Firm Expectations and News: Micro v Macro*

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Abstract

Using firm-level data, we study how firm expectations adjust to news while accounting for a) the heterogeneity of news and b) the heterogeneity of firms. We classify news as either micro or macro, that is, information about firm-specific developments or information about the aggregate economy. Survey data for German and Italian firms allows us to reject rational expectations: Both types of news predict forecast errors *at the firm level*. Yet while firm expectations overreact to micro news, they underreact to macro news. We propose a general-equilibrium model where firms suffer from 'island illusion' to explain these patterns in the data.

Keywords: Survey data, salience, overreaction, underreaction, micro news, macro news, island illusion, business cycle

JEL-Codes: D84, C53, E71

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1 Introduction

How do firms adjust their expectations to news? Addressing this question yields important insight into their expectation-formation process. *Rational expectations* provide a natural benchmark. In this case, forecast errors are possible but not predictable based on information that is available to the forecaster in real-time—since expectations adjust correctly and instantaneously to news. If, instead, news predicts *positive* forecast errors, expectations adjust too little: they underreact relative to the rational-expectations benchmark. If news predicts *negative* forecast errors, expectations overreact to news. Recent work studies systematically and at different levels of aggregation how news impacts forecast errors, mostly relying on surveys of professional forecasters (Coibion and Gorodnichenko 2015; Bordalo et al. 2020; Broer and Kohlhas 2023).

Against this background, our study offers a new perspective because it relies on a large panel of firm expectations. As a result, we are able to account for heterogeneity in the expectation-formation process along two dimensions. First, we study news of different types. While professional forecasters are surveyed about aggregate indicators, firms in our sample report expectations about firm-specific developments. In this context, we can classify news as either micro or macro, with micro news being information about firm-specific developments and macro news being information about the aggregate economy that, in turn, matters for (expectations about) firm-specific developments, too. Second, by focusing on firm expectations instead of professional forecasters' expectations, we can exploit a much larger and richer data set and probe into the role of (firm) heterogeneity in the expectation-formation process. Specifically, we rely on the ifo survey of German firms, which features responses from some 1,500 firms each month and covers 15 years of data. In addition, we verify that our main results also hold for the Banca d'Italia's "Survey on Inflation and Growth Expectations" (SIGE) of Italian firms.

We find that the distinction between micro and macro news is essential: firm expectations overreact to micro news, but simultaneously underreact to macro news. This pattern emerges robustly across a variety of specifications and for all firm types that we consider (e.g., small and large, young and old). It also holds for different measures of expectations and different outcome variables. The variation of overreaction across firms is also systematically related to measures of firm performance. To rationalize these results, we put forward a stylized general-equilibrium model. It builds on the dispersed information model of Lorenzoni (2009), but assumes, in addition, that firms suffer from 'island illusion': They systematically underestimate the importance of aggregate developments for their own performance. This departure from rational expectations allows the model to predict simultaneous over- and underreaction to micro and macro news.

More in detail, the first part of the paper presents new evidence on how firms' expectations change in response to news. This evidence is based on data from the ifo survey of German firms, which is a well-known and widely used survey that has been conducted since 1949 and whose design has since then been adopted by surveys around the world (Becker and Wohlrabe 2008; Born et al. 2022). Our data covers the period from April 2004 to December 2019. We first focus on firms' expectations about their production over the next three months, which are reported in a qualitative manner. This raises some challenges in defining forecast errors, which we address in Section 2 below. However, our results are robust once we consider quantitative measures of expectations based on both, the ifo survey and SIGE.

To study how firm expectations respond to news, we adopt the framework of Coibion and Gorodnichenko (2015), which is by now widely used in the literature. The idea is straightforward: we regress firms' forecast errors about the change of production over the next three months on news that is available in the current month. We approximate what is news to firms by their forecast revision, that is, the change in what they report as production expectations. Importantly, these revisions may reflect firm-specific news (micro news) or news about the aggregate economy (macro news). We isolate the effect of the micro component as we purge a firm's forecast revision of the firm-specific impact of a set of macroeconomic indicators that are available in real-time and by controlling for macro news.

To construct macro news, we rely on the ifo *business climate index*, which is an aggregate indicator of the German business cycle compiled on the basis of the ifo survey. This index is widely watched and Bloomberg samples a consensus forecast prior to its release. The difference between the current release of the index and the consensus forecast, both available in real-time, provides us with a natural measure of macro news. Two aspects are important to note. First, the ifo index is constructed by aggregating expectations across firms in the survey such that micro and macro news are directly comparable but differ in the level of aggregation. Second, regarding the timing, we note that macro news is released at the end of the previous month and is thus available as firms report their forecast in the current month—just like micro news. For these reasons, both micro and macro news should not predict the forecast error under rational expectations. And yet, our first key result, based on firm-level and pooled panel regressions, is that they do so robustly.

Our second result is that they do so in systematically different ways. Macro news, or information about the overall economy, tends to lead to positive forecast errors, meaning that actual production ends up exceeding expectations. More concretely, if the current ifo index surprises positively, a firm's production is likely to exceed its expectation over the course of the next three months. In this sense, firm expectations do not fully account for macro news as it becomes available: they underreact to macro news. Micro news, instead, has a negative effect on the forecast error, that is, an upward revision of production expectations tends to be followed by a worse-than-expected output performance. Firm expectations respond too strongly to micro news: they overreact.

We find that these patterns are a robust feature of our data set. They emerge for alternative definitions of news and forecast errors and also once we consider firms' business expectations which are reported on a quantitative scale and pertain to a 6-month horizon. We also determine whether our findings generalize beyond the ifo survey, which we use as our main data source. To do this, we turn to the SIGE. This survey provides us with a measure of firms' quantitative price expectations over a 12-month horizon, and we can use it to measure micro and macro news as we do in the ifo survey. And just like for the ifo survey, we find that firm expectations overreact to micro news but underreact to macro news.

In addition to analyzing the overall response to news using a panel of pooled observations, we also examine how individual firms respond to news by taking advantage of the large number of consecutive observations available for most firms in the ifo survey. We find that overreaction to micro news is a pervasive feature across firms. Firm-level estimates are consistently negative and tightly distributed in a narrow range. There is no economically significant difference in estimates across firm characteristics, such as firm size or firm age. The response to macro news is somewhat more dispersed across firms. Although there is underreaction for most firms, firms differ in how strongly they underreact to macro news. Larger firms, for instance, underreact more strongly. This result may reflect a stronger impact of the macroeconomy on the production—and hence the forecast errors—of larger firms.

The estimated response coefficients also vary over time, although they do not change their signs. The underreaction to macro news is strongest during the Great Recession, reflecting a more substantial impact of the macroeconomy in turbulent times. We also find that underreaction and overreaction are persistent over time—forecast errors respond not only to current but also to past news. This finding suggests that our results are not caused by measurement error. Lastly, we establish that the variation in the reaction to news across firms correlates with firm-level outcomes in a systematic way. We find, in particular, that a stronger overreaction to micro news is associated with lower profits, and both overreaction to micro news and underreaction to macro news is associated with higher firm-level production and forecast-error volatility. These findings are consistent with earlier work which shows that firm expectations matter for firm outcomes (Bachmann et al. 2013; Enders et al. 2022).

In the last part of the paper, we put forward a general equilibrium model in order to rationalize our findings. The model builds on Lorenzoni (2009), which in turn is based on Lucas (1972), but can be solved in closed form. In addition to the noisy-information structure of the original model, we assume that firms are prone to 'island illusion,' meaning that they tend to underestimate the influence of overall economic conditions on their own performance. We think of island illusion as an instance of salience, which Taylor and Thompson (1982) define as "the phenomenon that when one's attention is differentially directed to one portion on the environment rather than to others, the information contained in that portion will receive disproportionate weighing in subsequent judgments" (see also Bordalo et al. 2013). Island illusion is hence consistent with the notion that firm-specific developments are salient stimuli to firms because they attract firms' attention "bottom-up, automatically and involuntarily" (Bordalo et al. 2022). As such, they feature disproportionately in firms' expectation-formation process—while other sources of information have to be gathered and processed actively.[1]

Our model setup differs from earlier work by Bordalo et al. (2020) and Broer and Kohlhas (2023) as we model the response of expectations about firm-level outcomes in a fully specified general-equilibrium setting. This is essential in the context of our analysis because it allows us to account for the cross-equation restrictions which govern the impact of micro and macro news on firm expectations. In the model, information is dispersed across firms. Firms observe their own developments plus a public signal and use this information to forecast sales. Prices are set before actual demand is observed. Firms are then assumed to adjust production in order to meet demand given posted prices. Consequently, the aggregate state of the economy is important for firms when it comes to forecasting their own production. The model is sufficiently stylized so that we can derive our main result in closed form: We show that island illusion causes firm expectations to overreact to micro news and underreact to macro news. It also accounts for how differences in the response to news across firms correlate with firm outcomes, such as profits and forecast-error volatility.

The rest of the paper is organized as follows. In the remainder of the introduction, we place the paper's contribution in the context of the literature. Section 2 provides details about our data set. In Section 3, we introduce our empirical framework and present the results. We develop and solve a general equilibrium model with dispersed information and island illusion in Section 4. The final section offers some conclusions.

Related Literature. Our paper builds on three strands of the literature. First, at an empirical level, our work relates to the literature which is concerned with macroeconomic expectations of firms, see, for instance, Andrade et al. (2022), Coibion et al. (2018, 2020), and Savignac et al. (2021), as well as the recent survey by Candia et al. (2022). In contrast, our focus is on firm expectations about firms' own performance. Here, only a limited number of

[1] Bianchi et al. (2022) use a machine-learning algorithm to estimate time-varying systematic expectational errors and find that—consistent with our notion of island illusion—survey respondents place too much weight on the private or judgmental component of their forecasts and too little weight on publicly available economic information.

studies have analyzed firm expectations about firm outcomes (see Born et al. 2022). Massenot and Pettinicchi (2018), in particular, use ifo data as well, regressing expectations and forecast errors on past changes of the business situation (rather than on forecast revisions). They find the regression coefficient is positive and significant, and refer to this result as "over-extrapolation". Enders et al. (2019), in turn, take a macro perspective and document that the response of firm expectations to monetary policy shocks is non-linear in the size of the shock. Neither of these studies distinguishes between the response to micro and macro news.

Second, our empirical setup builds on a framework that has been popularized by Coibion and Gorodnichenko (2015), see Born et al. (2024) for a survey. Importantly, as in Bordalo et al. (2020), we estimate our model at the level of individual forecasters.[2] Predictable forecast errors at this level allow us to reject rational expectations. But this does not imply a rejection of rationality *per se*: Predictable forecast errors may emerge because of forecasters' asymmetric loss function, specific constraints on information processing, or in a learning environment with parameter uncertainty (e.g., Elliott et al. 2008; Farmer et al. 2023; Kohlhas and Roberston 2022; Bachmann et al. 2023).[3]

Lastly, our paper relates to theoretical work that accounts for behavioral aspects in expectation formation.[4] Models of *level-K thinking*, *cognitive discounting* and *sticky expectations* can rationalize why there is underreaction to current news (e.g., Farhi and Werning 2019; García-Schmidt and Woodford 2019; Gabaix 2020; Bouchaud et al. 2019; Carroll et al. 2020), while *constrained memory* may account for overreaction (Azeredo da Silveira and Woodford 2019). Ba et al. (2023) show that bounded rationality at various stages of belief formation can lead to both over- and underreaction. Potentially unrepresentative media reporting or, more broadly, *narratives* may also distort the expectation formation process (Shiller 2017; Chahrour et al. 2021; Andre et al. 2022). Our model of island illusion is conceptually closely related to *diagnostic expectations* and *overconfidence* (Bordalo et al. 2019, 2020; Broer and Kohlhas 2023). It differs from these approaches in simultaneously accounting for under- and overreactions in a general-equilibrium setting. Such a setting is key because it allows us to model expectations about firm outcomes based on micro and macro news consistently.

[2] See also Angeletos et al. (2021), Broer and Kohlhas (2023), and Kučinskas and Peters (2022) for further evidence on the reaction to news of households, professional forecasters, or participants of experiments.

[3] However, we stress that models that abandon the full information assumption in favor of noisy information still predict that forecast errors should not be predictable at the level of individual forecasters (see, again Coibion and Gorodnichenko 2015; Bordalo et al. 2020). This includes models of rational inattention (e.g., Mackowiak and Wiederholt 2009).

[4] Under certain conditions, behavioral models and incomplete information models give rise to equivalent equilibrium effects (Angeletos and Huo 2021).

2 Measuring forecast errors and news

In this section, we first introduce the data set for our empirical analysis. It is centered around the ifo survey of German firms. We also provide details on the construction and descriptive statistics of firms' forecast errors and the news measures.

2.1 The ifo survey

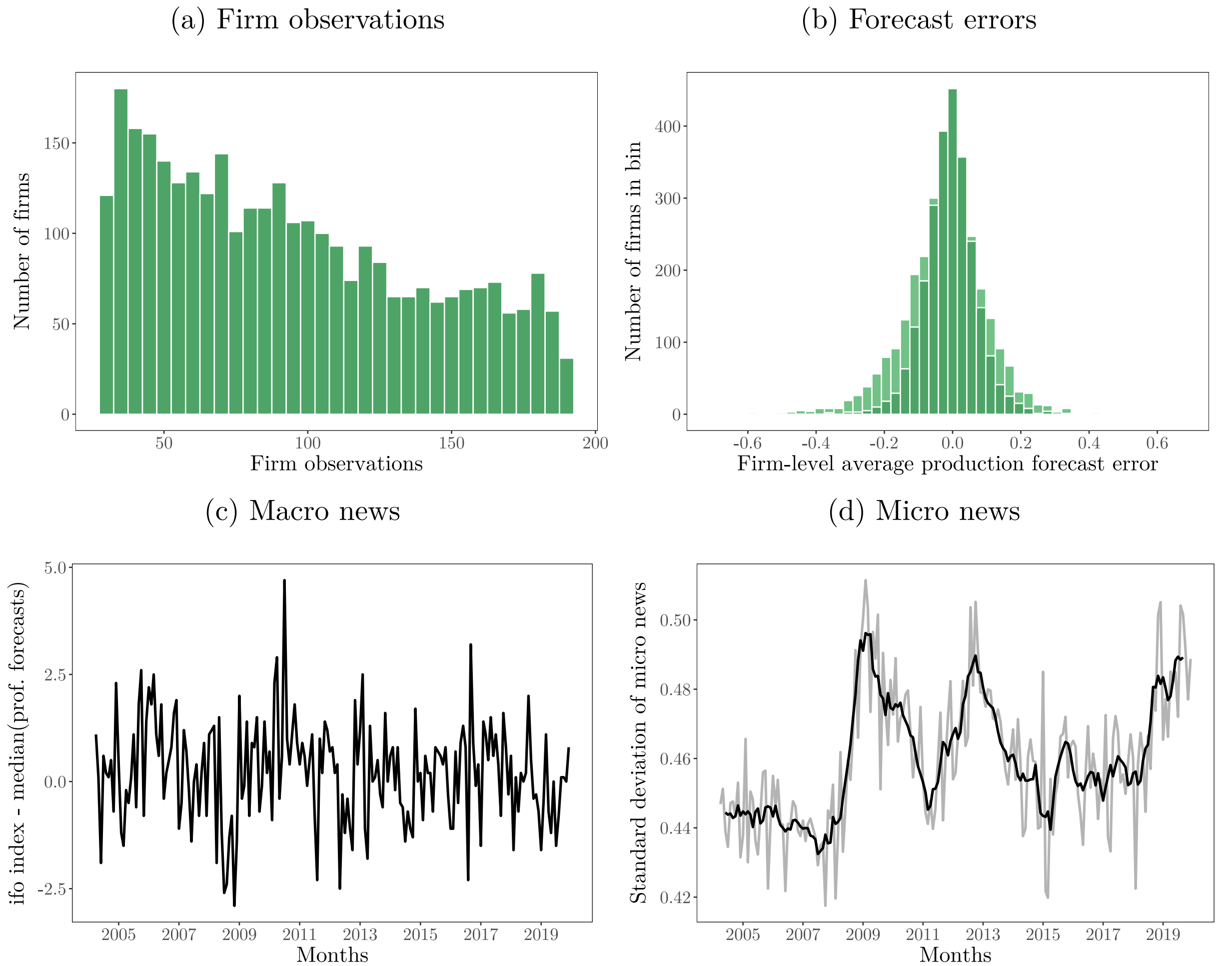
The ifo survey is a mostly qualitative, monthly survey among German firms and representative of the German economy (Hiersemenzel et al. 2022).[5] While the ifo survey was launched in 1949—and some aggregate statistics based on it were first used by Theil (1955)—the underlying micro data is available for research since 1980. Participation is voluntary and firms only receive non-monetary compensation in the form of sectoral and aggregate results of the survey. The individual filling a firm's questionnaire is a member of the senior management, 85 percent are CEOs or department heads (Sauer and Wohlrabe 2019). Response rates for the ifo survey are generally high: Out of all firms initially contacted in mid-2021, around two-thirds returned at least two surveys. For the comparable Survey of Business Uncertainty in the United States, the response rate is around one-third only (Altig et al. 2022). Response rates remain high also after initial contact, with an average monthly response rate of 82 percent; the sample attrition is moderate (Enders et al. 2022).

Our analysis below relies on measures of firms' forecast errors and news and builds on three main components: (i) the ifo Business Climate *Survey* in the manufacturing sector (IBS-IND 2020, from now on "ifo survey"), (ii) the ifo Business Climate *Index* (ifo index), and (iii) the Bloomberg consensus forecasts for the ifo index. Our sample is restricted by limited data availability of the Bloomberg forecasts and runs from April 2004 to December 2019.

To measure firm expectations and forecast errors, we rely on the ifo survey. It features a core set of questions, including questions about expected and realized production, prices, and business situation, where firms can report either an increase, no change, or a decrease. While this makes quantitative statements challenging, the qualitative nature arguably reduces the room for measurement error. In our empirical analysis, we rely on time-series data at the level of individual firms. Therefore, we restrict our sample to those firms which are in the survey for at least 30 months and which exhibit some time-series variation in their expectations and expectation errors. In any given month, this leaves us with more than 1,000 responses and often more than 1,500. Panel (a) of Figure 1 plots the distribution of firms

[5] Quantitative questions were added in 2005, distributional questions in 2013, see Bachmann et al. (2020, 2021) for details. While the survey is technically at the product level, we follow the literature and treat each respondent as a separate firm (e.g., Bachmann et al. 2019; Born et al. 2022; Enders et al. 2022).

Figure 1: The ifo survey, forecast errors, and news



Notes: Panel (a): distribution of monthly firm observations, i.e., the number of firms for which a firm-specific time series of a certain length is available. Panel (b): histogram of firm-level average forecast errors for production. The color indicates if estimates are significantly different from zero at the five percent level (light green) or not (dark green). Panel (c): macro news over time, defined as the surprise in the ifo index compared to median professional forecasts, see Equation (2). Panel (d): cross-sectional standard deviation of micro news over time, defined as the residuals of a regression of forecast revisions on real-time economic indicators, see Equation (4). The grey line depicts the standard deviation of micro news at a monthly level and the black line depicts the six-month rolling average.

sorted according to the number of months a firm is in the sample. The median firm is in the survey for around 90 months and 25 percent of firms are in the survey for more than 130 months. We exploit the fact that we have fairly long time series available for individual firms in our analysis in Section 3. In particular, it allows us to characterize the heterogeneity of the expectation-formation process systematically.

