uncertainty and expectations is state-dependent: it is much weaker in bad times, when—regardless of expectations—uncertainty is generally perceived as high. This persistence in uncertainty is in line with models featuring endogenous feedback mechanisms between uncertainty and economic activity in recessions.

As an alternative approach to traditional time series analysis, the availability of micro data of managers' perceptions allows me to exploit the variation between firms to directly examine the link between uncertainty and corporate decisions. Focusing on the onset of the COVID-19 crisis, I empirically study the "real options" channel of uncertainty. Specifically, I analyze the relation of uncertainty and expectations to firms' decisions to postpone investment projects and to reduce employment. I find that changes in uncertainty during the aggregate downturn do not predict "wait and see" behavior. By contrast, changes in expectations are related to the deferral of investment and a reduction of the workforce.

These results may be particular to the sharp economic downturn in March 2020, which was extraordinary in many respects. More research should be devoted to examine the link between perceived uncertainty and corporate actions. Of particular interest could be later stages of a recession, when expectations improve but uncertainty remains elevated.

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Appendix

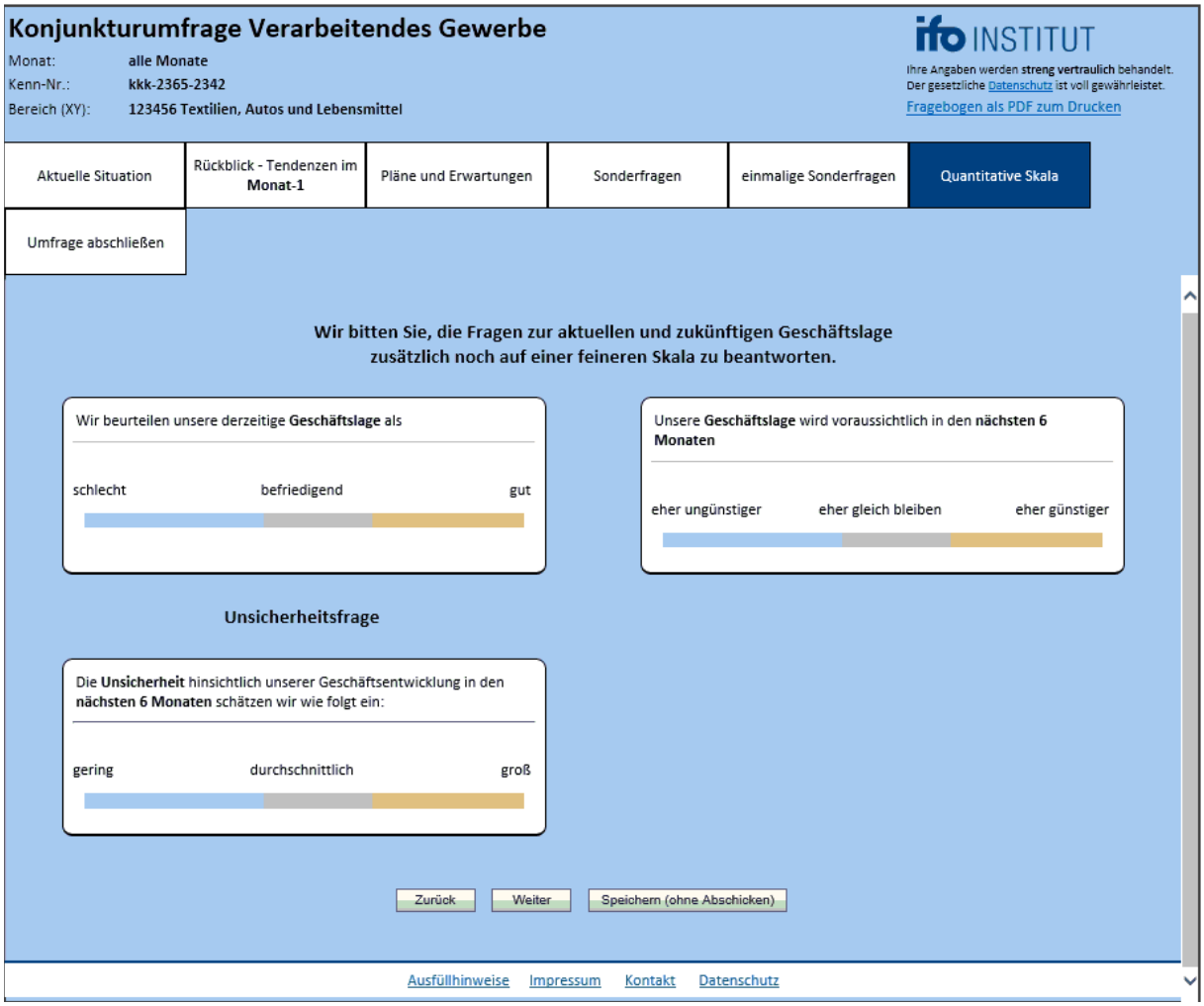
Appendix A Data

Table 3: Comparison of responses online with all responses to the ifo Business Survey

	online responses		all responses	
	Mean	N	Mean	N
Firm characteristics				
Small firms	0.449	170,191	0.482	256,799
Medium firms	0.192	170,191	0.190	256,799
Large firms	0.082	170,191	0.071	256,799
Sector manufacturing	0.339	170,191	0.310	256,799
Sector construction	0.066	170,191	0.100	256,799
Sector wholesale & retail trade	0.234	170,191	0.270	256,799
Sector services	0.361	170,191	0.321	256,799
Firm perceptions				
Situation bad	0.411	170,191	0.402	256,799
Situation normal	0.437	170,191	0.451	256,799
Situation good	0.147	170,191	0.142	256,799
Expectation unfavorable	0.187	170,191	0.179	256,799
Expectation unchanged	0.594	170,191	0.605	256,799
Expectation favorable	0.212	170,191	0.208	256,799
Uncertainty: Easy or rather easy	0.286	75,979	0.301	109,130
Uncertainty: Rather difficult	0.531	75,979	0.527	109,130
Uncertainty: Difficult	0.183	75,979	0.171	109,130

Notes: The table presents shares and the number of observations for a list of variables for two samples: the subsample of responses to the online part of the ifo Business Survey and all observations (that include paper-based responses). The top panel of the table presents the shares and frequencies of the responses from three firm size classes and the four major sectors that ifo surveys. The size classes are defined in accordance with the definition by the German Statistical Office. Small firms have less than 50 employees, medium firms between 50 and 250 employees, and large firms more than 250 employees. The second panel presents shares of responses to the traditional trichotomous questions about the business situation and expectations, as well as responses to question 4 in Section 2.1 on uncertainty.

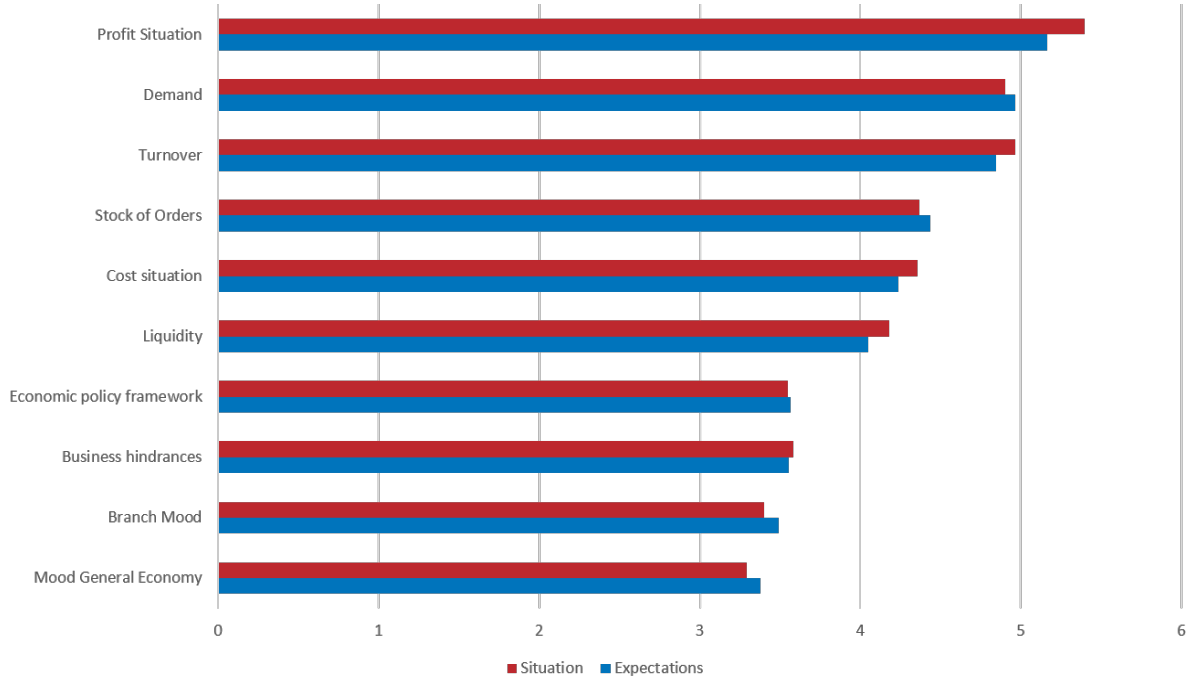
Figure 6: Online questionnaire with questions using visual analogue scales



Notes: In the original German, the screenshot shows the section of the online survey questionnaire that elicits an assessment of the business situation as well as expectations and subjective uncertainty about the future business development using visual analogue scales. They correspond to questions 1, 2, and 3 in Section 2.1.

Appendix B Measuring Managers' Perceptions

Figure 7: Determinants of business situation and expectations from meta survey



Notes: The bar chart presents the results of two questions in a meta survey about the ifo Business Survey conducted in fall 2019. Respondents were asked to rate the importance of a list of variables for their assessment of their business situation and for their current business expectations using numbers from 0 (unimportant) to 6 (very important).

Table 4: Summary statistics of situation, expectations, and uncertainty (*unc*)

Variable	No. Obs	Mean	Std. Dev.	P1	P10	P25	P50	P75	P90	P99
Business situation	158,366	55.1	22.6	1	25	42	53	72	86	99
Business expectations	157,965	50.7	17.7	3	28	43	50	60	74	96
Uncertainty: *unc*	159,996	54.2	22.4	1	22	44	52	70	84	99

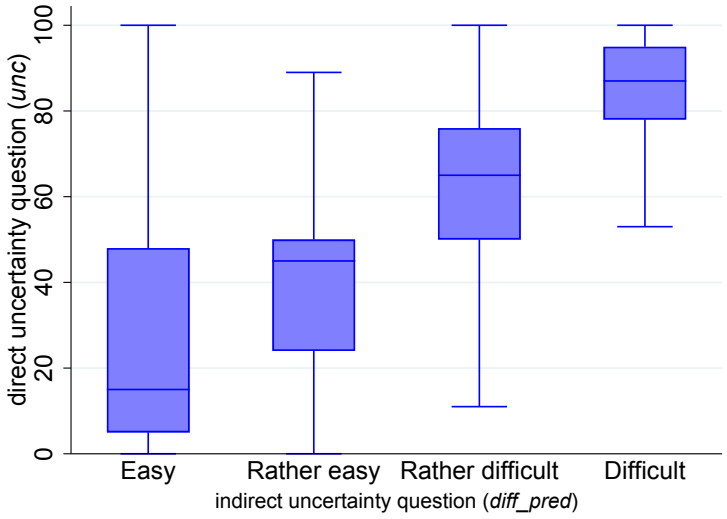
Notes: Summary statistics of the responses from questions 1, 2, and 3 in section 2.1. The sample consists of the online part of the ifo Business Survey and ranges from July 2017 to July 2020.