2.2 Forecast errors

To construct firms' forecast errors, we follow the approach of Bachmann et al. (2013) and focus on expected and realized production as reported in the ifo survey. Here, firm j reports for its own production the realized change over the previous month $x^j_{t,t-1} \in \{-1, 0, 1\}$ and the expected change over the following three months $F^j_t(x^j_{t+3,t}) \in \{-1, 0, 1\}$, see Appendix-Table A.1 for the exact wording of the survey questions. To harmonize the time horizons, we aggregate the realized changes over the following three months: $x^j_{t+3,t} = \sum_{s=0}^{2} x^j_{t+s+1,t+s}$. Given the aggregated realized and expected changes, we define the forecast error as:

$$x^j_{t+3,t} - F^j_t(x^j_{t+3,t}) = \begin{cases} 0 & \text{if } \text{sign}\{x^j_{t+3,t}\} = \text{sign}\{F^j_t(x^j_{t+3,t})\}, \\ \frac{1}{3}[x^j_{t+3,t} - F^j_t(x^j_{t+3,t})] & \text{else.} \end{cases} \tag{1}$$

When the signs of the aggregated realized change and the expected change coincide, no error is assigned. In all other cases, the forecast error is equal to the difference between the realized and the expected change, standardized by the forecasting horizon of three months.

Generally, we find forecast errors to be well-behaved. Panel (b) of Figure 1 shows the distribution of forecast errors: More than 75 percent of firm-level average forecast errors are not significantly different from zero. And while these forecast errors are based on qualitative rather than quantitative data, Born et al. (2022) show that key facts which characterize firms' forecast errors emerge robustly from qualitative and quantitative data and across countries.

2.3 Macro news

To measure macro news, we compute the *surprise component* of the ifo *index.* The ifo index is compiled on the basis of the ifo survey by the ifo Institute and is a widely watched indicator of the German business cycle (Carstensen et al. 2020; Lehmann 2023). The index is based on firms' responses about their current business situation and their business expectations over the next 6 months, see again Appendix-Table A.1 for the wording of the survey question.[6] The index is compiled as follows:

$$\text{business climate}_t = \sqrt{(\text{business situation}_t + 200)(\text{business expectation}_t + 200)} - 200 \ ,$$

where business situation$_t$ and business expectation$_t$ are balances, that is, the share of positive answers ("increase") minus the share of negative answers ("decrease") across firms in month t. For publication, the ifo institute reports the business climate as an index relative to a base year (Sauer and Wohlrabe 2018).

[6]Since April 2018, the index also includes responses from service-sector firms (Sauer and Wohlrabe 2018).

We measure the surprise component in the ifo index based on professional forecasts for the ifo index, available from the Bloomberg consensus survey. In this survey, professional forecasters can submit and update their forecasts of macroeconomic indicators, for example, GDP, employment, and confidence indexes, up until they are released. In the literature, these forecasts have been used to assess the impact of news on long-term treasury bonds (Altavilla et al. 2017) and stock prices (Elenev et al. 2022; Born et al. 2023; Gilbert et al. 2017; Kurov et al. 2019); see also the construction of uncertainty indexes by Scotti (2016) and the nowcast errors by Enders et al. (2021). For the German ifo index and starting in April 2004, the Bloomberg survey features some 40 professional forecasters.

We construct macro news as the difference between the published ifo index and the median professional forecast of the ifo index from Bloomberg. The timing is key: In the first three weeks of month $t-1$, firms respond to the survey. Until the last week of month $t-1$, professional forecasters submit their forecasts for the ifo index in $t-1$ to Bloomberg. In the last week of month $t-1$, the ifo institute then publishes the value of the ifo index. In the first three weeks of month t and after observing the macro news, firms again fill out the ifo survey. Formally, we define macro news, as observable at the beginning of month t as follows:

$$\text{macro news}_t = \text{ifo index}_{t-1} - \text{median}(\text{professional forecasts for ifo index}_{t-1})\ . \tag{2}$$

We display the resulting time series of macro news in Panel (c) of Figure 1.

We can be confident that macro news is part of the information set of firms when forecasting their production in t. First, media attention to the index as well as its professional forecasts is high due to its predictive power for the German business cycle. The ifo index is ranked among Bloomberg's "12 Global Economic Indicators to Watch" and news outlets report on both the realized value and, importantly, the professional forecasts.[7] Second, information about the aggregate index (as well as the sectoral results) is given to firms as compensation for their participation in the survey by the ifo institute at the end of month $t-1$.

[7]Examples include leading weekly newspapers *Der Spiegel* and *Die Zeit.* Der Spiegel ("Unternehmen sind wegen vierter Coronawelle äußerst besorgt", 24 November 2021) discusses the November 2021 index value of 96.5 as well as the professional forecast of 96.6. Die Zeit ("Geschäftsklimaindex überraschend gestiegen", 25 January 2022) reports that, contrary to professional forecasts, the January 2022 index value increased by 0.9 points compared to the previous month.

2.4 Micro news

Our measure of micro news is based on forecast revisions. Formally, we define the forecast revision of firm j in month t, FR_t^j, as the first difference of production expectations:

$$FR_t^j = \text{sign}\{F_t^j(x_{t+3,t}^j) - F_{t-1}^j(x_{t+2,t-1}^j)\} \ , \tag{3}$$

which is equal to 0 when there is no change in expectations, equal to +1 for an upward revision (for example, from no change in $t-1$ to an increase in t), and equal to -1 for a downward revision (for example, from no change in $t-1$ to decrease in t).

As the forecast horizon is fixed at 3 months, the overlap in the monthly forecast revisions is two months. In what follows, we thus assume that forecast revisions reflect mostly news (rather than changes in the forecast horizon).[8] To assess the informativeness of the forecast revisions, we relate the average forecast revisions over time to German manufacturing production growth, see Figure A.1 in the appendix. It turns out that the average forecast revision is a leading indicator for changes in manufacturing production. This is especially visible during the Great Recession and in 2018/2019 when the manufacturing sector cooled down considerably.

Importantly, firms are likely to revise expectations about their own production either because their expectations about the macroeconomy change or because they expect changes in their business conditions due to idiosyncratic developments. Hence, in our analysis below, we control for macro news in order to isolate the effect of micro news which is reflected in the forecast revision. This yields our baseline specification.

In addition, to ensure that forecast revisions are not driven by a macro component, we consider an alternative measure of micro news, which we obtain by purging firms' forecast revisions of the potential impact of macroeconomic indicators that are observable at the beginning of month t. In this specification, we obtain micro news as the residual of the following regression:

$$FR_t^j = \gamma_j \Gamma_t + \text{micro news}_t^j \ . \tag{4}$$

The vector of macroeconomic indicators Γ_t includes the real-time monthly changes in German industrial production, the CPI, manufacturing orders, the stock market index DAX, as well as month-fixed effects to control for potential seasonality. There are two attractive features of this set-up: i) We only add *observed* changes of the state of the macroeconomy—after

[8]In Section 3, we demonstrate that our findings also hold for alternative specifications where the overlap is more substantial.

Table 1: Macro news and forecast revisions

	$\widehat{\beta}$	$SE(\widehat{\beta})$
Macro News	0.008	0.001
Macro News		
× 1. Quartile by employees	0.007	0.002
× 2. Quartile by employees	0.008	0.002
× 3. Quartile by employees	0.008	0.002
× 4. Quartile by employees	0.008	0.001
Macro News		
× Firm age $<$ 20 years	0.007	0.003
× Firm age $\geq$ 20 years	0.006	0.001
Macro News		
× Time in survey $<$ half a year	0.015	0.007
× Time in survey $\geq$ half a year	0.008	0.001
Macro News		
× Low business-cycle exposure	0.007	0.001
× High business-cycle exposure	0.006	0.003
Macro News		
× Positive sign of news	0.012	0.002
× Negative sign of news	0.005	0.001
Macro News		
× Outside Great Recession	0.007	0.001
× During Great Recession	0.012	0.002

Notes: Reaction of forecast revisions to macro news. Firms' forecast revisions are regressed on macro news, interaction terms, and firm-fixed effects for each interaction variable separately. For (quartiles of) the number of employees, we rely on annual questions in the ifo survey. For firm age, we rely on a one-time question about the year the firm was founded. To compute the firm age, we subtract from the year of response the year of foundation. For the Great Recession, we rely on a dummy equal to 1 during the years 2007 to 2008 and 0 else. For business-cycle exposure, we rely on a one-time question, where firms rank the importance of general economic developments in Germany for their business on a five-point scale from very important [1] to unimportant [5]. Business-cycle exposure is high when the response was very important. Standard errors are clustered at the firm level.

correcting for seasonality—in the regression and ii) we run the regressions separately for each firm to allow for firm-specific macro exposure and reactions to the respective changes of macroeconomic states. Panel (d) of Figure 1 shows how the cross-sectional dispersion of micro news fluctuates over time. It is largest during the Great Recession, the European debt crisis, and towards the end of our sample period.

Before turning to our main analysis, we verify that macro news impacts forecast revisions significantly. We present results in Table 1 for a range of specifications that interact macro news with a number of indicators. Across specifications, we find a significant and positive impact on forecast revisions. The positive sign shows that after receiving positive macro news in the form of a better-than-expected ifo index, firms revise expectations about their own production and business situation upwards as well. This holds across the size distribution of firms, for old and young firms, for firms that have entered the survey more recently and earlier, and for firms where self-reported business-cycle exposure is high and low (see the definition in the table notes). Positive and negative macro news trigger largely symmetric forecast revisions and, last, we find the impact of macro news somewhat stronger during the Great Recession. Generally, however, the economic impact of macro news on forecast revisions is limited. This is in line with our theoretical explanation of a subdued reaction of firms to macro news (see Section 4).

3 How firm expectations respond to news

In this section, we first introduce our empirical framework, which builds on Coibion and Gorodnichenko (2015). We then report estimates for the average effect of micro and macro news across firms as well as results that account for firm heterogeneity. In addition, we show how the reaction to news is related to real activity. Finally, in Section 3.6, we corroborate the results for the ifo survey in the Banca d'Italia's SIGE.

3.1 Empirical framework

Under rational expectations, forecast errors should not be predictable based on information that is available to the forecaster in real time. If one assumes full information in addition to rational expectations, the average forecast error across forecasters should also not be predictable based on average news—a point which Coibion and Gorodnichenko (2015) develop. They test the full-information rational expectations (FIRE) hypothesis based on the following specification:

$$x_{t+h,t} - F_t(x_{t+h,t}) = \beta_0 + \beta_1 \cdot \text{news}_t + \varepsilon_t \ . \tag{5}$$

Here, $x_{t+h,t} - F_t(x_{t+h,t})$ is the average forecast error and news_t is some surprise, typically proxied by the average forecast revisions across forecasters. Under FIRE, we have $\beta_1 = 0$. However, Specification (5) is not just simply a test of FIRE. It also points towards specific alternative models of expectation formation. When positive news tends to be followed by positive forecast errors ($\beta_1 > 0$), the forecast revision turns out to be too weak from an ex-post point of view. Hence, there is an underreaction to news. Conversely, when positive news is on average followed by negative forecast errors ($\beta_1 < 0$), the forecast revision is too strong from an ex-post point of view: There is an overreaction to news.

Earlier work estimates versions of Specification (5) using expectations that pertain to macroeconomic outcomes. Coibion and Gorodnichenko (2015), in particular, obtain positive regression coefficients based on the median (consensus) professional forecast for inflation. This result is still consistent with rational expectations: It may simply reflect a failure of the full-information assumption. Yet, and this point is stressed by Coibion and Gorodnichenko (2015), once Specification (5) is estimated at the level of individual forecasters, rational expectations imply $\beta_1 = 0$, independently of whether there is full information or not. The key point is that $news_t$ is observed by forecasters in real time. Bordalo et al. (2020) estimate a version of Specification (5) based on individual forecasts and find a negative coefficient, that is, they find overreaction to news, rejecting rational expectations, see also Broer and Kohlhas (2023). In sum, once we estimate Specification (5) at the level of individual forecasters it provides us with a more stringent test: A test of rational expectations instead of a test of FIRE.

We make three innovations relative to earlier work by estimating a variant of Specification (5) on data for individual forecasters. First, we consider firms instead of professional forecasters or households. Second, we focus on firm-level variables, notably production (and prices), rather than macro-level variables (such as aggregate inflation). Last but not least, we distinguish between micro news and macro news regarding firm performance. This distinction takes center stage in our analysis which is based on the following regression equation:

$$x^j_{t+h,t} - F^j_t(x^j_{t+h,t}) = \beta_0 + \beta_1 \cdot \text{micro news}^j_t + \beta_2 \cdot \text{macro news}_t + v^j_t \ . \tag{6}$$

Here, $x^j_{t+h,t} - F^j_t(x^j_{t+h,t})$ is a firm's forecast error for its own production defined in Equation (1) above. In what follows, we refer to β_1 as the "micro coefficient" and β_2 as the "macro coefficient": under rational expectations, these coefficients are zero because micro and macro news are part of a firm's information set, as explained in the previous section. As our baseline, we measure micro news with the forecast revision, defined in Expression (3) above, while controlling for macro news, given by the surprise component in the ifo index of the previous month, as in Equation (2). Section 4 below provides a microfoundation for this specification based on a fully specified structural model. In principle, measurement error may induce a negative correlation between forecast errors and the forecast revisions, a possibility which we consider in Section 3.3 below.

3.2 Results

To establish our main result, we pool observations across time and firms and estimate Equation (6) while allowing for firm-fixed effects. The top panel of Table 2 displays the

Table 2: Over- and underreaction to news

(a) Firms' forecast errors about their production

	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.191*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.209*** (0.001)	-0.208*** (0.001)	
Macro News				
Surprise component of the ifo index	0.022*** (0.0007)	0.022*** (0.0007)		0.021*** (0.0007)
Observations	302,737	302,737	302,737	302,737
R^2	0.16260	0.15806	0.15313	0.08967
Within R^2	0.08471	0.07974	0.07435	0.00498

(b) Firms' forecast errors about their business situation

	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+6}	-0.441*** (0.004)			
Forecast Revision for x_{t+6} net of $\gamma_j \Gamma_t$		-0.453*** (0.004)	-0.450*** (0.004)	
Macro News				
Surprise component of the ifo index	0.857*** (0.044)	0.795*** (0.044)		0.697*** (0.044)
Observations	153,398	153,398	153,398	153,398
R^2	0.31864	0.30652	0.30357	0.25466
Within R^2	0.08861	0.07240	0.06845	0.00303

Notes: Results based on Equation (6); observations are pooled across firms, specification includes firm-fixed effects. Panel (a) shows results for the production expectations (3-month horizon, qualitative data), and Panel (b) for the expected business situation (6-month horizon, quantitative data). Macro news is the surprise component of the ifo index. Column (1): micro news measured by forecast revisions (while controlling for macro news). Columns (2) and (3): micro news represents forecast revisions net of real-time observable aggregate developments, measured by macroeconomic indicators Γ_t with idiosyncratic reaction coefficient γ_j (see Section 2.4 for more details). All specifications include firm-fixed effects and standard errors clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

results based on firms' production expectations. The bottom panel shows results for firm expectations about their business situation which are measured on a quantitative scale. Consider the top panel first. Column (1) on the left reports estimates for a specification that features forecast revisions and macro news simultaneously. As a result, the forecast revision provides a direct measure of micro news. We find that both types of news induce predictable, statistically significant forecast errors. Hence, we reject rational expectations for firms, consistent with the result of Bordalo et al. (2020) for professional forecasts. In addition, we find that the type of news is key for *how* expectations fail to meet the rational expectations benchmark: While positive micro news predicts negative forecast errors, positive macro news predicts positive forecast errors. This implies, as explained above, that firms overreact to micro news but underreact to macro news. In Section 4 below, we offer a theoretical perspective based on a general-equilibrium model where firms suffer from island illusion.

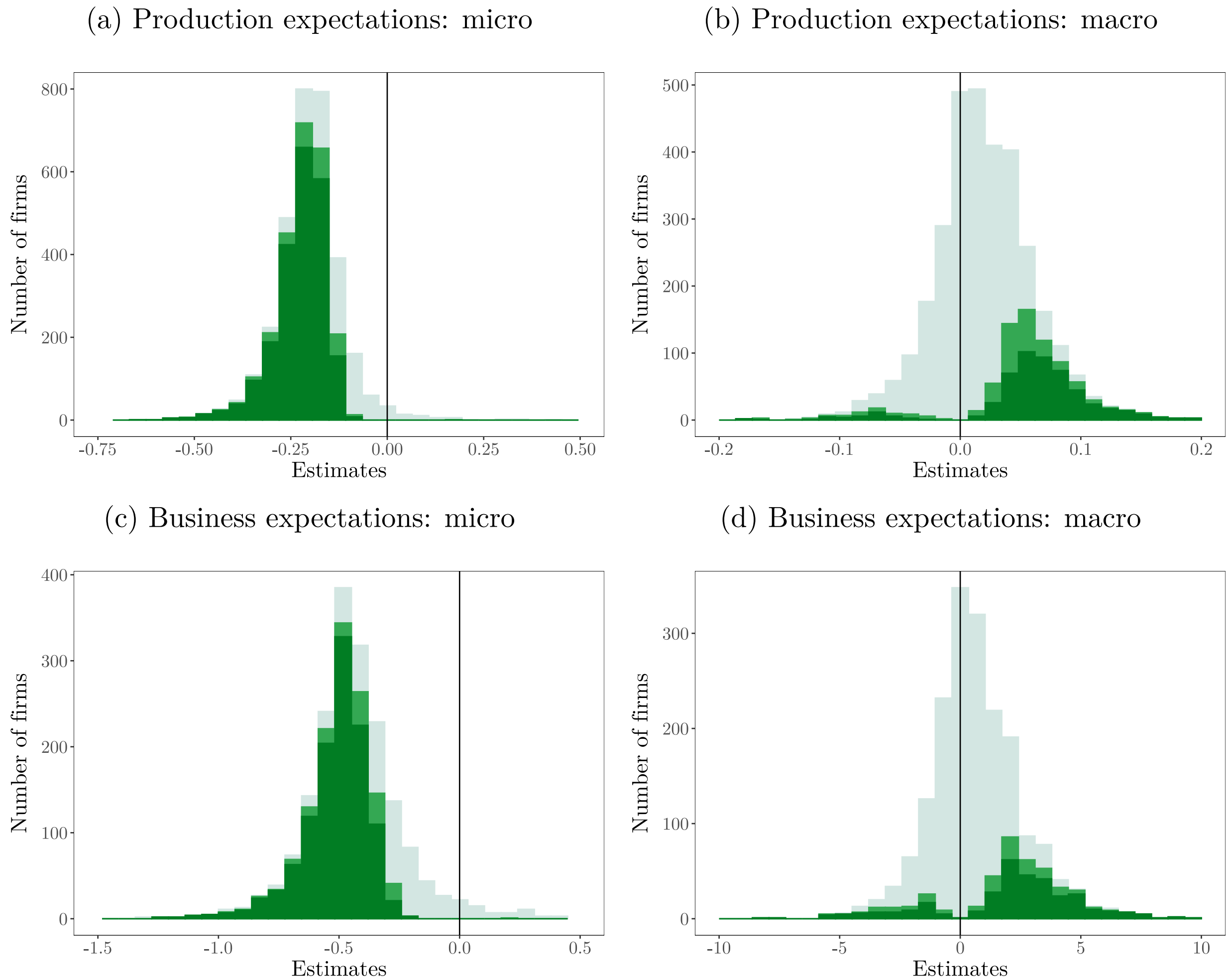
The remaining columns in the top panel of the table confirm the results reported in Column (1): the micro coefficient remains negative and highly significant when we purge the forecast revision of the impact of real-time macro indicators (second column). The estimate also hardly differs from the baseline. In what follows, we therefore always measure micro news by the forecast revision net of the macro factors. Note further that when we drop macro news from the regression, the result for the impact of micro news remains virtually unchanged: Column (3). This is to be expected because forecast revisions are purged of the impact of macroeconomic indicators. The macro coefficient remains positive and significant when including only macro news in the regression (fourth column).