Table 5: Summary statistics of uncertainty: *diff_pred*

	No. Obs.	Share
Easy	4,426	0.04
Rather easy	28,448	0.26
Rather difficult	57,563	0.53
Difficult	18,693	0.17
Total	109,130	1.00

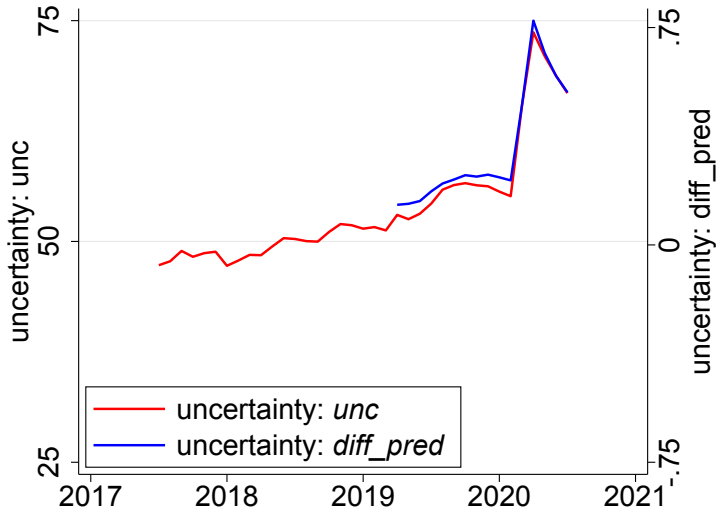
Notes: Distribution of the responses to question 4 in section 2.1. The sample ranges from April 2019 to July 2020.

Figure 8: Micro data comparison of two measures of subjective uncertainty



Notes: The box plot illustrates the distribution of the responses of the direct uncertainty question 3 in Section 2.1 (*unc*) for each of the answer options of the indirect uncertainty question 4 (*diff_pred*). The figure is based on 73,413 firm-time observations. Less than one percent of the responses fall in the answer category "Easy" of the indirect question.

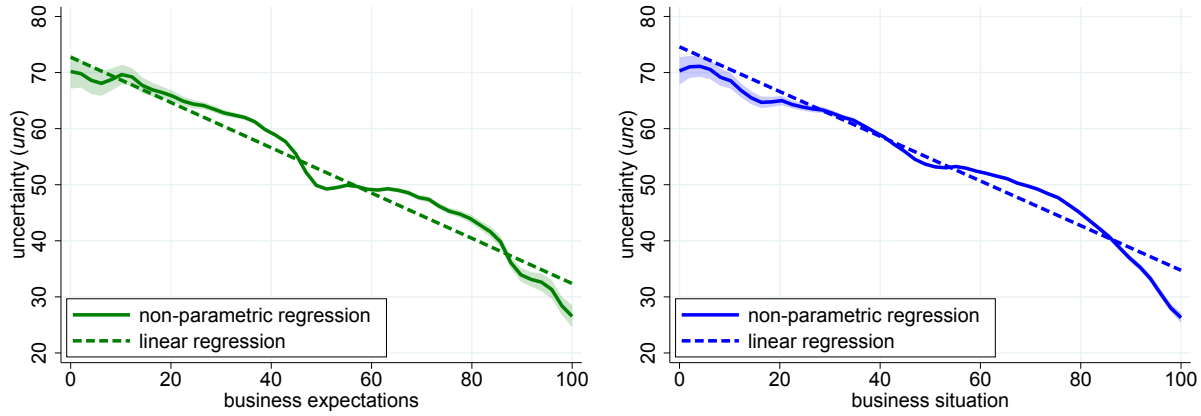
Figure 9: Time series comparison of two measures of subjective uncertainty



Notes: Unweighted means of the two uncertainty measures *unc* and *diff_pred* based on survey questions 3 and 4 in Section 2.1 over time. The categorical values of *diff_pred* "Easy", "Rather Easy", "Rather difficult", and "Difficult" are coded as -1.5, -0.5, 0.5, and 1.5, respectively. *unc* is available from July 2017 to July 2020, *diff_pred* from April 2019 to July 2020.

Appendix C Subjective Uncertainty at the Micro Level

Figure 10: Relation of uncertainty (*unc*) to expectations and the business situation, excluding the COVID-19 crisis



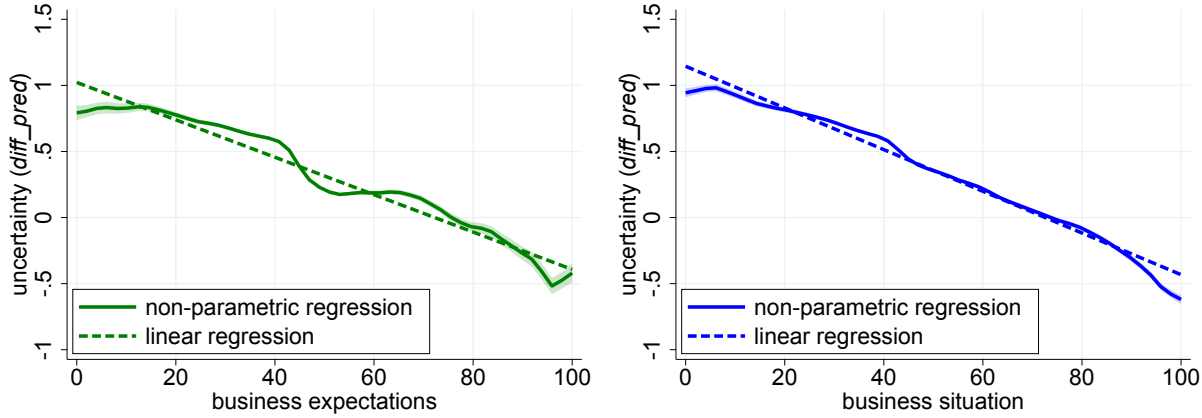
Notes: This figure shows non-parametric kernel regression lines of degree zero with shaded 95% confidence bands as well as fitted linear regression lines for the relationship between uncertainty (*unc*) and business expectations in the left plot, and between uncertainty (*unc*) and the business situation in the right plot. The non-parametric lines use an epanechnikov kernel and the "rule-of-thumb" bandwidth (Fan and Gijbels, 1996). The assessment of the business situation, expectations, and uncertainty are based on questions 1, 2, and 3 in Section 2.1. Responses are elicited using visual analogue scales that range from 0 to 100, respectively. The plots are based on the sample from July 2017 to February 2020, which excludes the COVID-19 crisis.

Table 6: Relation of uncertainty (*unc*) to expectations and the business situation, excluding the COVID-19 crisis

Dependent variable: Subjective uncertainty (*unc*)	(1) POLS	(2) POLS	(3) FE	(4) FE
Business expectations	-0.404***		-0.282***	
	(0.0131)		(0.00853)	
Business situation		-0.398***		-0.321***
		(0.0109)		(0.00745)
Constant	72.74***	74.58***	66.26***	70.00***
	(0.691)	(0.614)	(0.495)	(0.453)
No. of obs.	134140	134623	119299	119781
R-sq.	0.10	0.16	0.046	0.068

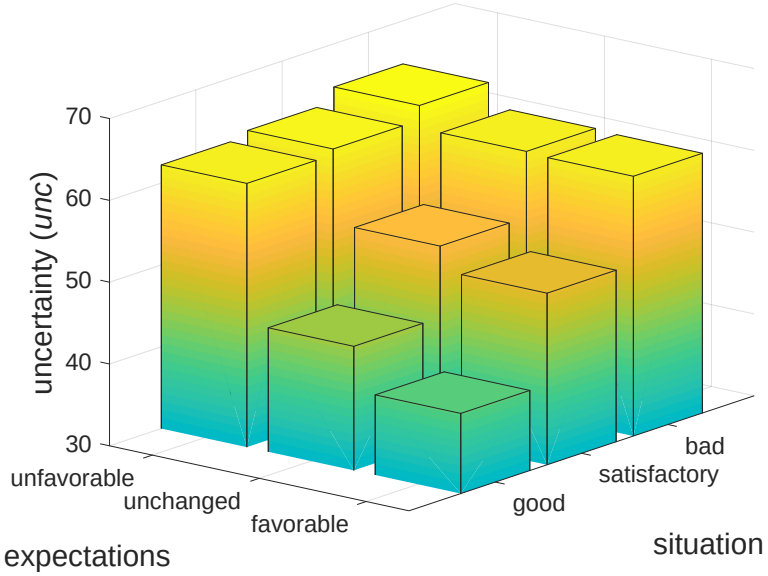
Notes: Results from pooled OLS and fixed effects (FE) regressions with firm-time observations. The dependent variable is subjective uncertainty (*unc*). The table is based on a shorter sample from July 2017 to February 2020, which excludes the COVID-19 crisis. The FE regression are based on the subsample of firms with at least 10 responses of the variables used in the regressions, respectively. The R-squared values in columns 3 and 4 show the R-squared within firms. Standard errors in parentheses, clustered by firm; * p < 0.10, ** p < 0.05, *** p < 0.01.

Figure 11: Relation of uncertainty (*diff_pred*) to expectations and the business situation



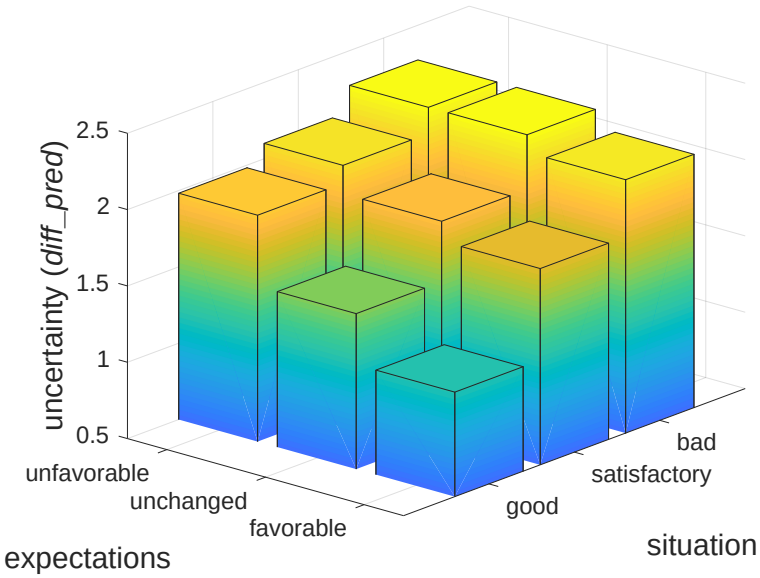
Notes: This figure shows non-parametric kernel regression lines of degree zero with shaded 95% confidence bands as well as fitted linear regression lines for the relationship between uncertainty (*diff_pred*) and business expectations in the left plot, and between uncertainty (*diff_pred*) and the business situation in the right plot. The assessment of the business situation, expectations, and uncertainty are based on questions 1, 2, and 4 in section 2.1, respectively. The categorical values of diff_pred "Easy", "Rather Easy", "Rather difficult", and "Difficult" are coded as -1.5, -0.5, 0.5, and 1.5, respectively.

Figure 12: Uncertainty (*unc*) by combinations of business situation and expectations, excluding the COVID-19 crisis



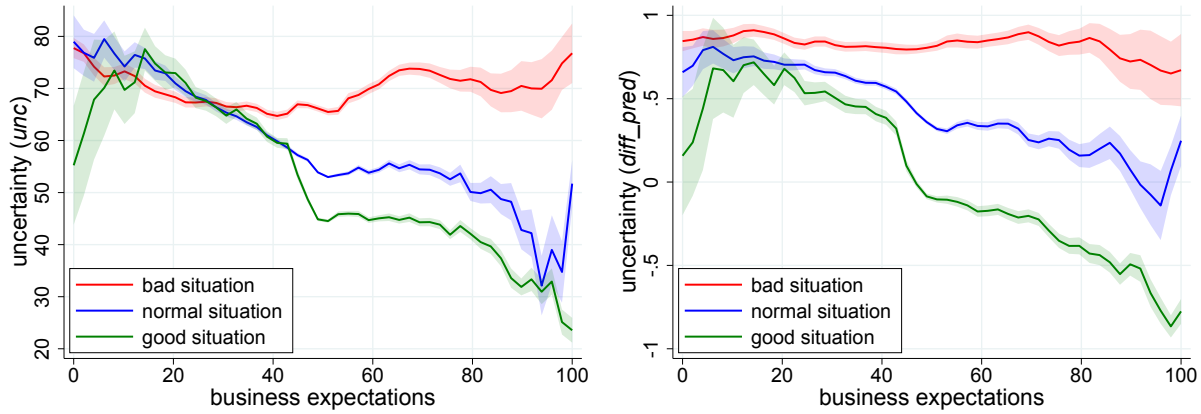
Notes: The bar chart illustrates the mean values of uncertainty (*unc*) by the nine combinations of the categorical responses to the trichotomous questions about the business situation and business expectations outlined in Section 2.1. Each mean is based on at least 1,900 firm-time observations. The plot is based on the subsample from July 2017 to February 2020, which excludes the COVID-19 crisis.