Note that the magnitude of the coefficients in the top panel of Table 2 is quantitatively meaningful. In general, the economic importance of the news coefficients is not straightforward to assess due to the qualitative nature of the forecast revisions. However, we may interpret their (relative) importance. Take the specification in Column (2). The average absolute size of micro news is 0.271 and leads to an increase in the absolute value of the forecast error by 0.052 (that is, 0.14 standard deviations of the forecast error). The average absolute size of macro news is 0.971 and leads to an increase in the absolute value of the forecast error by 0.02 (0.05 standard deviations of the forecast error). Hence, the effects on forecast errors are not negligible, and the micro-news effect is about 2-3 times stronger than that of macro news.

The results in Table 2 are based on estimates for which we pool observations across firms. But we may exploit the fact that there is a sufficient number of time-series observations for each firm in order to estimate the reaction to news at the level of individual firms. To this end, we re-estimate Specification (6) for each of the 3,000 firms in our sample. Throughout, we rely on the forecast revisions purged of macro factors as a measure of micro news and report results in Figure 2.[9] The top panels show the distribution of estimates for β_1 and β_2 based on production expectations. These coefficients capture the response to micro and macro news, respectively. There is a clear pattern: the mass of the estimates for β_1 is concentrated to the left of zero. In fact, as Panel (a) shows, most estimates are significantly smaller than zero (dark green bars). Specifically, for the subset of significant estimates, the micro coefficient

[9] As discussed in Section 2, our sample includes only firms with at least 30 monthly observations and some variation in their production expectations and forecast errors.

Figure 2: Distribution of firm-level responses to news



Notes: Top panels show results for production expectations (3-month horizon, qualitative data), bottom panels for expectations about firms' business situation (6-month horizon, quantitative data). Grey area represents insignificant estimates, light green area represents estimates significant at the 10% level, dark green area indicates significance at the 5% level.

is negative for all firms. The estimates for β_2 instead are centered to the right of zero. In this case, estimates are not always significantly different from zero (grey bars), but when we consider significant estimates only, the macro coefficient is positive for 92 percent of firms. Overall, our results for the regression which pools observations also hold up when we consider firm-level estimates: the micro coefficient is generally negative while the macro coefficient tends to be positive. In subsection 3.4 below, we zoom in on how the reactions depend on specific firm characteristics.

A distinct feature of the estimates considered so far is that they are based on qualitative responses of firms: they report whether they expect production to increase, stay the same, or decline. We now turn to a quantitative measure of firm expectations which is also elicited by the ifo survey. It pertains to firms' expected business situation over the next six months and answers are provided in a range from 0 (rather less favorable) to 100 (rather favorable). Correspondingly, the survey also asks about the current business situation, with possible answers ranging from 0 (bad) to 100 (good).

We may thus compile forecast errors for the expected business situation over a six-month period, analogously to forecast errors for production expectations.[10] Micro and macro news are measured in the exact same way as above, except that micro news is measured in terms of revisions in business expectations instead of production expectations.

We report results based on firms' business expectations in Panel (b) of Table 2 above. As for firm expectations about production reported in Panel (a), we find that firm expectations overreact to micro news but underreact to macro news. Moreover, this holds also across the alternative specifications in Columns (1) to (4) of the table. This is notable since not only does the nature of responses (qualitative v quantitative) vary across the panels, but also the time horizon (three v six months) and economic concept (production v business situation). With regard to the latter, we note that production expectations are more precisely defined.[11] Yet, we also report firm-level estimates based on the business situation in the bottom panels of Figure 2 and detect a very similar pattern as in the top panels: when it comes to business expectations, overreaction to micro news is pervasive at the firm level, while firms tend to underreact to macro news.

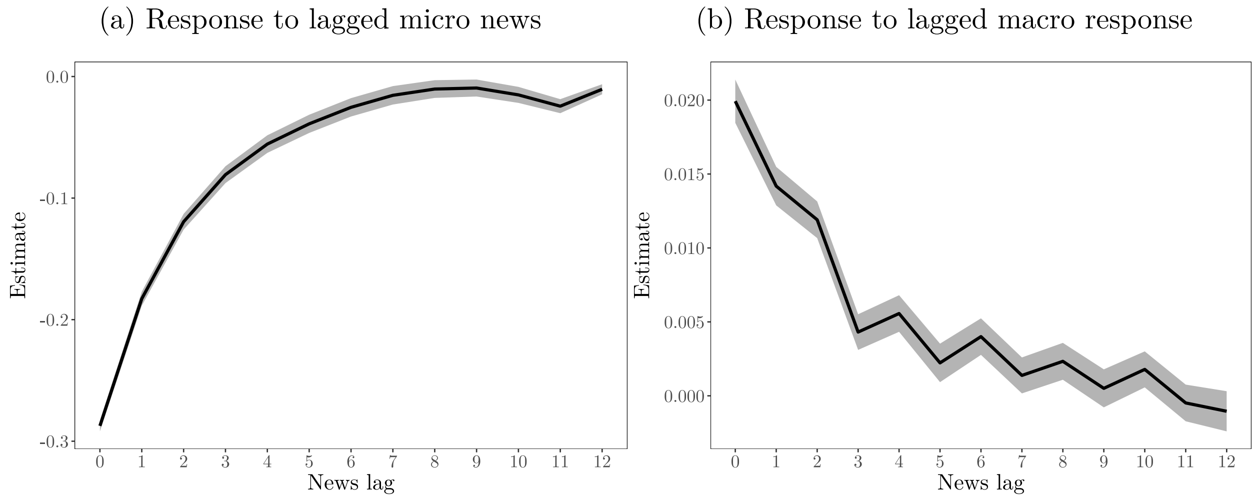
3.3 Measurement error and robustness

In what follows, we show that our results are not likely driven by measurement error, a concern raised by Juodis and Kučinskas (2023) in a related context. In principle, measurement error may indeed induce a mechanical relationship between the forecast revision of period t and the forecast error in period $t+1$. To see this, consider the possibility that firms do not report their actual expectations but, for whatever reason, deviate from the 'true' value when reporting their expectations in the survey. Formally, let $\varepsilon_t^{rep.}$ denote an error term such that the reported expectations amounts to $F_t^{j,rep.}(x_{t+h,t}^j) = F_t^j(x_{t+h,t}^j) + \varepsilon_t^{rep.}$. The observed forecast error $x_{t+h,t}^j - F_t^j(x_{t+h,t}^j) - \varepsilon_t^{j,rep.}$ is then automatically negatively correlated with the reported forecast revision: $FR_t^{j,rep.} = FR_t^j + \varepsilon_t^{j,rep.} - \varepsilon_{t-1}^{j,rep.}$. Hence, taken at face value, measurement error offers an explanation for our results regarding the response to micro news

[10] Link (2020) argues that answers pertain to the level of the expected business situation rather than the change. We report the results of the level interpretation but verify that our results are robust when we consider the alternative interpretation.

[11] In addition, the quantitative business situation is only elicited for a subset of firms, starting in September 2005. This accounts for a reduction in the sample size by almost 50 percent.

Figure 3: Response to concurrent and lagged news



Notes: Estimates based on Equation (7). Black lines represent point estimates, grey areas correspond to 95% confidence intervals.

(but not to macro news).[12]

To tackle the issue, we first relate the forecast error in period $t+1$ to micro news in periods $t-1$ instead of news in period t. As the first panel of Table 3 shows, there is still overreaction to micro news in this case. Second, we consider a fully dynamic specification and regress the forecast error on lagged news in addition to current news.[13] Specifically, we estimate a model which features 12 lags of both micro and macro news:

$$x^j_{t+3,t} - F^j_t(x^j_{t+3,t}) = \beta_0 + \sum_{p=0}^{12}(\beta_{1,p} \cdot \text{micro news}^j_{t-p} + \beta_{2,p} \cdot \text{macro news}_{t-p}) + \mu_i + v^j_t \ . \quad (7)$$

Figure 3 displays the results. Note that the overreaction and underreaction is strongest for concurrent news, but it persists over time and declines only gradually. Only after about one year, news ceases to be a cause of forecast errors. This holds both for micro news (left) and macro news (right). This pattern, too, illustrates that our results are not driven by measurement error.

[12] We note in passing that this kind of measurement error is less of a concern in the case of qualitative data because the answer possibilities of survey participants are limited. Moreover, actual firm decisions are correlated with reported expectations, as we document in Section 3.5 below, and the average forecast revision is a leading indicator for changes in manufacturing production, see Section 2.4 and Appendix-Figure A.1. This, too, suggests that measurement error is contaminating our data to a negligible extent.

[13] In the context of our analysis, this approach is more suitable than local projections to trace out the effect of news over time because news may be autocorrelated. And indeed, we find that—since micro (macro) news is negatively (positively) autocorrelated—the micro (macro) coefficient on current news is larger (smaller) in this set-up.

That said, the first panel of Table 3 provides additional evidence. Turning to the results for the quantitative business situation, we follow Kohlhas and Walther (2021) and exclude outliers of forecast errors and micro news. Again, the estimates show that there is a significant overreaction to micro news, although the estimate is slightly attenuated. We also report estimates that are based on a subsample of observations restricted to firms that revise their qualitative production expectations to zero. In this way, we ensure that the results are not mechanically biased by the qualitative revision scale. The overreaction to micro news is still present. The same holds if we set, in addition, small errors to zero. In the second panel of the table, we report results for a specification in which we again set small forecast errors—potentially driven by measurement error—to zero. We find that results are robust: there is still a significant overreaction to micro news. This also holds when we consider only firms that expect 'no change' in production.

In the remainder of the table, we turn to additional robustness tests. So far estimates are based on OLS and the definition of qualitative production forecast errors by Bachmann et al. (2013), see Equation (1). The third panel shows that our results also hold when we treat forecast errors qualitatively and use ordered logit rather than OLS for the estimation. Panel 4 reports results for alternative ways to measure macro news. Specifically, we purge firms' forecast revision by means of time-fixed and time-sector-fixed effects. Again, results are robust to this change.

Lastly, we vary the definition of macro news. We find, in particular, underreaction to the surprise component in manufacturing orders, the change in the ifo index, the average forecast revision, the average forecast revision per sector, and the change in the stock market index.

3.4 Accounting for heterogeneity

Figure 2 shows that firms differ in how they react to news. To investigate this more systematically, we zoom in on the determinants of the response to micro and macro news. For this purpose, we re-run the pooled regressions from Table 2 while adding interaction terms that capture heterogeneity, both along the cross-sectional and time-series dimensions. We use a Wald test to check if these interaction terms are statistically different from each other. Along the cross-section, we consider the number of employees, firm age, and the duration for which firms participate in the survey. More specifically, for the number of employees, we distinguish between firms in different quartiles; for firm age, we split between firms below 20 years of age and older firms, where a firm's age is measured at the time of the survey based on the year of the reported incorporation; and for the time in the survey, we distinguish between responses submitted during and after the first six months of being in the survey. In

Table 3: Alternative specifications

Variation	Details	Micro coeff.	Macro coeff.
1) Micro News (Forecast Revisions)			
Use one month lagged micro news	Table A.2a	-0.021^{***}	0.021^{***}
Business situation (remove outliers)	Table A.2b	-0.387^{***}	0.711^{***}
Use only revisions towards zero	Table A.2c	-0.110^{***}	0.030^{***}
As above and set small errors ($\pm\frac{1}{3}$) to zero	Table A.2d	-0.086^{***}	0.023^{***}
2) Forecast error (Bachmann et al. 2013)			
Set small errors ($\pm\frac{1}{3}$) to zero	Table A.2e	-0.128^{***}	0.018^{***}
Above only for no-change expectations	Table A.2f	-0.192^{***}	0.018^{***}
3) Estimation (OLS)			
Ordered logit	Table A.2g	-1.24^{***}	0.11^{***}
4) Macro component of forecast revision (real-time indicators)			
Fixed effect by time	Table A.2h	-0.194^{***}	0.021^{***}
Fixed effect by time and sector	Table A.2i	-0.196^{***}	0.021^{***}
5) Macro News (surprise component in ifo index)			
Surprise component in manuf. orders	Table A.2j	-0.208^{***}	0.005^{***}
First difference of ifo index	Table A.2k	-0.208^{***}	0.002^{***}
Average forecast revision	Table A.2l	-0.209^{***}	0.345^{***}
Average forecast revision by sector[a]	Table A.2m	-0.211^{***}	0.216^{***}
First difference of stock market index	Table A.2n	-0.208^{***}	0.328^{***}

Notes: Each row corresponds to a variation of the specification for which we report results in Table 2, see Appendix A for details. Micro coefficient and Macro coefficient are the estimates on micro and macro news.
[a] In this specification, the macro component of forecast revisions is the time and sector average.
*** p<0.01, ** p<0.05, * p<0.1.

addition, we consider heterogeneity regarding the self-reported exposure to the business cycle for the firms (see Table A.1 for the wording of the question). Finally, along the time-series dimension, we distinguish between positive and negative news and the period during (outside) the Great Recession.

Table 4 displays the results. To facilitate the comparison, we reproduce the results from Table 2, Column (2) in the top panel: On average firms overreact to micro news (measured by negative news coefficients) and underreact to macro news (positive news coefficients). We find that this pattern holds across interaction terms. The micro coefficient is robustly negative in the cross-section and not significantly different across different levels of firm age, time in the survey, and importance of the business cycle. The overreaction significantly decreases with firm size, but the differences in terms of magnitude are small. This is consistent with the

Table 4: Heterogeneity

		Micro News			Macro News		
Interaction	N	$\widehat{\beta}_j$	$SE(\widehat{\beta}_j)$	W	$\widehat{\beta}_j$	$SE(\widehat{\beta}_j)$	W
(1) News	302,737						
Overall (see Table 2, (2))		−0.209***	0.001		0.022***	0.001	
(2) News	302,737			0.001			0.000
× 1. Quartile by employees		−0.216***	0.003		0.013***	0.002	
× 2. Quartile by employees		−0.211***	0.002		0.019***	0.001	
× 3. Quartile by employees		−0.210***	0.002		0.022***	0.001	
× 4. Quartile by employees		−0.203***	0.002		0.026***	0.001	
(3) News	162,776			0.554			0.408
× Firm age < 20 years		−0.205***	0.005		0.019***	0.003	
× Firm age ≥ 20 years		−0.208***	0.002		0.021***	0.001	
(4) News	302,737			0.919			0.045
× Time in survey < half a year		−0.210***	0.010		0.033***	0.006	
× Time in survey ≥ half a year		−0.209***	0.001		0.021***	0.001	
(5) News	129,053			0.25			0.038
× Low business-cycle exposure		−0.203***	0.003		0.016***	0.002	
× Medium business-cycle exposure		−0.209***	0.002		0.021***	0.001	
× High business-cycle exposure		−0.208***	0.003		0.022***	0.002	
(6) News	302,737			0.000			0.000
× Positive sign of news		−0.191***	0.002		0.011***	0.001	
× Negative sign of news		−0.232***	0.003		0.035***	0.001	
(7) News	302,737			0.000			0.000
× Outside Great Recession		−0.206***	0.001		0.017***	0.001	
× During Great Recession		−0.224***	0.003		0.041***	0.002	

Notes: All regressions include micro and macro news with interaction terms and firm-fixed effects. Standard errors are clustered at the firm level. N is the number of observations, $\widehat{\beta}_j$ is the point estimate and SE($\widehat{\beta}_j$) is its standard error. Column W reports the p-value for the null that the news coefficients are jointly the same. We run the Wald test separately for each type of news. For (quartiles of) the number of employees, we rely on annual questions in the ifo survey. For firm age, we rely on a one-time question about the year the firm was founded. To compute the firm age, we subtract from the year of response the year of foundation. For the Great Recession, we rely on a dummy equal to 1 during the years 2007 to 2008 and 0 else. For business-cycle exposure, we rely on a one-time question, where firms rank the importance of general economic developments in Germany for their business on a five-point scale from very important [1] to unimportant [5]. Business-cycle exposure is high when the response was very important [1], medium when the response was important [2], and low otherwise [3-5]. *** p<0.01, ** p<0.05, * p<0.1.

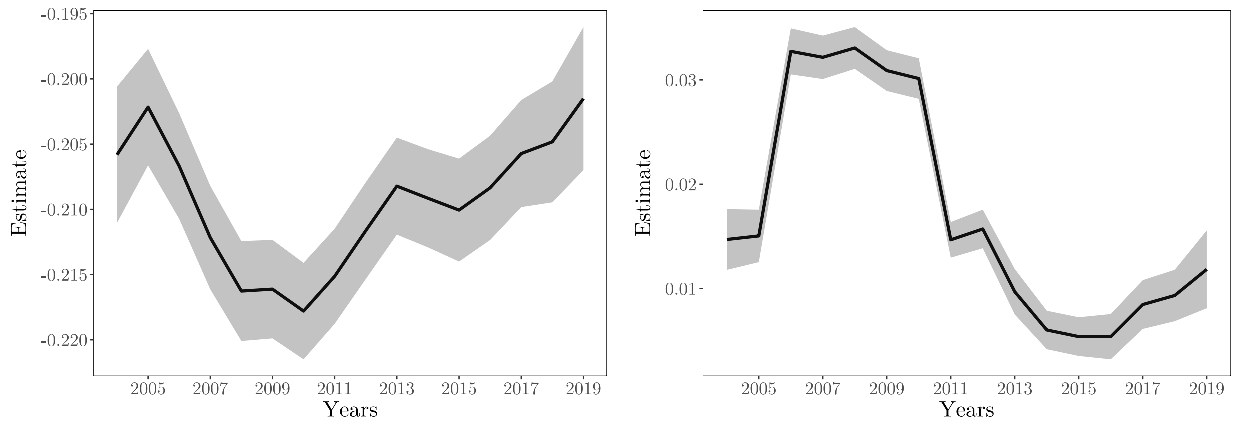
evidence in Panel (a) of Figure 2 which shows that the firm-level estimates for β_1 cluster in a fairly tight range. Along the time-series dimension, the micro coefficient is significantly larger for positive news compared to negative news and during the Great Recession compared to other periods.

For the response to macro news, in turn, we find sizeable and significant heterogeneity for firm size, time in the survey, the sign of news, and the Great Recession, again consistent with the more widely distributed estimates of β_2 shown in Panel (b) of Figure 2. Looking at firm size (Panel (2) of Table 4), the underreaction to macro is news is strictly and statistically significantly increasing across employee quartiles. The underreaction of the largest firms is twice as strong as that of the smallest firms. This result may reflect a stronger impact of the macro economy on the production—and hence the forecast errors—of larger firms. Regarding firm age, reported in Panel (3), there is no statistical difference in the response to macro news between young and old firms. So there is no evidence that firms learn simply by getting older. When comparing the underreaction of firms that recently joined the survey (within six months) to firms with longer tenure, reported in Panel (4), we find evidence for "learning through survey" (Kim and Binder 2023). The underreaction among more tenured firms is about one-third smaller than for firms that recently joined the survey and the difference is statistically significant. This finding is also in line with Massenot and Pettinicchi (2018), who find, for example, that firms' absolute forecast errors about their own business situation decrease as time since entry in the ifo survey passes. For the exposure to the business cycle, Panel (5), we distinguish between firms that rank the business cycle as very important, important, or less important to them. Here, in line with the heterogeneity by firm size, a high business-cycle exposure is associated with a significantly larger underreaction. Turning to the time-series dimension, we find the underreaction to macro news to be countercyclical. First, the underreaction to negative news is about three times stronger than in the case of positive news, Panel (6), and significantly so. Second, the underreaction is much stronger during the Great Recession, Panel (7), and significantly different from the remaining sample period.

To explore the issue further, we estimate the baseline specification on 5-year rolling windows, following again Coibion and Gorodnichenko (2015). Figure 4 shows the results. The left panel shows how the estimated response coefficients for micro news evolve over time, while the right panel does the same for the macro news coefficient. A number of observations are in order. First, firms overreact to micro news and underreact to macro news over the entire sample. Second, the deviations from the rational expectations benchmark are largest during the Great Recession. Third, for macro news, the variation over time appears to be substantial in economic terms: the underreaction is about three times as large during the Great Recession compared to non-recession periods. Taken at face value, this pattern (in addition to the over- and underreaction to news) conflicts with the notion of rational inattention because one would expect firms to pay more attention to the aggregate economy in times of crisis (see also, Flynn and Sastry 2022). Rather, as argued above, an increased underreaction may simply reflect a stronger impact of macro variables on firm outcomes,

Figure 4: Response to news over time

(a) Response to micro news over time (b) Response to macro news over time



Notes: estimates based on 5-year rolling windows. Black lines represent point estimates, grey areas correspond to 95% confidence intervals.

without an (sufficiently large) increase in attention.

Finally, we ask what the joint distribution of firm-level response coefficients for micro and macro news looks like. To this end, we relate the firm-level estimates of micro and macro news (illustrated in Figure 2). Figure A.2 in the appendix displays a binned scatterplot between the micro and macro news coefficients. Indeed, we find a negative relationship that is especially strong if we zoom into the subsample of firms with significant overreaction to micro news and underreaction to macro news ($\rho = -0.35$). Hence, the stronger the underreaction to macro news of a given firm, the stronger is also the overreaction to micro news.

In sum, overreaction to micro news and underreaction to macro news is a robust and pervasive phenomenon—across firms and states of the world.

3.5 Reaction to news and firm performance

Expectations matter for firm decisions and firm outcomes, as Enders et al. (2022) establish specifically for the ifo data set. Against this background, we investigate whether over- and underreaction to news is related to measures of firm performance in a systematic way. We will then revisit this evidence in light of our theoretical model below. Specifically, we relate the estimated response coefficients for each firm to their profits, their production volatility, and forecast error volatility. We rely on the firm-level estimates discussed in Section 3.2 above and restrict the sample to firms that overreact to micro news and underreact to macro news, in line with the aggregate findings.

Table 5: Over- and underreaction to news and real activity

	$\text{mean}_i(\text{profits}_{it})$		$\text{sd}_i(\text{production}_{it})$		$\text{sd}_i(\text{error}_{it})$	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.224		0.383***		0.226***	
	(0.177)		(0.011)		(0.007)	
Reaction micro news	1.70**	1.79**	-0.371***	-0.360***	-0.318***	-0.312***
($\beta_1 < 0$)	(0.782)	(0.756)	(0.046)	(0.046)	(0.028)	(0.028)
Reaction macro news	-0.673	-1.10	1.63***	1.61***	1.31***	1.30***
($\beta_2 > 0$)	(1.79)	(1.78)	(0.097)	(0.097)	(0.062)	(0.062)
Observations	1,691	1,691	2,227	2,227	2,227	2,227
R^2	0.003	0.051	0.146	0.162	0.230	0.252
Within R^2		0.004		0.143		0.228
Sector FE		✓		✓		✓
Size FE		✓		✓		✓

Notes: Estimates from linear regressions of average profits, Columns (1)–(2), production dispersion of firms, Columns (3)–(4), and forecast-error dispersion, Columns (5)–(6), on the firm-level estimates of the micro and macro news coefficients. The sample is restricted to firms that overreact to micro news and underreact to macro news. Size-fixed effects refer to firm-size quartiles based on the number of employees. Standard errors are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

Since 2009, the ifo Business Climate Survey includes a quantitative question about the profits in the current year.[14] For each firm, we calculate the average profits and regress them on the micro and macro news coefficients estimated in Section 3.2. In addition, we absorb sector- and size-fixed effects. Columns (1) and (2) in Table 5 display the results. A stronger overreaction to micro news is associated with a significant decrease in average profits, while a stronger underreaction to macro news is not significantly related to the average profits. In terms of magnitude, a one standard deviation increase in the overreaction to micro news leads to a reduction in profits by on average about 0.14 percentage points.

As a second exercise, we calculate the standard deviation of realized production changes as a proxy for firm-level production volatility. Then, we follow the procedure above and regress it on the estimated response coefficients to micro and macro news, obtained in Section 3.2. Columns (3) and (4) in Table 5 display the results. The estimates indicate a tight relation between production volatility and the over- and underreaction to news at the firm level. An increase in the overreaction to micro news is associated with higher volatility. While the point estimate is larger for micro news than for macro news, a one standard deviation increase in the estimated coefficient is associated with a somewhat stronger increase of output volatility in case of macro news. Projecting these cross-sectional estimates on the macro level

[14] Profits are elicited in May and September. We rely on the September wave to capture a larger information set. In addition, we subtract the yearly average profits to ensure that the results are not confounded by heterogeneity over time (in a recession, profits are lower and underreaction stronger, see Section 3.4).

implies higher micro-level volatility in the presence of over- and underreactions. This is a potential explanation for the high observed idiosyncratic volatility of firm outcome variables (Bachmann et al. 2013; Bloom 2009).

Lastly, we do the same for the standard deviation of qualitative forecast errors as a proxy for the accuracy of firm expectations. Columns (5) and (6) in Table 5 display the results. Again, the estimates indicate a tight (negative) relation between the accuracy of forecasts and the over- and underreaction to news at the firm level.

3.6 Further evidence for Italian firms

We now turn to an alternative survey of firm expectations in order to assess to what extent our results generalize beyond the ifo survey of German firms. Specifically, we rely on the quarterly "Survey on Inflation and Growth Expectations" (SIGE) operated by the Banca d'Italia, which has also been used by, for example, Coibion et al. (2020). Two features of the SIGE are particularly noteworthy in the context of our analysis. First, it elicits answers in the form of growth rates and, as such, answers are quantitative. Second, it asks firms about their price expectations: not only about their own prices but also about aggregate price developments, that is, inflation.[15]

Mimicking our earlier strategy for the ifo survey as closely as possible, we estimate a version of Specification (6) on data from the SIGE. Instead of production expectations, we now consider firms' price expectations: We compute, consistent with the definition of the forecast error in Expression (1) above, the one-year-ahead expectation error for firms' own prices in quarter t by subtracting the expected change reported in quarter t from the actual change, as reported in quarter $t + 4$.

We measure macro news as the surprise component of inflation: we subtract the (average) professional forecast submitted to Consensus Economics up until a month before the publication from the realized inflation rate. To measure micro news, we again rely on forecast revisions, here the first-difference of firms' expectations about their own prices. As firm expectations are for a twelve-month fixed forecast horizon, the overlap in quarterly forecast revisions is nine months. Since, as above, we include macro news in the regression, the forecast revisions for firms' own prices allow us to directly estimate the effect of micro news on the forecast error. In an alternative specification, we purge the forecast revision of the change in CPI inflation. Importantly, both news and the change in CPI inflation are in the firm's information set as the survey question about expected inflation provides firms with the current inflation rate in every quarter.[16]

[15]For further details on the SIGE, see Appendix B and Grasso and Ropele (2018).

[16]See Table B.1 in Appendix B for the exact wording. For the timing, consider Summer 2022 as an example.

Table 6: Over- and underreaction to news—Italian firms

	Forecast error about firm's own prices					
	(1)	(2)	(3)	(4)	(5)	(6)
Micro News						
Forecast Revision for π^i_{t+12}	-0.478^{***}		-0.457^{***}	-0.405^{***}		-0.376^{***}
	(0.022)		(0.020)	(0.016)		(0.013)
FR for π^i_{t+12} net of $\Delta\pi_t$		-0.502^{***}			-0.340^{***}	
		(0.020)			(0.024)	
Macro News						
Surprise component of π_{t-1}	4.113^{***}	3.758^{***}		2.735^{***}	2.642^{***}	
	(0.356)	(0.470)		(0.195)	(0.239)	
FR for π_{t+12}			0.242^{***}			0.210^{***}
			(0.058)			(0.031)
Drop top and bottom 1%	no	no	no	yes	yes	yes
Observations	21,707	14,030	29,471	21,073	13,610	28,492
R^2	0.103	0.116	0.094	0.074	0.054	0.056
Within R^2	0.127	0.127	0.110	0.097	0.061	0.078

Notes: Regressing firms' forecast errors about their own prices on micro news and macro news. For each type of news, we consider two alternative definitions. For micro news, we consider firms' own forecast revisions for their own prices in their raw form, as well as revisions purged from changes in aggregate inflation for each firm with at least 20 observations. For macro news, we consider the surprise component of inflation in the previous quarter. More specifically, we subtract from the realized value the (mean) professional forecast from Consensus Economics. Alternatively, we consider firms' own forecast revisions about aggregate inflation. Columns (1) to (3) use the full sample, while columns (4) to (6) drop the top and bottom 1% of forecast errors and forecast revisions from the full sample. The sample starts in 2002 (2013 for inflation surprises) and ends in 2022. Firm-fixed effects are always included and standard errors are clustered at the firm level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6 reports the results. In the first two columns, we proceed in the same fashion as with the data from the ifo survey. Micro news is the forecast revision for a firm's own prices, both raw and net of aggregate developments. Macro news is the surprise component in the aggregate inflation rate. In line with our findings for the ifo survey, the coefficients for micro news are negative and those for macro news are positive. Both are highly significant.

The third column moves beyond the setup for the ifo survey. Here, we exploit the fact that the SIGE also polls firm expectations about inflation. This allows us to compile firm-specific macro news, namely the forecast revisions of the firm's aggregate inflation expectations. Also for this specification, coefficients for micro news are negative, those for macro news are

On June 13, Consensus Economics polled professional forecasters about their expectations for the inflation rate in the second quarter and published the results on June 16. The Banca d'Italia published the inflation rate on July 8. We use the difference between the realized value and the average professional forecast as a measure of macro news in 2022Q3. Importantly, the SIGE in 2022Q3 ran between August 25 and September 15 and firms are explicitly informed about the current rate of inflation. Macro news is therefore in their information set.

positive, and both significantly so.[17] The last three columns then show that these results are robust to dropping the top and bottom 1% of forecast errors and forecast revisions. This again speaks against plain measurement error as a driver of our empirical results. We estimate specification (6) at the firm level as well. The resulting coefficients are distributed in a similar way as those for the ifo survey; see Figure B.1 in Appendix B. Looking at the joint distribution of significant micro and macro coefficients, we find that they are negatively and significantly correlated ($\rho = -0.24$), also in line with the results for the ifo survey.

Overall, our results based on the SIGE show that overreaction to micro news and underreaction to macro news is a pertinent feature of firms' expectation formation process. It is not limited to the ifo survey of German firms but also characterizes the expectation formation of Italian firms. This is particularly noteworthy because the SIGE differs from the ifo survey along a number of important dimensions.

4 A model of island illusion

In the following, we develop a stylized model in order to rationalize the evidence established above. Specifically, the model provides a microfoundation for our empirical Specification (6) and allows us to establish conditions under which firm expectations overreact to micro news and underreact to macro news. Two aspects set our model apart from related theoretical work, some of which we reference in the introduction above. First, our focus is on expectations about a firm's own performance and how these, in turn, are shaped by micro and macro news. To represent these news and their interaction in a consistent manner, we need to specify a full-fledged general equilibrium model. Second, the distinct feature of our model is that firms suffer from 'island illusion'. As a result, firms systematically underestimate the importance of aggregate developments for their own performance. This appears plausible to the extent that for firms firm-specific developments are more salient of economic performance—consistent with findings according to which direct experience impacts (risk) perceptions more strongly than outcomes experienced by others (Smith et al. 2001; Viscusi and Zeckhauser 2015). It is also in line with our results in Section 2, which show that firms' reaction to aggregate news is statistically significant but economically limited.

[17] In Appendix B, Table B.2a shows that this also holds in univariate regressions including either micro or macro news. In Table B.2b, we consider as a fourth possible definition for macro news the forecast revision computed by subtracting from the current six-month-ahead inflation expectation the one-year-ahead expectation six months ago, where we also find positive response coefficients for macro news and negative coefficients for micro news, that are both highly significant.

Our setup relates to Bordalo et al. (2020) where news is overly representative for forecasters and thus triggers an overreaction. Our model, however, accounts for simultaneous over- and underreaction to different types of news at the level of individual forecasters. What sets our model apart from the model of overconfidence put forward by Broer and Kohlhas (2023) is a general-equilibrium perspective that accounts for the cross-equation restrictions regarding the impact of micro and macro news.[18]

Formally, we build on the model with dispersed and noisy information put forward by Lorenzoni (2009). We depart from the original model in two ways. First, we assume firms are subject to island illusion. Second, we simplify the original model by assuming predetermined rather than staggered prices in order to solve an approximate model in closed form and to derive analytical results. In what follows, we first describe the structure of the economy, including technology and preferences. Afterward, we specify expectations and policy and present our main result regarding over- and underreaction.

4.1 Setup and timing

There is a continuum of islands, indexed by $r \in [0, 1]$, each populated by a representative household and a unit mass of firms, indexed by $j \in [0, 1]$. Each household buys from a subset of all islands, chosen randomly in each period. Specifically, it buys from all firms on n islands included in the set $\mathcal{B}_t^r$, with $1 < n < \infty$.[19] Households have an infinite planning horizon. Firms manufacture differentiated goods on the basis of island-specific productivity, which is simultaneously driven by a permanent, economy-wide component and a temporary, idiosyncratic component.[20] Household-specific demand also features an aggregate and an idiosyncratic stochastic component such that we can write in general terms:

$$\vartheta_t^r = \sqrt{\varpi_\vartheta}\vartheta_t' + \sqrt{1 - \varpi_\vartheta}\bar{\vartheta}_t'^r \ . \tag{8}$$

Here ϑ_t^r is either technology a_t^r of a firm on island r or demand q_t^r of the household on the same island, while ϑ_t' and $\bar{\vartheta}_t'^r$ are the aggregate and idiosyncratic components, respectively. Both are i.i.d. random variables. The weight ϖ_ϑ determines the importance of aggregate relative to idiosyncratic shocks. Relation (8) implies $Var(\vartheta_t^r) = Var(\vartheta_t') = Var(\bar{\vartheta}_t'^r)$, such that total

[18] In related work, Kohlhas and Walther (2021) put forward a model of asymmetric attention which rationalizes the observation that forecasts of output growth underreact to *average* forecast revisions (news) but overreact to recent realizations of output growth. They stress, however, that asymmetric attention may arise in a fully rational framework.

[19] This assumption ensures that households cannot exactly infer aggregate productivity from observed prices. At the same time, individual firms have no impact on the price of households' consumption baskets.

[20] As argued by Lorenzoni (2009), this setup can account for the empirical observations that the firm-level volatility of productivity is large relative to aggregate volatility and that individual expectations are dispersed.

volatility is divided between the aggregate contribution $\varpi_\vartheta Var(\vartheta_t^r)$ and the idiosyncratic contribution $(1-\varpi_\vartheta)Var(\vartheta_t^r)$.

The timing of events is as follows: Financial markets are complete such that, assuming identical initial positions, wealth levels of households are equalized at the beginning of each period. Each period consists of three stages. During stage 1 of period t, information about all variables of period $t-1$ is released. Subsequently, nominal wages are determined and the central bank sets the interest rate based on expected inflation.

The aggregate and idiosyncratic components of productivity materialize in the second stage. Concerning technology, firms only observe their own productivity (micro news). Additionally, a noisy public signal about the aggregate demand shock is released to firms and households, based on, say, market research (macro news). Given these information sets, firms set prices.

During the third and final stage, households split up. Workers work for all firms on their island, while consumers allocate their expenditures across differentiated goods based on public information and information reflected in the prices of the goods they purchase. Additionally, individual demand shocks influence their consumption decisions. Because the common productivity component is permanent, demand shocks are purely temporary, and households' wealth and information are equalized in the next period, agents expect the economy to settle on a new steady state from period $t+1$ onward.

4.2 Households

A representative household on island r ("household r", for short) maximizes lifetime utility

$$U_t^r = E_{t|3}^r \sum_{\tau=t}^{\infty} \beta^{\tau-t} \left(Q_\tau^r \ln C_\tau^r - \frac{(L_\tau^r)^{1+\varphi}}{1+\varphi} \right) \qquad \varphi \geq 0, \quad 0 < \beta < 1,$$

where $E_{t|3}^r$ is the expectation operator based on household r's information set at the time of its consumption decision in stage 3 of period t (see below), while C_t^r denotes the consumption basket of household r. L_t^r is its total labor supply, which aggregates labor the household supplies to individual firms j on island r, $L_t^{j,r}$. As described in Equation (8), the demand shock Q_t^r consists of an aggregate and an island-specific component. In linearized form with lower-case letters denoting percentage deviations from steady state, this implies

$$q_t^r = \sqrt{\varpi_q} q_t' + \sqrt{1-\varpi_q} \bar{q}_t'^r \equiv q_t + \bar{q}_t^r,$$

with $q_t = \sqrt{\varpi_q} q_t'$ and $\bar{q}_t^r = \sqrt{1-\varpi_q} \bar{q}_t'^r$, where q_t' and $\bar{q}_t'^r$ are i.i.d. shocks with mean zero and variance $Var(q_t') = Var(\bar{q}_t'^r) = Var(q_t^r)$. While actual demand, including the shocks, realizes only in stage 3 of the period, a public signal about the (weighted) aggregate component is released to firms and households in the second stage, representing macro news:

$$s_t = q_t + e_t,$$

where e_t is an i.i.d. noise shock with variance σ_e^2 and mean zero. The ratio between the volatility of idiosyncratic demand $Var(q_t^r)$ and the volatility $Var(s_t)$ of the signal, which are both observable, is defined as $\bar{v} \equiv Var(q_t^r)/Var(s_t)$.

The flow budget constraint of the household is given by

$$E_{t|1}\varrho_{t,t+1}^r \Theta_t^r + B_t^r + \sum_{m \in \mathcal{B}_t^r} \int_0^1 P_t^{j,m^r} C_t^{j,m,r} dj \leq \int_0^1 \Pi_t^{j^r} dj + W_t^r L_t^r + \Theta_{t-1}^r + (1 + r_{t-1}) B_{t-1}^r,$$

where $C_t^{j,m,r}$ denotes the amount bought by household r from firm j on island m and $P_t^{j,m,r}$ is the price for one unit of $C_t^{j,m,r}$. At the beginning of the period, the household receives the payoff Θ_{t-1}^r, given a portfolio of state-contingent securities purchased in the previous period. $\Pi_t^{j,r}$ are the profits of firm j on island r and $\varrho_{t,t+1}^r$ is household r's stochastic discount factor between t and t+1. The period-t portfolio is priced conditional on the (common) information set of stage 1, hence we apply the expectation operator $E_{t|1}$. B_t^r are state non-contingent bonds paying an interest rate of r_t. The complete set of state-contingent securities is traded in the first stage of the period, while state-non-contingent bonds can be traded via the central bank throughout the entire period. The interest rate of the non-contingent bond is set by the central bank. All financial assets are in zero net supply. The bundle C_t^r of goods purchased by household r consists of goods sold in a subset of all islands in the economy[21]

$$C_t^r = \left(\frac{1}{n} \sum_{m \in \mathcal{B}_t^r} \int_0^1 \left(C_t^{j,m,r} \right)^{\frac{\gamma-1}{\gamma}} dj \right)^{\frac{\gamma}{\gamma-1}} \qquad \gamma > 1.$$

While each household purchases a different random set of goods, we assume that all households visit the same number of islands n. The price index of household r is therefore

$$P_t^r = \left(\frac{1}{n} \sum_{m \in \mathcal{B}_t^r} \int_0^1 \left(P_t^{j,m,r} \right)^{1-\gamma} dj \right)^{\frac{1}{1-\gamma}}.$$

[21]See, e.g., Enders (2020) for a more detailed treatment of a consumption bundle consisting of a finite number of goods.