Figure 13: Uncertainty (*diff_pred*) for combinations of business situation and expectations



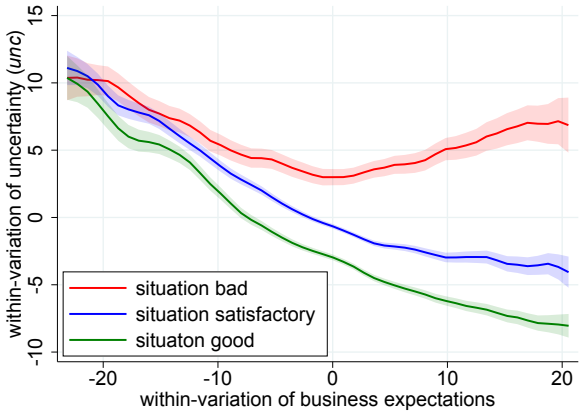
Notes: The bar chart illustrates the mean values of uncertainty (*diff_pred*) by the nine combinations of the categorical responses to the trichotomous questions about the business situation and business expectations described in Section 2.1. Each mean is based on at least 3,000 firm-time observations. For this illustration, the categories of *diff_pred* "Easy", "Rather Easy", "Rather difficult", and "Difficult" are coded as 0, 1, 2, and 3, respectively. The underlying sample spans from April 2019 to July 2020.

Figure 14: Relation of uncertainty (*unc* and *diff_pred*) to expectations, by business situation



Notes: The figure shows two plots with non-parametric kernel regression lines of degree zero with shaded 95% confidence bands for the relationship between uncertainty and business expectations. The three lines in each plot correspond to three subsamples according to the respondents' categorical assessment of their business situation as being bad, normal, or good. The vertical axis of the left plot depicts the uncertainty measure *unc* that is based on question 3 in Section 2.1; for the right plot it is *diff_pred* that is based on question 4 in Section 2.1. Business expectations are based on question 2 in Section 2.1. The categorical values of *diff_pred* "Easy", "Rather Easy", "Rather difficult", and "Difficult" are coded as -1.5, -0.5, 0.5, and 1.5, respectively.

Figure 15: Within variation of uncertainty (*unc*) and expectations, by business situation



Notes: The figure shows three non-parametric kernel regression lines of degree zero with shaded 95% confidence bands for the relationship between the within-variation of uncertainty (*unc*) and the within-variation of expectations. The three lines correspond to three subsamples according to the respondents' categorical assessment of their business situation as being bad, normal, or good. The variables capturing the within-variation are computed as differences from the firm-specific means, respectively. The sample consists of firms with at least 10 responses to question 1, 2, and 3 in in Section 2.1. More than 93% of firm-time observations remain. The top and bottom 5% of the variables at the horizontal axis are excluded for better visibility.

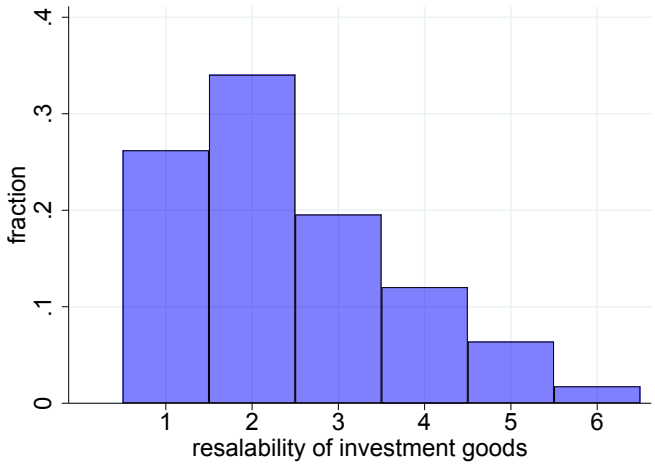
Appendix D Uncertainty, Expectations, and Corporate Decisions

In November 2020, the ifo Business Survey included a special question about the irreversibility of firms' investment. The English translation of the question reads:

Considering your company's main activity, how well would newly acquired devices, equipment or production facilities currently resell if needed? Please consider the time required and the resale price that can be achieved.

badly resalable ☐ ☐ ☐ ☐ ☐ ☐ well resalable

Figure 16: Resalability of investment goods



Note: Histogram of the answer shares of the special question from November 2020 on resalability. Lower numbers on the horizontal axis indicate higher irreversibility: managers perceive their investment goods as more costly or difficult to resell.

Below is the author's English translation of a special question on firms' actions in response to the Corona pandemic in the ifo Business Survey from April 2020. For the baseline analysis in section 5, I use the responses on whether or not businesses reduced employment and whether or not they postponed investment projects. Additional regressions use the responses on short-time work and the cancellation of investment projects.

Which measures has your firm taken in response to the Corona pandemic?

Operations:

☐ Intensified use of working from home

☐ Short-time work

☐ Reduction of time accounts and leave days

☐ Reduction of employment (e.g., lay-offs, desist from extensions)

□ Plant closure, stop of production

□ Increased stock-keeping

□ Change of suppliers / diversification of supply chains

Finances / Investment:

□ Use of existing credit lines

□ Acquisition of new credit lines

□ Application for public liquidity facilities

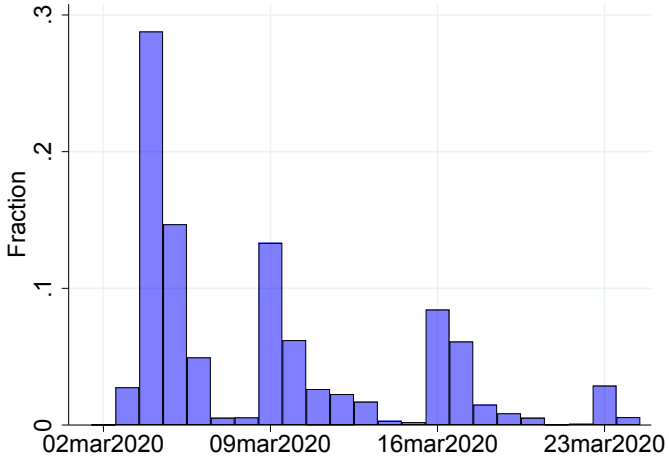
□ Postponement of investment projects

□ Cancellation of investment projects

Table 7: Selected events at the onset of the COVID-19 crisis in Germany

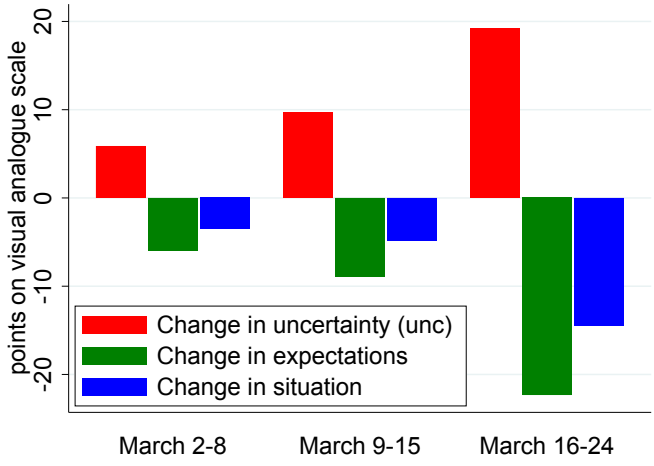
Date	Event
March 2	The German Robert Koch Institute that monitors public health raises the threat level for the population to "moderate" because of COVID-19.
March 6	The German health minister rules out "any measure leading to restrictions on travel" within the European Union.
March 8	Recommendation of the German health minister to cancel events with more than 1000 participants.
March 9	Second death because of COVID-19 in Germany; more than 1,200 verified infections.
March 12	Federal and State governments recommend to avoid gatherings and social contacts.
March 13	Schools and childcare facilities close in almost all federal states.
March 16	German federal borders are closed; start of shutdown in which most shops and many public facilities are being closed.

Figure 17: Histogram of the submission dates of the responses in March 2020



Note: Histogram of the submission dates of the questionnaires of the ifo Business Survey in March 2020. It was conducted from March 2 to March 24.

Figure 18: Changes of uncertainty, expectations, and the business situation in March 2020



Notes: The figure presents changes in subjective uncertainty (*unc*), business expectations and the business situation between three periods in March 2020 (indicated on the horizontal axis) against the averages of the responses from the same groups of firms in February, respectively. These measures are based on the firm-level answers to questions 1, 2, and 3 in Section 2.1. The labels at the vertical axis are numbers from a visual analogue scales that ranges from 0 to 100.

Table 8: Representativeness of subsample of firms responding from March 16 to 24

	March 2 to 15		March 16 to 24	
	Mean	N	Mean	N
Firm characteristics				
Dummy small firms	0.557	4,767	0.546	1,269
Dummy medium firms	0.297	4,767	0.284	1,269
Dummy large firms	0.143	4,767	0.164	1,269
Dummy manufacturing	0.319	4,767	0.251	1,269
Dummy construction	0.093	4,767	0.128	1,269
Dummy wholesale & retail trade	0.245	4,767	0.199	1,269
Dummy services	0.342	4,767	0.422	1,269
Responses in February 2020				
Situation (visual analogue scale)	53.5	3,367	54.7	809
Expectations (visual analogue scale)	51.2	3,370	52.0	806
Uncertainty (*unc*) (visual analogue scale)	55.4	3,367	54.5	804
Dummy situation bad	0.157	4,251	0.136	920
Dummy situation good	0.335	4,251	0.370	920
Dummy expectation unfavorable	0.213	4,251	0.192	920
Dummy expectation favorable	0.178	4,251	0.184	920
Dummy uncertainty (*diff_pred*): easy or rather easy to predict	0.343	4,224	0.357	908
Dummy uncertainty (*diff_pred*): rather difficult to predict	0.532	4,224	0.537	908
Dummy uncertainty (*diff_pred*): difficult to predict	0.125	4,224	0.106	908
Responses in April 2020				
Dummy investment postponed	0.405	4,248	0.426	1,004
Dummy employment reduced	0.151	4,248	0.161	1,004
Dummy investment canceled	0.196	4,248	0.187	1,004
Dummy short-time work	0.471	4,248	0.488	1,004

Notes: The table presents means and the number of observations for a list of variables for two subsamples: firms the responded between March 2 and March 15, and firms that responded between March 16 and March 24. The top panel of the table presents the shares and frequencies of the responses from three size classes and four major economic sectors, respectively. The second panel considers past responses of the firms from February 2020 about the business situation, expectations, and uncertainty. The last panel shows the firms' subsequent responses in April 2020 about investment and employment decisions.

Table 9: Correlation of regressors, levels and changes

	ΔUnc. in $t-1$	Unc. in $t-2$	ΔExp. in $t-1$	Exp. in $t-2$	ΔSit. in $t-1$	Sit. in $t-2$
ΔUnc. in $t-1$	1.00					
Unc. in $t-2$	-0.53	1.00				
ΔExp. in $t-1$	-0.21	0.05	1.00			
Exp. in $t-2$	0.18	-0.32	-0.46	1.00		
ΔSit. in $t-1$	-0.23	0.19	0.47	-0.24	1.00	
Sit. in $t-2$	0.31	-0.49	-0.20	0.53	-0.36	1.00

Notes: Pairwise correlations of main regressors in Table 11: uncertainty (*unc*), expectations, and business situation as levels in February ($t-2$) and as month-over-month changes in March 2020 ($t-1$). These variables are based on the responses to questions 1, 2, and 3 in Section 2.1

Table 10: Relationship between other corporate investment and employment decisions and past uncertainty, expectations, and situation