4.3 Firms

Firm j on island r produces according to the following production function

$$Y_t^j = A_t^r (L_t^j)^\alpha \qquad 0 < \alpha < 1,$$

featuring labor supplied by the local household as the sole input. $A_t^r = A_t^{j,r}$ denotes the productivity level of firm j, which is the same for all firms on island r.[22] During stage 2, the firm sets the optimal price for the current period, conditional on the expectation about the third stage of period t, specified below. Given prices, the level of production is determined by demand during stage 3. Since each island is visited by n consumers, total demand of firm j on island r is given, in linearized form, by

$$q_t^{r,j} = q_t + \sum_{\{m|r\in\mathcal{B}_t^m\}} \frac{\bar{q}_t^m}{n}.$$

Log-productivity on each island a_t^r depends on last period's aggregate technology x_{t-1}, an aggregate shock, and an island-specific shock:

$$a_t^r - x_{t-1} = \sqrt{\varpi_a} a_t' + \sqrt{1-\varpi_a}\bar{a}_t'^r \equiv \varepsilon_t + \eta_t^r,$$

with $\varepsilon_t = \sqrt{\varpi_a} a_t'$ and $\eta_t^r = \sqrt{1-\varpi_a}\bar{a}_t'^r$, where a_t' and $\bar{a}_t'^r$ are i.i.d. shocks with mean zero and variance $Var(\bar{a}_t'^r) = Var(a_t') = Var(a_t^r - x_{t-1})$. The shock $a_t'^r$ (and therefore also η_t^r) aggregates to zero across all islands. Idiosyncratic productivity thus contains private information (micro news) about the aggregate level of technology x_t, which follows a random walk

$$\Delta x_t = \sqrt{\varpi_a} a_t' \equiv \varepsilon_t.$$

Firms only observe productivity on their own island a_t^r.

4.4 Island illusion

We now turn to the details of the expectation-formation process. To set island illusion apart from rational expectations, we first specify the rational forecasts.

[22]Note that from here on, with a slight abuse of notation, we drop, where the result is unambiguous, the island index r for firm-specific variables in the main text to simplify the expressions: $E_{t|s}^j \equiv E_{t|s}^{j,r}$; $Y_t^j \equiv Y_t^{j,r}$, $L_t^j \equiv L_t^{j,r}$, etc.

Firms. The rational forecast for Δx_t is given by

$$\bar{E}^j_{t|2}\Delta x_t = \bar{\delta}^p_x (a^r_t - x_{t-1}),$$

where $\bar{E}^j_{t|2}$ is the rational expectation of firm j on island r when setting prices (in stage 2). The coefficient $\bar{\delta}^p_x$ is a function of the structural parameters that capture the informational friction. It is non-negative and smaller than unity:

$$\bar{\delta}^p_x = \frac{\sigma^2_\varepsilon}{\sigma^2_\varepsilon + \sigma^2_\eta} = \varpi_a. \tag{9}$$

The rational forecast for q_t is given by

$$\bar{E}^j_{t|2} q_t = \bar{\rho}^p_q s_t, \qquad \text{with} \qquad \bar{\rho}^p_q = \frac{\sigma^2_q}{\sigma^2_q + \sigma^2_e} = \varpi_q \bar{v}.$$

Rather than assuming that all expectations are formed in a rational way, however, we suppose that firms are subject to island illusion. Specifically, we assume that firms underestimate the importance of aggregate developments, relative to idiosyncratic developments. Put differently, firms think that their own technology and the demand for their product are driven to a smaller extent by aggregate developments compared to what they would believe under rational expectations. In our setup, island illusion is governed by a single parameter Υ which downweighs the importance of the aggregate component relative to the actual weight:

$$\hat{\varpi}_\vartheta = \Upsilon \varpi_\vartheta.$$

Here $\hat{\varpi}_\vartheta$ is the weight ϖ_ϑ as perceived by firms and Υ measures the degree of the bias. If $\Upsilon = 1$, firms weigh the importance of both components correctly, while $\Upsilon < 1$ reflects island illusion (and $\Upsilon > 1$ the hypothetical case of 'continent illusion').[23]

Thus, actual firm expectations are formed according to

$$E^j_{t|2}\Delta x_t = \delta^p_x (a^r_t - x_{t-1}) \qquad\qquad E^j_{t|2} q_t = \rho^p_q s_t,$$

[23]The crucial point is that agents misjudge the *relative* contribution of both components to productivity or demand. That is if σ^2_ε or σ^2_q is under- or overestimated, agents would still not display a bias if they under- or overestimate σ^2_η or σ^2_e by the same degree (i.e., the 'signal-to-noise ratio' is correctly assessed, see equations (A-21) and (A-22) in Appendix D). Similarly, models of rational inattention assume that agents perceive certain information with noise. Given, however, that they know about this imperfect perception, they have a correct understanding of the signal-to-noise ratio and therefore do not display a bias: Υ would be unity.

with

$$\delta_x^p = \hat{\varpi}_a = \Upsilon \varpi_a < \varpi_a = \bar{\delta}_x^p$$
$$\rho_q^p = \hat{\varpi}_q \bar{\upsilon} = \Upsilon \varpi_q \bar{\upsilon} < \varpi_q \bar{\upsilon} = \bar{\rho}_q^p.$$

Consumers. Regarding consumers, we assume that they form rational expectations in the following way. While shopping during stage 3, they observe a set of prices. They can hence infer the productivity level of each firm in their sample:

$$E_{t|3}^r \Delta x_t = \delta_x^h \tilde{a}_t^r,$$

where $\tilde{a}_t^r$ is the average over the realizations of $a_t^m - x_{t-1}$ for each island m in household r's sample $\mathcal{B}_t^r$. δ_x^h is equal across households and given in Appendix C. Consumers have complete information if $n \to \infty$. Furthermore, households rationally incorporate the information contained in the public signal concerning the aggregate demand shock into their expectations of the aggregate price level, see Appendix C. Note that our results regarding the effects of island illusion on the side of the firms are not affected by a potential bias in the expectation formation process of households, as long as firms have a correct understanding of households' average reaction to news.

4.5 Monetary policy and market clearing

The central bank follows an interest-rate feedback rule but sets r_t before observing prices, that is during stage 1 of period t in linearized form:

$$r_t = \psi E_{t|1}^{cb} \pi_t + \nu_t \qquad \psi > 1,$$

where π_t is economy-wide net inflation, calculated on the basis of all goods sold in the economy. The expectation operator $E_{t|1}^{cb}$ is conditional on the information set of the central bank. This set consists of information from period $t-1$ only, that is, the central bank enjoys no informational advantage over the private sector.[24] ν_t is a monetary policy shock which we include in the model as an example of shock that is observable by firms and households alike.

[24] Pre-set prices and interest rates allow us to discard the noisy signals about quantities and inflation observed by firms and the central bank in Lorenzoni (2009), simplifying the signal-extraction problem without changing the qualitative predictions of the model. Pre-set wages, on the other hand, guarantee the determinacy of the price level. They do not affect output dynamics after noise and technology shocks, because goods prices may still adjust in the second stage of the period.

Goods and labor markets clear in each period:

$$\int_0^1 C_t^{j,m,r} dr = Y_t^{j,m} \ \ \forall j, m \qquad L_t^r = \int_0^1 L_t^{j,r} dj \ \ \forall r,$$

where $C_t^{j,m,r} = 0$ if household r does not visit island m. The asset market clears in accordance with Walras' law.

4.6 Accounting for over- and underreaction

In order to account for the evidence presented in Section 3 above, we derive a solution of the model based on a linear approximation to the equilibrium conditions around the symmetric steady state; see Appendix C for details. We first define forecast errors and forecast revisions in the model to provide an explicit microfoundation for our empirical specification.

To map the model to the data, we interpret the intra-period stages of a generic period t as the relevant time units. In what follows we thus drop the time subscript t and index variables only with the stages which define the information flow and the decision-making process within a period t. We can write the forecast error of firm j as follows: $y_3^j - E_2^j(y^j)$, that is, firm j's actual output in stage 3 relative to its forecast in stage 2. We define the forecast revision accordingly as $FR_2^j = E_2^j(y^j) - E_1^j(y^j)$, that is, the change in the forecast of the same firm between stage 1 and stage 2. This revision reflects the response of firm expectations to the private and the public signal, s, which is common to all firms. Armed with these definitions, we can derive our main result (see Appendix D for the proof):

Proposition 1. *Consider the regression*

$$y_3^j - E_2^j(y^j) = \beta_1 FR_2^j + \beta_2 s_2 + \omega^j \ , \tag{10}$$

where all subscripts refer to different stages of a generic period t. FR^j *is the forecast revision of firm* j*,* s *is the macro news common to all firms, and* ω^j *represents a potential error term. In the case of island illusion, that is, for* $\Upsilon < 1$*, we obtain*

$$\beta_1 < 0 \qquad \textit{and} \qquad \beta_2 > 0,$$

where β_1 *measures the firm's reaction to micro news and* β_2 *the reaction to macro news.*

Equation (10) is the counterpart to our empirical specification (6) and thus provides an explicit microfoundation for our empirical analysis. Moreover, Proposition 1 establishes stringent conditions under which our empirical results can be rationalized: In the presence of island illusion, that is, whenever $\Upsilon < 1$, the model predicts simultaneous overreaction to private signals and underreaction to public information by individual firms—based on a single parameter that captures the departure from rational expectations.

Intuitively, in a rational-expectations framework, individual future forecast errors cannot be predicted by current forecast revisions ($\beta_1 = 0$) or public signals ($\beta_2 = 0$), as firms could otherwise easily improve on their forecasts.[25] However, given that in our model firms suffer from island illusion and therefore underestimate the importance of aggregate developments, they place too little weight on the private signal ($\delta_x^p < \bar{\delta}_x^p$) when revising their forecast of aggregate technology, relative to the rational-expectations benchmark. Hence, on average, firms attribute too little of a positive surprise in their own technology to a change in aggregate technology. Put differently, after a successful technological innovation at their own firm, managers underestimate the potential of competitors to engineer a similar reduction in prices. Hence they overestimate how much their own production will change, yielding $\beta_1 < 0$.[26]

Regarding the effect of the public signal on firms' forecast errors, firms also underestimate the role of aggregate developments. That is, they deem aggregate demand disturbances q_t to fluctuate less than they actually do. At the same time, they correctly observe the volatility of the signal, such that they overestimate the contribution of noise to the signal. Consequently, they pay less attention to the signal than under the rational-expectations benchmark ($\rho_x^p < \bar{\rho}_x^p$). Following a positive signal, they hence underestimate the increase in demand for their own and their competitors' products. Hence, firms expect their own demand and the prices of competitors to be lower than what they, on average, turn out to be after a positive signal and, therefore, underestimate their own output, such that $\beta_2 > 0$.

The model allows us to derive a number of additional predictions which conform well with the pattern in the data. We discuss them in turn. As before, proofs are found in Appendix D.

Proposition 2. *A higher degree of island illusion (a lower Υ) implies*

(a) A stronger overreaction to micro news (a lower β_1) and simultaneously a larger underreaction to the public signal (a larger β_2).

(b) Lower expected profits.

(c) A larger variance of the firm-specific forecast error.

[25] To be precise, $\beta_1 = \beta_2 = 0$ as long as agents have a correct estimate of the relative variances of the components of the signals, see the proof of Proposition 1 and Footnote 23.

[26] In general equilibrium, there are two, partly offsetting effects: On the one hand, firms expect prices of competitors to be on average higher than what they will actually turn out, increasing expected demand for the firms' products. On the other hand, firms expect overall demand to be lower than warranted, reducing expected idiosyncratic demand as well. Overall, the first effect dominates, and firms on average overestimate their future sales after having observed a negative surprise in idiosyncratic technology.

Intuitively, if firms underestimate aggregate developments, they, as explained above, underestimate the information content of the public signal and simultaneously overestimate their technological advantage in case of positive developments in their idiosyncratic technology—which corresponds to the evidence in Figure A.2 in the appendix. Given that the optimal forecast (that achieves an expected forecast error of zero, seen from an econometrician's view) obtains for $\Upsilon = 1$, any deviations lead to biased forecasts in the profit maximization problem of the firm and hence lower expected profits. Likewise, it raises the forecast-error variance. These predictions are in line with our findings in Section 3.5 above.

Proposition 3. *For a given degree of island illusion Υ, a higher business-cycle exposure (a higher ϖ_q) leads to a larger underreaction to macro news (a larger β_2).*

For firms that are more exposed to aggregate demand conditions, island illusion matters more, inducing a stronger underreaction. Intuitively, if demand for a firm's products is entirely idiosyncratic ($\varpi_q = 0$), island illusion does not play any role as it biases the estimated $\hat{\varpi}_q$ towards zero. For those firms, being on an island is no illusion but reality.

5 Conclusion

How do expectations adjust to news about the economy? We address this question while zooming in on firms' expectations about their own performance. This focus sets our study apart from earlier work, as does the distinction between micro and macro news. Analyzing firm surveys from Germany and Italy, we find robustly that firm expectations overreact to micro news and underreact to macro news. We estimate at the level of individual firms and provide detailed evidence which suggests that our results are not driven by measurement error. This allows us to reject rational expectations. But since our estimates show that firm expectations— independent of firm characteristics—respond in a systematically different way to micro and macro news, they directly inform attempts that move beyond rational expectations in modeling the expectation-formation process.

The last part of the paper represents such an attempt. Here we put forward a stylized general equilibrium model which assumes that firms suffer from island illusion: They perceive what's happening to them as less common than it actually is. We think of island illusion as an instance of salience. In the model, it is governed by a single parameter, representing a disciplined departure from rational expectations. The model provides microfoundation to our empirical specification and shows that island illusion can simultaneously account for overreaction to micro news and underreaction to macro news. Assessing further the validity of island illusion in other contexts of expectation formation seems a promising avenue for future research.

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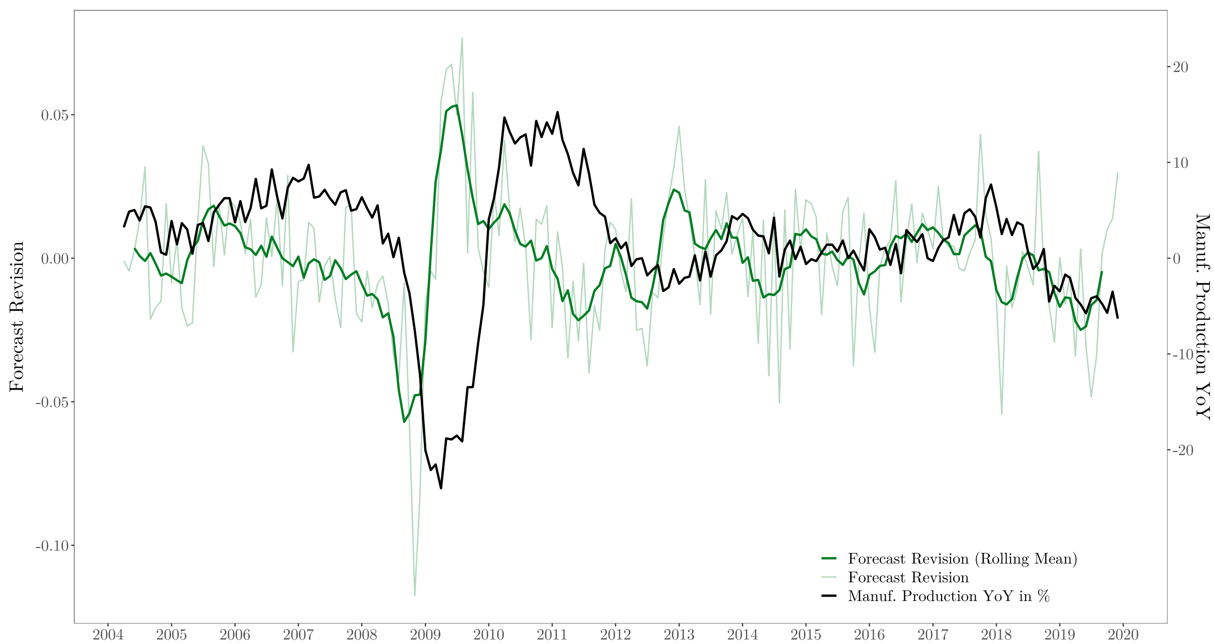
Appendix

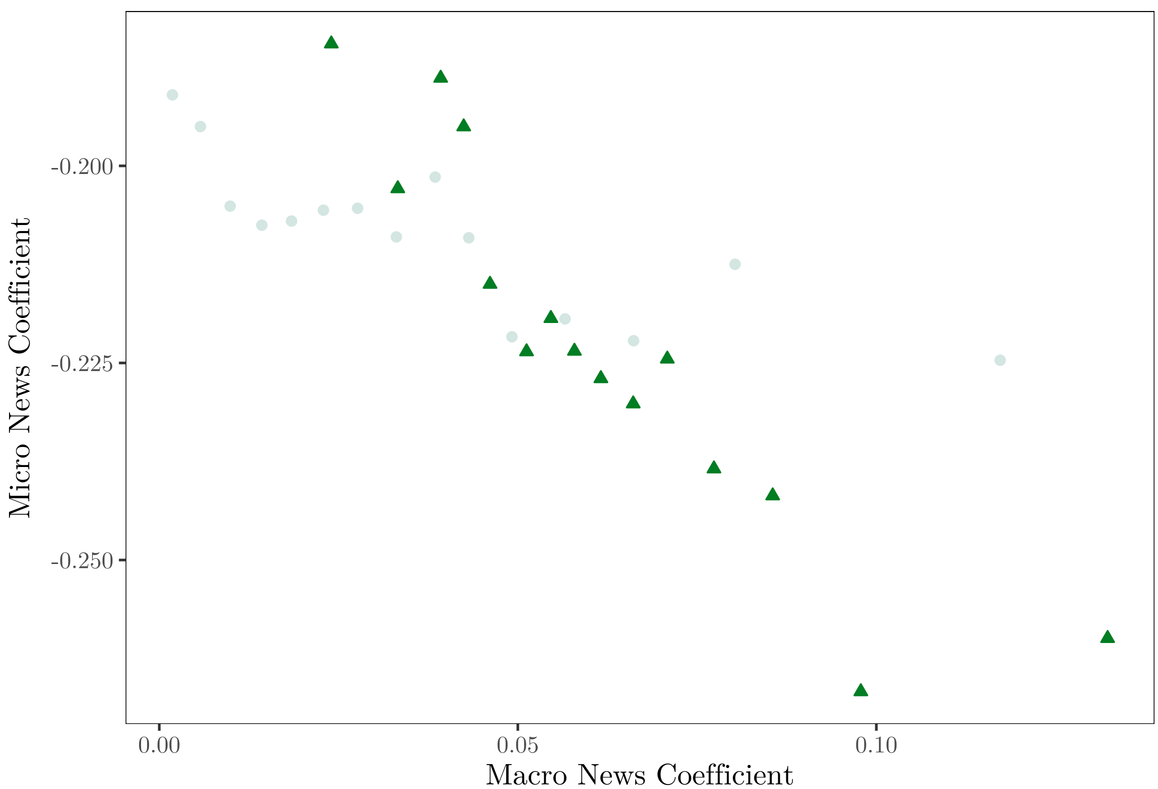
A Additional Figures and Tables

Figure A.1: Average forecast revisions and production growth



Notes: The figure displays the average, seasonally adjusted forecast revision (rolling mean over 6 months) in green and year-on-year growth of manufacturing production in black (administrative data).

Figure A.2: Relation between macro and micro coefficients at the firm-level



Notes: The figure displays two binned scatter plots (15 bins) between firm-level micro news coefficients and macro news coefficients. The grey points display the binned scatter based on the subsample of firms with negative micro news coefficients and positive macro news coefficients ($\rho = -0.09$). The green triangles display the binned scatter based on the subsample of firms with *significant* negative micro news coefficients and *significant* positive macro news coefficients ($\rho = -0.35$). The firm-level estimates are also displayed in Figure 2.

Table A.1: Relevant questions from ifo survey

Label	Name	Question	Possible answers
Q1	Expected state of business (qualitative)	Plans and Expectations for the next 6 months: Our business situation will be	rather more favorable [1] not changing [0] rather less favorable [-1]
Q2	Expected state of business (quantitative)	Expectations for the next 6 months: In cyclical regards our state of business will be	slider with range 0 [be rather less favorable] to 100 [rather more favorable]
Q3	Realized state of business (qualitative)	Current situation: We evaluate our state of business to be	good [1] satisfiable [0] bad [-1]
Q4	Realized state of business (quantitative)	Current situation: We consider our state of business to be	slider with range good [100] to bad [0]
Q5	Realized production	Review - tendencies in [t-1]: Compared to [t-2] our production	increased [1] stayed about the same [0] decreased [-1]
Q6	Expected production	Plans and Expectations for the next 3 months: Our production is expected to be	increasing [1] not changing [0] decreasing [-1]
Q7	Macro importance	How important is the general economic development in Germany for your business situation?	very important [1] important [2] not as important [3] less important [4] unimportant [5]

Notes: Most recent wording of relevant questions from the ifo survey taken from the EBDC Questionnaire manual. t denotes the month of the survey, so in July Q5 asks about the change in June compared to May.

Table A.2: Alternative specifications

(a) Expectations: use lagged micro news

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.191***			
	(0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.021***	-0.020***	
		(0.001)	(0.001)	
Macro News				
Surprise component of the ifo index	0.022***	0.021***		0.021***
	(0.0007)	(0.0007)		(0.0007)
Observations	302,737	280,583	280,583	302,737
R^2	0.16260	0.09452	0.08988	0.08967
Within R^2	0.08471	0.00580	0.00071	0.00498
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except we use one month lagged micro news. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(b) Business Situation: remove outliers (p1, p99)

	Firms' forecast errors about their business situation			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+6}	-0.394***			
	(0.004)			
Forecast Revision for x_{t+6} net of $\gamma_j \Gamma_t$		-0.387***	-0.383***	
		(0.005)	(0.005)	
Macro News				
Surprise component of the ifo index	0.760***	0.711***		0.615***
	(0.039)	(0.039)		(0.040)
Observations	147,226	147,409	147,409	150,166
R^2	0.29231	0.28251	0.27954	0.24130
Within R^2	0.06037	0.04779	0.04384	0.00287
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (b) except that we remove the top and bottom one percent of forecast errors, revisions, and micro news. Firm-fixed effects are always included and standard errors are clustered at firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(c) Expectations: only forecast revisions towards zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.091*** (0.003)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.110*** (0.003)	-0.112*** (0.003)	
Macro News				
Surprise component of the ifo index	0.030*** (0.0008)	0.030*** (0.0008)		0.030*** (0.0009)
Observations	205,962	205,962	205,962	205,962
R^2	0.17355	0.17605	0.16728	0.16331
Within R^2	0.02310	0.02605	0.01569	0.01100
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except that we only use observations where firms revise their expectations towards zero. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(d) Expectations: only forecast revisions towards zero and set small errors to zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.072*** (0.002)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.086*** (0.002)	-0.088*** (0.002)	
Macro News				
Surprise component of the ifo index	0.024*** (0.0008)	0.023*** (0.0008)		0.024*** (0.0008)
Observations	205,962	205,962	205,962	205,962
R^2	0.14081	0.14270	0.13592	0.13288
Within R^2	0.01729	0.01945	0.01170	0.00823
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except that we only use observations where firms revise their expectations towards zero and set small forecast errors ($\pm\frac{1}{3}$) to zero. Firm-fixed effects are always included and standard errors are clustered at firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(e) Forecast error: set small errors to zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.115*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.128*** (0.002)	-0.128*** (0.002)	
Macro News				
Surprise component of the ifo index	0.018*** (0.0006)	0.018*** (0.0006)		0.018*** (0.0006)
Observations	302,737	302,737	302,737	302,737
R^2	0.11352	0.11278	0.10838	0.07974
Within R^2	0.04103	0.04022	0.03547	0.00449
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except small forecast errors ($\pm\frac{1}{3}$) are set to zero. Firm-fixed effects are always included and standard errors are clustered at firm level. *** p<0.01, ** p<0.05, * p<0.1.

(f) Forecast error: set small errors to zero and no change expected

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.176*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.192*** (0.001)	-0.191*** (0.001)	
Macro News				
Surprise component of the ifo index	0.018*** (0.0006)	0.018*** (0.0006)		0.017*** (0.0006)
Observations	302,737	302,737	302,737	302,737
R^2	0.14684	0.14143	0.13768	0.07495
Within R^2	0.08113	0.07529	0.07125	0.00369
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except small forecast errors ($\pm\frac{1}{3}$) are set to zero when expectations are zero. Firm-fixed effects are always included and standard errors are clustered at firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(g) Estimation: Ordered Logit rather than OLS

Term	Estimate	Standard Error	t-value	Coeficient type	exp(estimate)
Micro News	-1.24	0.01	-158.19	coefficient	0.29
Macro News	0.11	0.00	37.16	coefficient	1.12
-4/3|-1	-6.04	0.03	-173.89	scale	0.00
-1|-2/3	-3.56	0.01	-337.00	scale	0.03
-2/3|-1/3	-2.45	0.01	-370.14	scale	0.09
-1/3|0	-1.27	0.00	-280.89	scale	0.28
0|1/3	1.52	0.00	314.78	scale	4.57
1/3|2/3	2.71	0.01	373.96	scale	15.10
2/3|1	3.91	0.01	321.66	scale	49.88
1|4/3	6.66	0.05	144.17	scale	782.37

Notes: Results using ordered logit to estimate the effect of micro news and macro news on the production forecast error. The last column shows the odds ratios. Rows 3 to 10 depict the cut points of the latent variable. The full, pooled sample is used.

(h) Micro news: absorb macro comp. of forecast revision with time-fixed effect

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.191*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.194*** (0.001)	-0.194*** (0.001)	
Macro News				
Surprise component of the ifo index	0.022*** (0.0007)	0.021*** (0.0007)		0.021*** (0.0007)
Observations	302,737	302,737	302,737	302,737
R^2	0.16260	0.16471	0.16015	0.08967
Within R^2	0.08471	0.08701	0.08202	0.00498
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except we absorb the macro component from forecast revisions by means of time-fixed effects (see Section 2). Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(i) Micro news: absorb macro comp. of forecast revision with time-sector-fixed effect

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.191*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.196*** (0.001)	-0.196*** (0.001)	
Macro News				
Surprise component of the ifo index	0.022*** (0.0007)	0.021*** (0.0007)		0.021*** (0.0007)
Observations	302,737	302,737	302,737	302,737
R^2	0.16260	0.16555	0.16100	0.08967
Within R^2	0.08471	0.08793	0.08295	0.00498
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except we absorb the macro component from forecast revisions by means of time-sector-fixed effects (see Section 2). Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(j) Macro news: manufacturing orders rather than ifo index

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.190*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.208*** (0.001)	-0.208*** (0.001)	
Macro News				
Surprise component of the ifo index	0.005*** (0.0003)	0.005*** (0.0003)		0.005*** (0.0003)
Observations	298,586	298,586	298,586	298,586
R^2	0.15828	0.15383	0.15286	0.08580
Within R^2	0.08023	0.07536	0.07431	0.00103
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except macro news are constructed from the median professional forecast of manufacturing orders. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(k) Macro news: first difference of ifo index rather than ifo index surprise

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.190*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.208*** (0.001)	-0.208*** (0.001)	
Macro News				
Surprise component of the ifo index	0.002*** (0.0002)	0.002*** (0.0003)		0.001*** (0.0003)
Observations	301,185	301,185	302,737	301,185
R^2	0.15737	0.15318	0.15313	0.08505
Within R^2	0.07908	0.07450	0.07435	0.00004
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except macro news is constructed with the first difference of the ifo index. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(l) Macro news: average forecast revisions rather than ifo index

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.194*** (0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.209*** (0.001)	-0.208*** (0.001)	
Macro News				
Surprise component of the ifo index	0.502*** (0.019)	0.345*** (0.018)		0.308*** (0.018)
Observations	302,737	302,737	302,737	302,737
R^2	0.16186	0.15526	0.15313	0.08681
Within R^2	0.08389	0.07668	0.07435	0.00187
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except macro news is constructed with average production forecast revisions. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(m) Macro news: average forecast revisions for each sector rather than ifo index

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.196***			
	(0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.211***	-0.208***	
		(0.001)	(0.001)	
Macro News				
Surprise component of the ifo index	0.326***	0.216***		0.129***
	(0.013)	(0.011)		(0.012)
Observations	302,737	302,737	302,737	302,737
R^2	0.16169	0.15506	0.15313	0.08580
Within R^2	0.08371	0.07646	0.07435	0.00076
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except macro news is constructed with average production forecast revisions for each sector. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(n) Macro news: first difference of stock market index rather than ifo index surprise

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News				
Forecast Revision for x_{t+3}	-0.190***			
	(0.001)			
Forecast Revision for x_{t+3} net of $\gamma_j \Gamma_t$		-0.208***	-0.208***	
		(0.001)	(0.001)	
Macro News				
Surprise component of the ifo index	0.371***	0.328***		0.328***
	(0.014)	(0.014)		(0.014)
Observations	302,737	302,737	302,737	302,737
R^2	0.15999	0.15518	0.15313	0.08716
Within R^2	0.08185	0.07659	0.07435	0.00224
Firm FE	✓	✓	✓	✓

Notes: Set-up as in Table 2 Panel (a) except macro news is constructed with the first difference of the German stock market index DAX. Firm-fixed effects are always included and standard errors are clustered at firm level.
*** p<0.01, ** p<0.05, * p<0.1.

B SIGE Data

The "Survey on Inflation and Growth Expectations" (SIGE) is a quarterly business survey launched in 1999. Until 2011 it features roughly 500 firms per quarter, 1,000 firms between 2011 and 2019, and more than 1,500 since 2021. The median firm responds for 7 quarters and 20 percent of firms respond for more than 23 quarters.[27] The questions relevant to our purposes are listed in Table B.1. These questions elicit growth rates in percentage points. The wording of Q3 about expected inflation ensures that firms receive the most recent inflation rates in Italy and the euro area.

Table B.1: Relevant questions from SIGE

Label	Name	Introduced	Wording
Q1	realized change in own prices	2002q4	In the last 12 months, what has been the average change in your firm's prices?
Q2	expected change in own price	1994q4	For the next 12 months, what do you expect will be the average change in your firm's prices?
Q3	expected inflation (12 months ahead)	1994q4	In July consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was 8.4 percent in Italy and 8.9 percent in the euro area. What do you think it will be in Italy in September 2023?
Q4	expected inflation (6 months ahead)	2010q4	In July consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was 8.4 percent in Italy and 8.9 percent in the euro area. What do you think it will be in Italy in March 2023?

Notes: Wording taken from the September 2022 questionnaire. Starting in 2012q3 alternative wordings for expected inflation (Q3) were used for randomly selected firms. We focus on the traditional wording including information about recent inflation. This wording is shown to 60 percent of the sample.

[27] For more details on the SIGE, see Grasso and Ropele (2018) and Coibion et al. (2020).

Table B.2: Additional regression results from the SIGE

(a) Univariate regressions

	Forecast error about firm's own prices				
	(1)	(2)	(3)	(4)	(5)
Micro News, firm-level purging	-0.477***				
	(0.018)				
Micro News, pooled purging		-0.461***			
		(0.017)			
Micro News, time-fe purging			-0.472***		
			(0.017)		
Macro News, inflation surprise				3.419***	
				(0.339)	
Macro News, forecast revision					0.212**
					(0.083)
Observations	28,561	38,048	38,048	25,420	28,928
R^2	0.0977	0.0904	0.0955	0.0105	0.0025
Within R^2	0.1039	0.1086	0.1128	0.0069	0.0009
Firm FE	✓	✓	✓	✓	✓

Notes: Regressing firms' forecast errors about their own prices on micro news and macro news separately. Micro news is based on firms' forecast revisions (*FR*) net of changes in the aggregate economy. For firm-level purging in column (1), we regress, for each firm separately, *FR*s on the first difference of the inflation rate and use the residuals as micro news. For pooled purging in (2), we run the same regression, but pool observations across firms. For time-fe purging in (3), we regress *FR*s on time-fixed effects and use the residual as micro news. For macro news, we consider two definitions. For inflation surprises in (4), we use the surprise component in the inflation rate of the previous quarter as measured by the difference between the realized rate and the (mean) professional forecast from Consensus Economics. Alternatively, we also consider as macro news, firms' own forecast revisions for 12-month-ahead inflation in columns (5).

(b) Regressions using actual forecast revisions

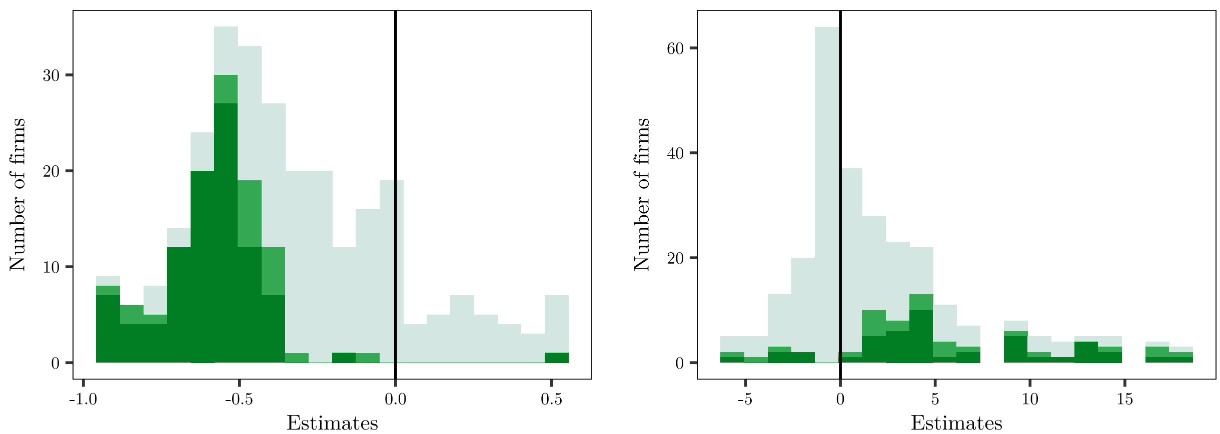
	Forecast error about firm's own prices		
	(1)	(2)	(3)
Micro News, firm-level purging	-0.495***		
	(0.023)		
Micro News, pooled purging		-0.454***	
		(0.027)	
Micro News, time-fe purging			-0.463***
			(0.027)
Macro News, forecast revision (6m - L6.12m)	0.431***	0.422***	0.415***
	(0.142)	(0.113)	(0.112)
Observations	11,312	14,998	14,998
R^2	0.1024	0.0821	0.0865
Within R^2	0.1189	0.1064	0.1097
Firm FE	✓	✓	✓

Notes: Regressing firms' forecast errors about their own prices on micro news and macro news. Micro news are as defined above. For macro news, we consider the forecast revision computed by subtracting from the current six-months-ahead inflation expectation (Q4 in Table B.1) the twelve-months-ahead inflation expectation six months ago (Q3).

Figure B.1: Firm-level regressions – univariate distribution of news coefficients

(a) Micro news

(b) Macro news



Notes: Forecast errors are for firms' own prices. Micro news is a firm's own forecast revision for their own prices purged from changes in inflation. Macro news is the surprise component of inflation in the previous quarter. We run the regression separately for each firm with at least 20 observations. Grey area represents insignificant estimates, light green area represents estimates significant at the 10 % level, dark green area indicates significance at the 5 % level.

C Model solution

In Appendix D, we provide the proofs for the propositions in Section 4. Before that, we outline the model solution and key equilibrium relationships. Throughout, we consider a linear approximation to the equilibrium conditions of the model. Lower-case letters indicate percentage deviations from steady state. We solve the model by backward induction. That is, we start by deriving expectations regarding period $t+1$. Using the result in the Euler equation of the third stage of period t allows us to determine price-setting decisions during stage 2. Eventually, we obtain the responses of forecasts and realizations to unexpected changes in productivity or the public signal.

Expectations regarding period $t+1$. Below, E_t^k stands for either $E_{t|2}^{j,r}$, referring to the information set of producer j on island r at the time of her pricing decision, or for $E_{t|3}^r$, referring to the information set of the household on island r at the time of its consumption decision. Variables with only time subscripts refer to economy-wide values. The wage in period $t+1$ is set according to the expected aggregate labor supply

$$E_t^k \varphi l_{t+1} = E_t^k (w_{t+1} - p_{t+1} - c_{t+1}).$$

This equation is combined with the aggregated production function

$$E_t^k y_{t+1} = E_t^k (x_{t+1} + \alpha l_{t+1}),$$

the expected aggregate labor demand

$$E_t^k (w_{t+1} - p_{t+1}) = E_t^k [x_{t+1} + (\alpha - 1) l_{t+1}],$$

and market clearing $y_{t+1} = c_{t+1}$ to obtain

$$E_t^k x_{t+1} = E_t^k y_{t+1} = E_t^k c_{t+1}. \tag{A-1}$$

Furthermore, the expected Euler equation, together with the Taylor rule, is

$$E_t^k c_{t+1} = E_t^k (c_{t+2} + \pi_{t+2} - \psi \pi_{t+1}).$$

Agents expect the economy to be in a new steady state tomorrow ($E_t^k c_{t+1} = E_t^k c_{t+2}$), given the absence of state variables other than technology, which follows a unit root process, and the demand shock, whose expected value is zero. Ruling out explosive paths yields

$$E_t^k \pi_{t+2} = E_t^k \pi_{t+1} = 0.$$

Stage 3 of period *t*. After prices are set, each household observes n prices in the economy. Since only productivity is idiosyncratic to firms at the time of setting prices, the productivity level $a_t^{j,r} = a_t^r$—which is the same for all producers $j \in [0,1]$ on island r—can be inferred from each price $p_t^{j,r}$ of the good from producer j on island r. Hence, household r forms its expectations about the change in aggregate productivity according to

$$E_{t|3}^r \Delta x_t = \delta_x^h \hat{a}_t^r,$$

where $\hat{a}_t^r$ is the average over the realizations of $a_{m,t} - x_{t-1}$ for each location m in household r's sample $\mathcal{B}_t^r$. The coefficients δ_x^h is equal across households and depend on n, σ_ε^2, and σ_η^2 in the following way:

$$\delta_x^h = \underbrace{\frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + \sigma_\eta^2/n}}_{\to 1 \text{ if } n \to \infty}. \tag{A-2}$$

Furthermore, households rationally incorporate the information contained in the public signal concerning the aggregate demand shock into their expectations of the aggregate price level.