Dependent variable:	decision: cancellation of investment projects					decision: short-time work				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔUncertainty in $t-1$	0.000401		-0.000121	-0.000101	0.000166	0.000502		-0.000677	-0.000622	-0.000443
	(0.63)		(-0.19)	(-0.16)	(0.25)	(0.61)		(-0.85)	(-0.79)	(-0.54)
Uncertainty in $t-2$	0.00282***		0.00125*	0.000815	0.000839	0.00326***		0.00124	-0.000151	0.00000262
	(3.82)		(1.69)	(1.03)	(1.00)	(3.24)		(1.20)	(-0.15)	(0.00)
ΔExpectations in $t-1$		-0.00280***	-0.00267***	-0.00171**	-0.00173**		-0.00575***	-0.00573***	-0.00246***	-0.00208**
		(-4.51)	(-4.04)	(-2.44)	(-2.45)		(-6.23)	(-6.04)	(-2.59)	(-2.08)
Expectations in $t-2$		-0.00613***	-0.00548***	-0.00412***	-0.00466***		-0.00689***	-0.00615***	-0.00167	-0.00130
		(-6.20)	(-5.39)	(-3.88)	(-4.17)		(-5.44)	(-4.62)	(-1.22)	(-0.93)
ΔSituation in $t-1$				-0.00214***	-0.00257***				-0.00725***	-0.00627***
				(-2.86)	(-3.08)				(-8.03)	(-6.23)
Situation in $t-2$				-0.00251***	-0.00226**				-0.00825***	-0.00576***
				(-3.07)	(-2.42)				(-7.56)	(-4.79)
Dummy medium sized firms					-0.00978					0.0869*
					(-0.28)					(1.93)
Dummy large firms					0.0544					0.106*
					(1.13)					(1.85)
Constant	0.0107	0.430***	0.333***	0.416***	0.303***	0.296***	0.715***	0.623***	0.891***	0.101
	(0.22)	(8.07)	(4.33)	(4.61)	(2.70)	(4.33)	(11.70)	(6.25)	(8.14)	(0.81)
Sector dummies					YES					YES
No. of firms.	653	653	653	653	653	653	653	653	653	653
R-sq.	0.024	0.063	0.069	0.085	0.18	0.018	0.070	0.076	0.18	0.32

Notes: Results from OLS regressions. The dependent variable in columns 1 to 5 is a dummy for the decision to cancel investment projects because of the COVID-19 crisis, in columns 6 to 10 it is a dummy for the decision to implement short-time work because of the COVID-19 crisis. Information on firms' decisions stems from the ifo Business Survey in April 2020. The regressors are levels of uncertainty (*unc)*, expectations, and business situation from February 2020, and month-over-month changes from March 2020. These measures are based on the responses to questions 1, 2, and 3 in Section 2.1. t-statistics in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 11: Robustness probit models: relationship corporate decisions and past uncertainty, expectations, and situation

Dependent variable:	decision: postponement of investment					decision: reduction of the number of employees				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔUncertainty in $t-1$	0.00174**		0.000709	0.000631	0.000579	0.000294		-0.000240	-0.000279	-0.000240
	(2.10)		(0.86)	(0.77)	(0.73)	(0.43)		(-0.38)	(-0.46)	(-0.41)
Uncertainty in $t-2$	0.00564***		0.00464***	0.00456***	0.00387***	0.00219***		0.000727	0.000679	0.000427
	(5.91)		(4.57)	(4.27)	(3.65)	(2.69)		(0.94)	(0.87)	(0.54)
ΔExpectations in $t-1$		-0.00535***	-0.00459***	-0.00312***	-0.00322***		-0.00305***	-0.00300***	-0.00147*	-0.00147*
		(-5.80)	(-4.80)	(-2.96)	(-3.13)		(-3.63)	(-3.54)	(-1.77)	(-1.77)
Expectations in $t-2$		-0.00455***	-0.00222	-0.000945	-0.00102		-0.00561***	-0.00522***	-0.00374***	-0.00390***
		(-3.59)	(-1.64)	(-0.64)	(-0.70)		(-5.25)	(-4.71)	(-3.20)	(-3.40)
ΔSituation in $t-1$				-0.00330***	-0.00344***				-0.00315***	-0.00337***
				(-3.31)	(-3.50)				(-4.09)	(-4.40)
Situation in $t-2$				-0.00210*	-0.00170				-0.00214**	-0.00209**
				(-1.76)	(-1.43)				(-2.47)	(-2.50)
Dummy medium sized firms					0.00947					0.0671**
					(0.22)					(2.14)
Dummy large firms					0.0445					0.0651*
					(0.87)					(1.72)
Sector dummies					YES					YES
No. of firms.	653	653	653	653	653	653	653	653	653	653
Pseudo R-sq.	0.038	0.040	0.065	0.078	0.10	0.019	0.075	0.079	0.11	0.13

Notes: Average marginal effects from probit regressions. The dependent variable in columns 1 to 5 is a dummy for the decision to postpone investment projects because of the COVID-19 crisis, in columns 6 to 10 it is a dummy for the decision to reduce employment because of the COVID-19 crisis. Information on these corporate decisions stems from the ifo Business Survey in April 2020. The regressors are levels of uncertainty (*unc)*, expectations, and business situation from February 2020, and month-over-month changes from March 2020. These measures are based on the responses to questions 1, 2, and 3 in Section 2.1. Sector dummies refer to the broad sectors manufacturing, construction, trade, and services. t-statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Robustness measurement error: relationship corporate decisions and past uncertainty, expectations, and situation

Dependent variable:	decision: postponement of investment					decision: reduction of the number of employees				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ΔUncertainty* in $t-1$	0.000309		-0.00155	-0.00185	-0.00225	0.000600		0.000104	-0.000174	-0.000180
	(0.15)		(-0.73)	(-0.89)	(-1.03)	(0.36)		(0.06)	(-0.10)	(-0.11)
Uncertainty* in $t-2$	0.00477***		0.00301*	0.000752	-0.000484	0.00302**		0.00127	-0.000255	-0.000542
	(2.93)		(1.76)	(0.41)	(-0.25)	(2.33)		(0.95)	(-0.18)	(-0.39)
ΔExpectations* in $t-1$		-0.0103***	-0.0103***	-0.00825***	-0.00791***		-0.00595***	-0.00577***	-0.00365**	-0.00235
		(-4.83)	(-4.75)	(-3.67)	(-3.39)		(-4.67)	(-4.30)	(-2.49)	(-1.43)
Expectations* in $t-2$		-0.00869***	-0.00710***	-0.00483**	-0.00466**		-0.00749***	-0.00693***	-0.00487***	-0.00444***
		(-4.54)	(-3.54)	(-2.36)	(-2.18)		(-5.70)	(-4.94)	(-3.54)	(-3.03)
ΔSituation* in $t-1$				-0.00620***	-0.00670***				-0.00601***	-0.00587***
				(-3.59)	(-3.57)				(-4.65)	(-4.31)
Situation* in $t-2$				-0.00531***	-0.00492***				-0.00401***	-0.00332***
				(-4.06)	(-3.23)				(-4.35)	(-3.22)
Dummy medium sized firms					0.0280					0.0270
					(0.58)					(0.73)
Dummy large firms					0.0254					-0.00868
					(0.40)					(-0.20)
Constant	0.128	0.705***	0.469***	0.740***	0.233	-0.0336	0.444***	0.343***	0.516***	0.151
	(1.15)	(8.44)	(2.99)	(4.11)	(1.36)	(-0.38)	(6.67)	(2.72)	(3.44)	(1.11)
Sector dummies					YES					YES
No. of firms.	629	629	629	629	629	629	629	629	629	629
R-sq.	0.018	0.038	0.048	0.079	0.19	0.012	0.045	0.047	0.090	0.24