The expectation formation of producers is discussed in the main text. Consumption follows an Euler equation with household-specific inflation, as only a subset of goods is bought. Agents expect no differences between households for $t+1$, such that expected aggregate productivity and the overall price level impact today's individual consumption. Additionally using $E_{t|3}^r p_{t+1} = E_{t|3}^r p_t$ and $E_{t|3}^r x_{t+1} = E_{t|3}^r x_t$ gives

$$c_t^r = E_{t|3}^r x_t + E_{t|3}^r p_t - p_t^r - r_t + q_t^r. \tag{A-3}$$

Similar to the updating formula for technology estimates, households use all relevant available information to form an estimate about the aggregate price level p_t according to

$$E_{t|3}^r p_t = \delta_p^h \hat{a}_t^r + \kappa_p^h w_t + \tau_p^h x_{t-1} - \eta_p^h r_t + \bar{\rho}_p^h s_t + \bar{\delta}_p^h q_t^r, \tag{A-4}$$

where the undetermined coefficients $\delta_p^h, \kappa_p^h, \tau_p^h, \eta_p^h, \bar{\rho}_p^h$, and $\bar{\delta}_p^h$ represent the impact of the relevant variable on the expected price level. Combining the above gives

$$c_t^r = (1+\tau_p^h)x_{t-1} + \delta_{xp}^h \hat{a}_t^r + \kappa_p^h w_t - (1+\eta_p^h)r_t - p_t^r + \bar{\rho}_p^h s_t + (1+\bar{\delta}_p^h)q_t^r \tag{A-5}$$

where $\delta_{xp}^h = \delta_x^h + \delta_p^h$. We will solve for the coefficients below. Total demand for good j on island r is

$$\begin{aligned} y_t^{j,r} &= -\gamma p_t^{j,r} + \gamma \sum_{\{m|r\in\mathcal{B}_t^m\}} \frac{p_t^m}{n} + \sum_{\{m|r\in\mathcal{B}_t^m\}} \frac{c_{m,t}}{n} \\ &= -\gamma p_t^{j,r} + \gamma \tilde{p}_t^r + \tilde{y}_t^r, \end{aligned} \tag{A-6}$$

where $\tilde{y}_t^r$ is the average consumption level of customers visiting island r, $1/n$th of which equals $p_t^{j,r}$. The index $\tilde{p}_t^r$ is the average price index of customers visiting island r. If customers bought on all (that is, infinitely many) islands in the economy, $\tilde{p}_t^r$ would correspond to the overall price level. Given (A-5), we have, with $\kappa^h = (1+\tau_p^h)x_{t-1} - (1+\eta_p^h)r_t + \kappa_p^h w_t$,

$$\begin{aligned} \tilde{y}_t^r &= \frac{1}{n} \sum_{\{m|r\in\mathcal{B}_t^m\}} [E_t^m x_t + E_t^m p_t - p_t^m - r_t + q_t^m] \\ &= \kappa^h + \delta_{xp}^h \sum_{m\in\mathcal{B}_t^r} \frac{\hat{a}_t^m}{n} - \sum_{\{m|r\in\mathcal{B}_t^m\}} \frac{p_t^m}{n} + (1+\bar{\delta}_p^h)\left(q_t + \sum_{\{m|r\in\mathcal{B}_t^m\}} \frac{\bar{q}_t^m}{n}\right) + \bar{\rho}_p^h s_t. \end{aligned} \tag{A-7}$$

Stage 2 of period *t*. During the second stage, firms obtain idiosyncratic signals about their productivity. Firms set prices according to

$$\begin{aligned} p_t^{j,r} &= w_t + \frac{1-\alpha}{\alpha} E_{t|2}^{j,r} y_t^{j,r} - \frac{1}{\alpha} a_t^r \\ &\equiv k' + k_1' E_{t|2}^{j,r} \tilde{p}_t^r + k_2' E_{t|2}^{j,r} \tilde{y}_t^r - k_3' a_t^r, \end{aligned}$$

with

$$k' = \frac{\alpha}{\alpha+\gamma(1-\alpha)} w_t \qquad k_1' = \frac{\gamma(1-\alpha)}{\alpha+\gamma(1-\alpha)} \qquad k_2' = \frac{1-\alpha}{\alpha+\gamma(1-\alpha)} \qquad k_3' = \frac{1}{\alpha+\gamma(1-\alpha)}. \tag{A-8}$$

From here onward, expressions that are based on common knowledge only (such as k') are treated like parameters in notation terms, i.e., they lack a time index. This facilitates the important distinction between expressions that are common information and those that are not. Evaluating the expectation of firm j about island-specific demand in period t, using

(A-7), results in

$$E^{j,r}_{t|2}\tilde{y}^r_t = \kappa^h + \delta^h_{xp}\left(\frac{1}{n}(a^r_t - x_{t-1}) + \frac{n-1}{n}E^{j,r}_{t|2}\varepsilon_t\right) - \left(\frac{1}{n}p^{j,r}_t + \frac{n-1}{n}E^{j,r}_{t|2}p_t\right) + \left[(1+\bar{\delta}^h_p)\rho^p_q + \bar{\rho}^h_p\right] s_t. \tag{A-9}$$

where ρ^p_q is the coefficient used by producers to form expectations about the aggregate demand shock based on the signal, and κ^h contains only publicly available information. Furthermore, it is taken into account that the productivity and prices of island r have a non-zero weight in the sample of productivity and price levels observed by consumers visiting island r. Note that producers still take the price index of the consumers as given, since they buy infinitely many goods on the same island.

Inserting the firm expectation (A-9) into the pricing equation (A-8) yields (here, p_t is the average of the prices charged by producers of all other islands, which is the overall price index)

$$p^{j,r}_t \equiv k + k_1 E^{j,r}_{t|2}p_t - k_3 a^r_t + k_4 s_t,$$

with

$$\Xi = 1 - \frac{1}{n}(k'_1 - k'_2) \qquad k = \frac{1}{\Xi}\left\{k' + k'_2\kappa^h + \frac{k'_2\delta^h_{xp}}{n}\left[(n-1)(1-\delta^p_x) - 1\right] x_{t-1}\right\}$$
$$k_1 = \frac{n-1}{n\Xi}\left(k'_1 - k'_2\right) \qquad k_3 = \frac{1}{\Xi}\left\{k'_3 - \frac{k'_2\delta^h_{xp}}{n}\left[(n-1)\delta^p_x + 1\right]\right\} \qquad k_4 = \frac{k'_2}{\Xi}\left[(1+\bar{\delta}^h_p)\rho^p_q + \bar{\rho}^h_p\right]. \tag{A-10}$$

Note that, according to (A-8), $0 < k'_1 - k'_2 < 1$ because $0 < \alpha < 1$ and $\gamma > 1$. Using the definition of k_1 in (A-10), this implies (observe that $n > 1$)

$$0 < k_1 < 1.$$

Aggregating over all producers gives the aggregate price index

$$p_t = k + k_1\overline{E}_t p_t - k_3 x_t + k_4 s_t,$$

where $\int a^r_t dr = x_t$, and $\overline{E}_t p_t = \iint E^{j,r}_{t|2}p_t \, djdr$ is the average expectation of the price level.

The expectation of firm j of this aggregate is therefore

$$\begin{aligned} E^{j,r}_{t|2}p_t &= k - k_3 E^{j,r}_{t|2}x_t + k_1 E^{j,r}_{t|2}\overline{E}_t p_t + k_4 s_t \\ &= k - k_3\delta^p_x a^r_t - k_3(1-\delta^p_x)x_{t-1} + k_1 E^{j,r}_{t|2}\overline{E}_{t|2}p_t + k_4 s_t. \end{aligned} \tag{A-11}$$

Inserting the last equation into (A-10) gives

$$p_t^{j,r} = k + k_1 k - k_1 k_3 (1 - \delta_x^p) x_{t-1} - (k_3 + k_1 k_3 \delta_x^p)\, a_t^r + k_1^2 E_{t|2}^{j,r} \overline{E}_{t|2} p_t + (k_4 + k_1 k_4) s_t.$$

To find $E_{t|2}^{j,r} \overline{E}_t p_t$, note that firm j's expectations of the average of (A-11) are

$$E_{t|2}^{j,r} \overline{E}_t p_t = k - k_3 (1 - \delta_x^p)(1 + \delta_x^p) x_{t-1} - k_3 \delta_x^{p2} a_t^r + k_1 E_{t|2}^{j,r} \overline{E}_{t|2}^{(2)} p_t + k_4 s_t.$$

where $\overline{E}^{(2)}$ is the average expectation of the average expectation. The price of firm j is found by plugging the last equation into the second-to-last:

$$\begin{aligned} p_t^{j,r} =& k + k_1 k + k_1^2 k - \left[k_1 k_3 (1 - \delta_x^p) + k_1^2 k_3 (1 - \delta_x^p)(1 + \delta_x^p) \right] x_{t-1} \\ & - \left[k_3 (1 + k_1 \delta_x^p) + k_1^2 k_3 \delta_x^{p2} \right] a_t^r + [k_4 + k_1 k_4 + k_1^2 k_4] s_t + k_1^3 E_{t|2}^{j,r} \overline{E}_{t|2}^{(2)} p_t. \end{aligned}$$

Continuing like this results in some infinite sums

$$\begin{aligned} p_t^{j,r} =& k \left(1 + k_1 + k_1^2 + k_1^3 \dots \right) \\ & - k_1 k_3 (1 - \delta_x^p) \left[1 + k_1 (1 + \delta_x^p) + k_1^2 (1 + \delta_x^p + \delta_x^{p2}) + k_1^3 (1 + \delta_x^p + \delta_x^{p2} + \delta_x^{p3} \dots) \right] x_{t-1} \\ & - k_3 \left(1 + k_1 \delta_x^p + k_1^2 \delta_x^{p2} + k_1^3 \delta_x^{p3} \dots \right) a_t^r + \left[k_4 + k_1 k_4 + k_1^2 k_4 + k_1^3 k_4 + \dots \right] s_t \\ & + k_1^\infty E_{t|2}^{j,r} \overline{E}_{t|2}^{(\infty)} p_t. \end{aligned}$$

This leads to

$$p_t^{j,r} = \frac{k}{1 - k_1} - \frac{k_1 (1 - \delta_x^p)}{1 - k_1} \frac{k_3}{1 - k_1 \delta_x^p} x_{t-1} - \frac{k_3}{1 - k_1 \delta_x^p} a_t^r + \frac{1}{1 - k_1} k_4 s_t + \underbrace{k_1^\infty \overline{E}_{t|2}^{(\infty)}}_{\to 0} p_t$$

or

$$p_t^{j,r} = \bar{k}_1 + \bar{k}_3 a_t^r + \bar{k}_4 s_t. \tag{A-12}$$

with

$$\bar{k}_1 = \frac{1}{1 - k_1} \left[k - (1 - \delta_x^p) \frac{k_1 k_3}{1 - k_1 \delta_x^p} x_{t-1} \right] \qquad \bar{k}_3 = - \frac{k_3}{1 - k_1 \delta_x^p} \qquad \bar{k}_4 = \frac{1}{1 - k_1} k_4.$$

The average over all producers yields the aggregate price index as

$$p_t \equiv \bar{k}_1 + \bar{k}_3 x_t + \bar{k}_4 s_t. \tag{A-13}$$

To arrive at qualitative predictions for the impact of the structural shocks ε_t and q_t on output growth and the forecast error, we need to determine the sign and the size of $\bar{k}_3$. Note that, according to (A-10),

$$-k_3 = \delta^h_{xp} \frac{k'_2 - nk'_3/\delta^h_{xp} + k'_2(n-1)\delta^p_x}{n - (k'_1 - k'_2)},$$

where the first part of the numerator can be rewritten, by observing (A-8), as

$$k'_2 - nk'_3/\delta^h_{xp} = \frac{1 - n/\delta^h_{xp} - \alpha}{\alpha + \gamma(1-\alpha)}.$$

Using (A-8) and (A-10) thus yields

$$-k_3 = \delta^h_{xp} \frac{(1-\alpha)[(n-1)\delta^p_x + 1] - n/\delta^h_{xp}}{(n-1)[\alpha + \gamma(1-\alpha)] + 1}.$$

Plugging this into the definition of $\bar{k}_3$ in (A-13) gives

$$\bar{k}_3 = \delta^h_{xp} \left\{ \frac{(1-\alpha)[(n-1)\delta^p_x + 1] - n/\delta^h_{xp}}{(n-1)[\alpha + \gamma(1-\alpha)] + 1} \right\} \left\{ 1 - \delta^p_x \frac{(n-1)(\gamma-1)(1-\alpha)}{(n-1)[\alpha + \gamma(1-\alpha)] + 1} \right\}^{-1}.$$

To obtain $\delta^h_{xp} = \delta^h_x + \delta^h_p$, we need to find the undetermined coefficients of equation (A-4). Start by comparing this equation with household r's expectation of equation (A-13):

$$E^r_{t|3} p_t = \underbrace{\bar{k}_1 + \bar{k}_3 x_{t-1}}_{\kappa^h_p w_t + \tau^h_p x_{t-1} - \eta^h_p r_t} + \underbrace{\bar{k}_3 \delta^h_x}_{\delta^h_p} \hat{a}^r_t + \underbrace{\bar{k}_4}_{\bar{\rho}^h_p} s_t, \tag{A-14}$$

with $\bar{\delta}^h_p = 0$, since the household knows that price-setters only have the public signal regarding demand, but not any information about actual demand. Hence, $\delta^h_{xp} = \delta^h_x(1 + \bar{k}_3)$. Inserting this into the above expression for $\bar{k}_3$ yields

$$\bar{k}_3 \equiv - \frac{n/\Sigma - \delta^h_x \Psi}{\Phi - \delta^h_x \Psi}, \tag{A-15}$$

with

$$\Sigma = (n-1)[\alpha + \gamma(1-\alpha)] + 1 > 0 \qquad \Psi = (1-\alpha)[(n-1)\delta^p_x + 1]/\Sigma > 0$$
$$\Phi = 1 - \delta^p_x (n-1)(\gamma-1)(1-\alpha)/\Sigma.$$

The signs obtain because $n > 1, 0 < \alpha < 1, \delta^p_x > 0$, and $\gamma > 1$. Observe that $\Psi\Sigma < n$ because

$\delta_x^p \leq 1$. Hence, $n/\Sigma - \delta_x^h \Psi > 0$ because

$$n - \underbrace{\delta_x^h}_{>0,<1} \underbrace{\Psi\Sigma}_{<n} > 0,$$

implying that the numerator of (A-15) is positive. Turning to the denominator $\Phi - \delta_x^h \Psi$, note that $\Phi - \Psi > 0$. The denominator of (A-15) is therefore positive as well, and we have $\bar{k}_3 < 0$. Next, consider that $n/\Sigma < \Phi$ and we obtain

$$-1 < \bar{k}_3 < 0.$$

This is a key result for the derivation of the propositions in Appendix D.

We now turn to $\bar{k}_4$. First, observe that

$$\begin{aligned} \Xi &= 1 - \frac{1}{n}(k_1' - k_2') \\ &= \frac{[(n-1)\gamma + 1](1-\alpha) + n\alpha}{n[\alpha + \gamma(1-\alpha)]} > 0 \end{aligned}$$

and

$$k_1 = \frac{(n-1)\varepsilon(1-\alpha) + (n-1)\alpha + 1 - n}{(n-1)\varepsilon(1-\alpha) + (n-1)\alpha + 1} < 1.$$

Thus,

$$\begin{aligned} \bar{k}_4 &= \frac{1}{1-k_1}\frac{k_2'}{\Xi}\left[\bar{k}_4 + \rho_q^p\right] \\ &= \frac{k_2'}{(1-k_1)\Xi - k_2'}\rho_q^p. \end{aligned}$$

Since $k_2' > 0$, for $\bar{k}_4 > 0$, we need to show that

$$(1-k_1)\Xi > k_2'$$

or

$$n\alpha^2 > -\alpha(1-\alpha)[(n-1)\gamma + 1],$$

which is true, such that $\bar{k}_4 > 0$.

Stage 1 of period *t* As information sets of agents are perfectly aligned during stage 1, we use the expectation operator $E_{t|1}$ to denote (common) stage-one expectations in what follows. Combining the results regarding expectations about inflation in period $t+1$ with the Euler equation, the Taylor rule, and the random-walk assumption for x_t gives, see equation (A-3),

$$E_{t|1}c_t = E_{t|1}y_t = E_{t|1}x_t + (1-\psi)E_{t|1}\pi_t + E_{t|1}q_t.$$

Remember that the monetary policy shock emerges after wages are set. Its expected value before wage-setting is zero, just like the expected value of the demand shock, as the signal is not yet released. Labor supply is given by

$$\varphi E_{t|1}l_t = E_{t|1}(w_t - p_t - c_t + q_t).$$

This equation can be combined with the aggregated production function

$$E_{t|1}y_t = E_{t|1}(x_t + \alpha l_t),$$

the expected aggregate labor demand

$$E_{t|1}(w_t - p_t) = E_{t|1}[x_t + (\alpha - 1)l_t],$$

and market clearing $y_t = c_t$ to obtain

$$\varphi E_{t|1}l_t = E_{t|1}(x_t + (\alpha - 1)l_t - c_t] + q_t$$

or

$$E_{t|1}y_t = E_{t|1}x_t.$$

Comparing this expression to the Euler equation, we get

$$E_{t|1}\pi_t = 0.$$

Nominal wages are set in line with these expectations. We thus have determinacy of the price level. The central bank then sets its interest rate based on expected inflation.