Notes: Results from OLS regressions. The dependent variable in columns 1 to 5 is a dummy for the decision to postpone investment projects, in columns 6 to 10 it is a dummy for the decision to reduce employment. Information on firms' decisions stems from the ifo Business Survey in April 2020. The right hand side variables marked with a star contain predicted values from regressions of the levels of uncertainty (*unc)*, expectations, and business situation elicited using visual analogue scales in February 2020 on their categorical counter-parts, respectively. The other regressors marked with a star are predicted values from regressions of monthly changes in the visual analogue scale variables on changes in the categorical variables in March 2020. In case of uncertainty (*unc*), the predicted values stem from regressions on *diff_pred*. This implements the Obviously Related Instrumental Variable approach to account for independent and identically distributed measurement error. The regressors are based on the responses to questions 1, 2, 3, and 4 as well the categorical questions on business expectations and the situation presented in Section 2.1. t-statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: Robustness uncertainty *diff_pred*: Relationship corporate decisions and past uncertainty, expectations, and situation

Dependent variable:	decision: postponement of investment					decision: reduction of the number of employees				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Uncertainty: negative change in $t-1$	0.111		0.0885	0.0896	0.0909	0.0349		0.0117	0.0107	0.0303
	(1.35)		(1.12)	(1.15)	(1.17)	(0.53)		(0.18)	(0.16)	(0.51)
Uncertainty: positive change in $t-1$	0.0968**		0.0369	0.0246	0.0182	0.0558**		0.0288	0.0136	0.000453
	(2.48)		(0.90)	(0.60)	(0.42)	(2.13)		(1.02)	(0.49)	(0.02)
Uncertainty: dummy 'rather difficult' in $t-2$	0.0986***		0.0645	-0.00123	-0.0324	0.0472*		0.0106	-0.0269	-0.0228
	(2.59)		(1.63)	(-0.03)	(-0.69)	(1.81)		(0.38)	(-0.89)	(-0.74)
Uncertainty: dummy 'difficult' in $t-2$	0.263***		0.164**	0.0757	0.0311	0.209***		0.123**	0.0718	0.0369
	(3.77)		(2.23)	(0.96)	(0.37)	(3.55)		(1.98)	(1.12)	(0.59)
Expectations: negative change in $t-1$		0.218***	0.191***	0.161***	0.143***		0.114***	0.0974***	0.0626**	0.0320
		(5.42)	(4.39)	(3.62)	(3.02)		(5.20)	(3.93)	(2.50)	(1.13)
Expectations: positive change in $t-1$		-0.101	-0.102	-0.0942	-0.0804		-0.0772	-0.0723	-0.0542	-0.0619
		(-1.09)	(-1.09)	(-1.01)	(-0.79)		(-1.24)	(-1.18)	(-0.88)	(-1.10)
Expectations: dummy 'favorable' in $t-2$		0.00574	0.0223	0.0241	0.0321		-0.0193	-0.0150	-0.0124	-0.00517
		(0.13)	(0.51)	(0.55)	(0.70)		(-0.69)	(-0.51)	(-0.42)	(-0.16)
Expectations: dummy 'unfavorable' in $t-2$		0.302***	0.249***	0.177***	0.198***		0.252***	0.223***	0.160***	0.140***
		(5.42)	(4.20)	(2.81)	(2.98)		(5.74)	(4.76)	(3.40)	(2.99)
Situation: negative change in $t-1$				0.119***	0.138***				0.131***	0.114***
				(2.89)	(3.14)				(4.40)	(3.82)
Situation: positive change in $t-1$				-0.0395	-0.0609				-0.0589	-0.0761*
				(-0.60)	(-0.90)				(-1.40)	(-1.71)
Situation: dummy 'good' in $t-2$				-0.136***	-0.142***				-0.0665**	-0.0312
				(-3.24)	(-3.08)				(-2.30)	(-1.01)
Situation: dummy 'bad' in $t-2$				0.109*	0.0833				0.114**	0.120**
				(1.78)	(1.29)				(2.39)	(2.46)
Dummy medium sized firms					0.0463					0.0457
					(1.07)					(1.44)
Dummy large firms					0.0596					0.0288
					(1.02)					(0.70)
Constant	0.279***	0.240***	0.185***	0.263***	0.812***	0.0657**	0.0431***	0.0218	0.0545*	-0.0385
	(7.10)	(7.28)	(4.35)	(5.08)	(9.05)	(2.53)	(2.88)	(0.86)	(1.76)	(-0.64)
Sector dummies					YES					YES
No. of firms.	775	775	775	775	775	775	775	775	775	775
R-sq.	0.025	0.046	0.056	0.078	0.17	0.024	0.051	0.058	0.091	0.24

Notes: Results from OLS regressions. The dependent variable in columns 1 to 5 is a dummy for the decision to postpone investment projects because of the COVID-19 crisis, in columns 6 to 10 it is a dummy for the decision to reduce employment because of the COVID-19 crisis. Information on firms' decisions stems from the ifo Business Survey in April 2020. The regressors are dummies for the levels of uncertainty (*diff_pred)*, expectations, and business situation from February 2020, and dummies for month-over-month changes from March 2020. These measures are based on the responses to question 4 and the categorical questions on business expectations and the situation presented in Section 2.1. t-statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.