D Proofs

Proof of Proposition 1 Calculating the expectation error of firms for idiosyncratic output, using demand equation (A-6), the island-specific demand (A-7), and the price-level equation (A-13), yields

$$\begin{aligned} FE_{t+1}^{j,r} &= \Delta y_t^{j,r} - E_{t|2}^{j,r}\Delta y_t^{j,r} = \gamma\frac{n-1}{n}\left(p_t - E_{t|2}^{j,r}p_t\right) + \tilde{y}_t^r - E_{t|2}^{j,r}\tilde{y}_t^r \\ &= \frac{n-1}{n}\left[(\gamma-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3)\right]\left(\varepsilon_t - E_{t|2}^{j,r}\varepsilon_t\right) + q_t - E_{t|2}^{j,r}q_t + \sum_{\{m|r\in\mathcal{B}_t^m\}}\frac{\bar{q}_t^k}{n} \\ &\equiv \Lambda\left(\varepsilon_t - E_{t|2}^{j,r}\varepsilon_t\right) + q_t - E_{t|2}^{j,r}q_t + \sum_{\{m|r\in\mathcal{B}_t^m\}}\frac{\bar{q}_t^k}{n}, \end{aligned} \tag{A-16}$$

where the Euler equations (A-5) of customers of island r is used in the second equation. The effect Λ of the expectation error regarding aggregate technology innovations, $\varepsilon_t - E_{t|2}^{j,r}\varepsilon_t$, on the expectation error regarding own output is negative if

$$\gamma - 1 > -\delta_x^h\frac{1+\bar{k}_3}{\bar{k}_3}. \tag{A-17}$$

Since

$$-\frac{1+\bar{k}_3}{\bar{k}_3} = \frac{(n-1)(1-\alpha)(\gamma-1)(1-\delta_x^p)}{n-\delta_x^h(1-\alpha)[(n-1)\delta_x^p+1]},$$

inequality (A-17) is fulfilled if

$$1 > \delta_x^h(1-\alpha),$$

which is correct, such that $\Lambda < 0$. The gap between expected own and aggregate output can be calculated using (A-6), (A-9), (A-12), and (A-13):

$$\begin{aligned} E_{t|2}^{j,r}y_t^{j,r} - E_{t|2}^{j,r}y_t &= -\gamma\frac{n-1}{n}\left(p_t^{j,r} - E_{t|2}^{j,r}p_t\right) + E_{t|2}^{j,r}\tilde{y}_t^r - E_{t|2}^{j,r}y_t \\ &= \frac{1}{n}\left[-\gamma(n-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3) - \bar{k}_3\right]E_{t|2}^{j,r}\eta_t^r \equiv K_1 E_{t|2}^{j,r}\eta_t^r. \end{aligned} \tag{A-18}$$

Aggregating individual Euler equations (A-3) over all individuals, using (A-13), and (A-14) gives aggregate output as

$$y_t = E_{t|3}^r x_t + E_{t|3}^r p_t - p_t - r_t + q_t = x_{t-1} + \underbrace{\left[\delta_x^h - \bar{k}_3(1-\delta_x^h)\right]}_{>0}\varepsilon_t + q_t \underbrace{-\frac{\alpha}{\alpha+\psi(1-\alpha)}}_{<0}\nu_t.$$

Note that, if households have full information ($n \to \infty$), we get $\delta_x^h \to 1$ and $y_t = x_t - \nu_t \alpha/(\alpha + \psi(1-\alpha))$. The signs indicated above result from $0 < -\overline{k}_3 < 1$ (derived above).

Forecast revisions are then given by the change in expectations between before and after receiving the private and public signals (that is, between stage one and stage two). The last equation implies

$$E_{t|2}^{j,r} y_t - x_{t-1} = \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] E_{t|2}^{j,r} \varepsilon_t + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)} \nu_t.$$

Using this equation together with equation (A-18) in the forecast revision gives

$$\begin{aligned} FR_t^{j,r} &= E_{t|2}^{j,r}(y_t^{j,r} - y_{t-1}^{j,r}) - E_t(y_t^{j,r} - y_{t-1}^{j,r}) = E_{t|2}^{j,r} y_t^{j,r} - E_{t|2}^{j,r} y_t + E_{t|2}^{j,r} y_t - E_t y_t \\ &= K_1 E_{t|2}^{j,r} \eta_t^r + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] E_{t|2}^{j,r} \varepsilon_t + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)} \nu_t. \end{aligned}$$

Since

$$E_{t|2}^{j,r} \varepsilon_t = \delta_x^p(\varepsilon_t + \eta_t^r) \qquad E_{t|2}^{j,r} \eta_t^r = (1-\delta_x^p)(\varepsilon_t + \eta_t^r) \tag{A-19}$$

we can write the above as

$$\begin{aligned} FR_t^{j,r} &= K_1(1-\delta_x^p)(\varepsilon_t + \eta_t^r) + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] \delta_x^p(\varepsilon_t + \eta_t^r) + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)} \nu_t \\ &\equiv X_1 \varepsilon_t + X_1 \eta_t^r + X_1^q q_t + X_1^q e_t + K_\nu \nu_t. \end{aligned}$$

with

$$X_1 = K_1(1-\delta_x^p) + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] \delta_x^p \qquad X_1^q = \rho_q^p \qquad K_\nu = -\frac{\alpha}{\alpha + \psi(1-\alpha)}.$$

Similarly, making use of (A-19), the forecast error (A-16) can be written as

$$FE_{t+1}^{j,r} = \Lambda\left[(1-\delta_x^p)\varepsilon_t - \delta_x^p \eta_t^r\right] + (1-\rho_q^p) q_t - \rho_q^p e_t \sum_{\{m|r \in \mathcal{B}_t^m\}} \frac{\bar{q}_t^k}{n}. \tag{A-20}$$

The sign of β_1 of regression (10) can then be determined in two steps. Since both independent variables, forecast revisions and the signal, are correlated, we first regress forecast revisions on the signal, yielding the regression coefficient

$$Coef_1 = \frac{Cov(FR_t^{j,r}, s_t)}{Var(s_t)} = \frac{X_1^q \sigma_q^2 + X_1^q \sigma_e^2}{\sigma_q^2 + \sigma_e^2} = X_1^q.$$

The residual of this regression can therefore be written as $FR_t^{j,r} - Coef_1 s_t$. The sign of the coefficient β_1 of regression (10) then depends on the sign of

$$\begin{aligned} Cov(FE_{t+1}^{j,r}; FR_t^{j,r} - Coef_1 s_t) &= Cov(FE_{t+1}^{j,r}; FR_t^{j,r}) - Coef_1 Cov(FE_{t+1}^{j,r}, s_t) \\ &= \underbrace{(X_1^q - Coef_1)}_{=0} R_e^q + \underbrace{\Lambda X_1}_{<0} \underbrace{R_\eta}_{>0} < 0, \end{aligned}$$

with

$$R_e^q = (1-\rho_q^p)\sigma_q^2 - \rho_q^p \sigma_{e,q}^2 \qquad R_\eta = (1-\delta_x^p)\sigma_\varepsilon^2 - \delta_x^p \sigma_\eta^2.$$

The signs obtain from $\Lambda < 0$ and

$$K_1 = \frac{1}{n}\left[-\gamma(n-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3) - \bar{k}_3\right] > 0 \qquad X_1 = K_1(1-\delta_x^p) + \left[\delta_x^h - \bar{k}_3(1-\delta_x^h)\right]\delta_x^p > 0,$$

as well as

$$R_\eta > 0 \quad \text{if} \quad \frac{\hat{\sigma}_\eta^2}{\hat{\sigma}_\varepsilon^2} > \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}, \tag{A-21}$$

that is

$$R_\eta > 0 \quad \text{if} \quad \frac{1-\Upsilon\varpi_a}{\Upsilon\varpi_a} > \frac{1-\varpi_a}{\varpi_a},$$

which results from the assumption of island illusion, $\Upsilon < 1$. Hence, $\beta_1 < 0$.

The sign of the coefficient β_2 of regression (10) can equivalently be derived by first regressing the forecast revision on the signal, which gives the coefficient

$$Coef_2 = \frac{Cov(FR_t^{j,r}, s_t)}{Var(FR_t^{j,r})} = \frac{X_1^q \sigma_q^2 + X_1^q \sigma_e^2}{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (X_1^q)^2\sigma_q^2 + (X_1^q)^2\sigma_e^2 + (K_\nu)^2\sigma_\nu^2},$$

which is positive since $X_1^q > 0$. The sign of β_2 in regression (10) then depends on the sign of

$$\begin{aligned} Cov(FE_{t+1}^{j,r}; s_t - Coef_2(FR_t^{j,r})) &= Cov(FE_{t+1}^{j,r}; s_t^q) - Coef_2 Cov(FE_{t+1}^{j,r}, FR_t^{j,r}) \\ &= \underbrace{(1 - Coef_2 X_1^q)}_{>0} \underbrace{R_e^q}_{>0} \underbrace{-Coef_2}_{<0} \underbrace{\Lambda X_1}_{<0} R_\eta. \end{aligned}$$

The signs obtain because

$$1 - Coef_2 X_1^q = \frac{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (K_\nu)^2\sigma_\nu^2}{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (X_1^q)^2\sigma_q^2 + (X_1^q)^2\sigma_e^2 + (K_\nu)^2\sigma_\nu^2},$$

which is positive but smaller than unity, and

$$R_e^q > 0 \quad \text{if} \quad \frac{\hat{\sigma}_e^2}{\hat{\sigma}_q^2} > \frac{\sigma_e^2}{\sigma_q^2}, \tag{A-22}$$

that is

$$R_e^q > 0 \quad \text{if} \quad \frac{1/\bar{v} - \Upsilon\varpi_q}{\Upsilon\varpi_q} > \frac{1/\bar{v} - \varpi_q}{\varpi_q},$$

which results from the assumption of island illusion. Hence, $\beta_2 > 0$. ■

Proof of Proposition 2

A higher degree of island illusion (a lower Υ) implies...

a) A stronger overreaction to micro news (a lower β_1) and simultaneously a larger under-reaction to the public signal (a larger β_2).

The coefficient β_1 of regression (10) is, where results from the proof of Proposition 1 are inserted in the first line

$$\beta_1 = \frac{Cov(FE_{t+1}^{j,r}; FR_t^{j,r} - Coef_1 s_t)}{Var(FR_t^{j,r} - Coef_1 s_t)} = \frac{(\overbrace{(X_1^q - Coef_1)}^{=0} R_e^q + \Lambda X_1 R_\eta)}{Var(X_1\varepsilon_t + X_1\eta_t^r + X_1^q q_t + X_1^q e_t + K_\nu\nu_t - X_1^q s_t)}$$
$$= \frac{\Lambda[\sigma_\varepsilon^2 - \delta_x^p\sigma_a^2]}{X_1\sigma_a^2 + (K_\nu)^2\sigma_\nu^2/X_1}.$$

First note that the derivative of X_1 with respect to δ_x^p equals

$$\frac{\partial X_1}{\partial\delta_x^p} = \frac{\partial K_1}{\partial\delta_x^p}(1-\delta_x^p) - K_1 + \delta_x^h - \bar{k}_3(1-\delta_x^h) - (1-\delta_x^h)\delta_x^p\frac{\partial\bar{k}_3}{\partial\delta_x^p}.$$

Since

$$\frac{\partial K_1}{\partial\delta_x^p} = \frac{1}{n}\left[-\gamma(n-1) + \delta_x^h - 1\right]\frac{\partial\bar{k}_3}{\partial\delta_x^p}$$

we have

$$\begin{aligned}\frac{\partial X_1}{\partial \delta_x^p} =& -K_1 + \delta_x^h - \overline{k}_3(1-\delta_x^h) + \left\{\frac{1}{n}\left[-\gamma(n-1)+\delta_x^h-1\right](1-\delta_x^p) - (1-\delta_x^h)\delta_x^p\right\}\frac{\partial \bar{k}_3}{\partial \delta_x^p} \\ =&\bar{k}_3\left[\frac{1}{n}\gamma(n-1)+\frac{1}{n}-(1-\delta_x^h)\right] + \delta_x^h\left[1-\frac{1}{n}(1+\bar{k}_3)\right] + \\ &\left\{\frac{1}{n}\left[-\gamma(n-1)(1-\delta_x^p)+\delta_x^h-1\right]+\delta_x^p\frac{1}{n}-\delta_x^p\left[\frac{1}{n}\delta_x^h+1-\delta_x^h\right]\right\}\frac{\partial \bar{k}_3}{\partial \delta_x^p} \\ =&\Lambda + \frac{n-1}{n}\left[-\gamma(1-\delta_x^p)+\delta_x^p(\delta_x^h-1)+(\delta_x^h-1)/(n-1)\right]\frac{\partial \bar{k}_3}{\partial \delta_x^p}.\end{aligned}$$

Because

$$\begin{aligned}\frac{\partial \bar{k}_3}{\partial \delta_x^p} =& \frac{\delta_x^h}{\Phi-\delta_x^h\Psi}\frac{\partial \Psi}{\partial \delta_x^p} + \frac{n/\Sigma - \delta_x^h\Psi}{(\Phi-\delta_x^h\Psi)^2}\left(\frac{\partial \Phi}{\partial \delta_x^p} - \delta_x^h\frac{\partial \Psi}{\partial \delta_x^p}\right) = \left[\delta_x^h + \overline{k}_3\left((\gamma-1)+\delta_x^h\right)\right]\frac{(n-1)(1-\alpha)}{\Sigma(\Phi-\delta_x^h\Psi)} \\ =& \, n\Lambda\frac{1-\alpha}{\Sigma(\Phi-\delta_x^h\Psi)}\end{aligned}$$

with

$$\Sigma(\Phi-\delta_x^h\Psi) = (n-1)(1-\alpha)\left[(\gamma-1)(1-\delta_x^p)-\delta_x^p\delta_x^h\right] + n - \delta_x^h(1-\alpha),$$

such that

$$\frac{\partial \bar{k}_3}{\partial \delta_x^p} = \frac{\Lambda}{[-1+\gamma(1-\delta_x^p)+(1-\delta_x^h)\delta_x^p](n-1)/n + 1/(1-\alpha) - \delta_x^h/n} < 0,$$

we can also write

$$\frac{\partial X_1}{\partial \delta_x^p} = \Lambda\frac{n\alpha/(1-\alpha)}{(n-1)[\gamma(1-\delta_x^p)+(1-\delta_x^h)\delta_x^p] + n\alpha/(1-\alpha) + 1 - \delta_x^h} \equiv \Lambda K_4 < 0,$$

with $K_4 > 0$. The derivative of β_1 with respect to δ_x^p is then positive if

$$\begin{aligned}\frac{\partial \Lambda}{\partial \delta_x^p}R_\eta - \Lambda\sigma_a^2 &> \Lambda R_\eta\frac{(\sigma_a^2 - K_\nu^2\sigma_\nu^2/X_1^2)}{X_1\sigma_a^2+(K_\nu)^2\sigma_\nu^2/X_1}\frac{\partial X_1}{\partial \delta_x^p} \\ \frac{X_1}{K_4}\frac{K_5R_\eta - \sigma_a^2}{\Lambda R_\eta} &> \frac{\sigma_a^2 - K_\nu^2\sigma_\nu^2/X_1^2}{\sigma_a^2+(K_\nu)^2\sigma_\nu^2/X_1^2} < 1,\end{aligned}$$

with

$$K_5 = \frac{n-1}{n}\frac{\gamma-1+\delta_x^h}{\Lambda}\frac{\partial \bar{k}_3}{\partial \delta_x^p}.$$

The above is fulfilled if

$$\begin{aligned} -\sigma_a^2 &< \left(\frac{K_4}{X_1}\Lambda - K_5\right) R_\eta \\ \text{or} \quad -1 &< \left(\frac{K_4}{X_1}\Lambda - K_5\right)(\varpi_a - \delta_x^p) . \end{aligned} \tag{A-23}$$

Since

$$\frac{K_4}{X_1}\Lambda - K_5 = \frac{\frac{\alpha}{1-\alpha}\frac{\Lambda}{X_1} - \frac{n-1}{n}(\gamma - 1 + \delta_x^p)}{[-1 + \gamma(1-\delta_x^p) + (1-\delta_x^h)\delta_x^p](n-1)/n + 1/(1-\alpha) - \delta_x^h/n}$$

inequality (A-23) can be written as

$$1-\gamma(1-\delta_x^p)-(1-\delta_x^h)\delta_x^p](n-1)/n-1/(1-\alpha)+\delta_x^h/n < \left[\frac{\alpha}{1-\alpha}\frac{\Lambda}{X_1} - \frac{n-1}{n}(\gamma - 1 + \delta_x^p)\right](\varpi_a - \delta_x^p)$$

or

$$(\varpi_a - 1)(\gamma - 1)\frac{n-1}{n} + \frac{\delta_x^p}{n}[\varpi_a(n-1) + 1] - 1 < \frac{\alpha}{1-\alpha}\left[(\varpi_a - \delta_x^p)\frac{\Lambda}{X_1} + 1\right].$$

We start with the left-hand side, which can be expressed as

$$(\varpi_a - 1)(\gamma - 1 + \delta_x^p)\frac{n-1}{n} + \delta_x^P - 1 < 0,$$

where the inequality follows from $\varpi_a, \delta_x^P < 1$. The right-hand side is positive if

$$(\varpi_a - \delta_x^p)\frac{\Lambda}{X_1} + 1 > 0. \tag{A-24}$$

Substituting X_1 and then Λ yields

$$\begin{aligned} \gamma\frac{\bar{k}_3}{\Lambda} &> \frac{1}{n-1} + \varpi_a \\ \gamma &> \frac{n-1}{n}\left[(\gamma - 1) + \delta_x^h\left(1 + \frac{1}{\bar{k}_3}\right)\right]\left(\frac{1}{n-1} + \varpi_a\right) \\ \gamma\underbrace{(1-\varpi_a)}_{>0} &> \underbrace{\left[\delta_x^h - 1 + \frac{\delta_x^h}{\bar{k}_3}\right]}_{<0}\underbrace{\left(\frac{1}{n-1} + \varpi_a\right)}_{>0}, \end{aligned}$$

such that inequality (A-23) is fulfilled and hence

$$\frac{\partial\beta_1}{\partial\Upsilon} = \underbrace{\frac{\partial\beta_1}{\partial\delta_x^p}}_{>0}\underbrace{\frac{\partial\delta_x^p}{\partial\Upsilon}}_{>0} > 0,$$

demonstrating that a larger degree of 'island illusion' (a lower Υ) leads to a stronger overreaction to micro news (a lower β_1).

Concerning the effect of Υ on β_2,

$$\beta_2 = \frac{(1 - Coef_2 X_1^q) R_e^q - Coef_2 \Lambda X_1 R_\eta}{Var(s_t - Coef_2(FR_t^{j,r}))}$$

$$\beta_1 = \frac{\Lambda X_1 R_\eta}{Var(X_1 \varepsilon_t + X_1 \eta_t^r + X_1^q q_t + X_1^q e_t + K_\nu \nu_t - X_1^q s_t)} \equiv \frac{\Lambda X_1 R_\eta}{V_{\beta_1}},$$

such that, also substituting X_1^q,

$$\beta_2 = \frac{(1 - Coef_2 \rho_q^p) R_e^q - Coef_2 \beta_1 V_{\beta_1}}{Var(s_t - Coef_2 FR_t^{j,r})}.$$

Since

$$R_e^q = (1-\rho_q^p)\sigma_q^2 - \rho_q^p \sigma_{e,q}^2 = (1-\Upsilon\varpi_q\bar{v})\varpi_q\bar{v}Var(s_t) - \Upsilon\varpi_q\bar{v}(1-\varpi_q\bar{v})Var(s_t) = (1-\Upsilon)\varpi_q\bar{v}Var(s_t).$$

and, see the proof of Proposition 1,

$$Coef_2 = \frac{Cov(FR_t^{j,r}, s_t)}{Var(FR_t^{j,r})} = \frac{X_1^q \sigma_q^2 + X_1^q \sigma_e^2}{X_1^2 \sigma_\varepsilon^2 + X_1^2 \sigma_\eta^2 + (X_1^q)^2 \sigma_q^2 + (X_1^q)^2 \sigma_e^2 + (K_\nu)^2 \sigma_\nu^2},$$

such that

$$Var(s_t - Coef_2 FR_t^{j,r}) = (1 - Coef_2)^2 Var(s_t) + Coef_2^2 V_{\beta_1} = Var(s_t) \frac{V_{\beta_1}}{Var(FR_t^{j,r})},$$

as well as

$$1 - Coef_2 \rho_q^p = \frac{X_1^2 \sigma_a^2 + (K_\nu)^2 \sigma_\nu^2}{Var(FR_t^{j,r})} = \frac{V_{\beta_1}}{Var(FR_t^{j,r})}$$

we obtain

$$\begin{aligned}\beta_2 &= \frac{\frac{V_{\beta_1}}{Var(FR_t^{j,r})}(1-\Upsilon)\varpi_q\bar{v}Var(s_t) - \frac{\rho_q^p Var(s_t)}{Var(FR_t^{j,r})}\beta_1 V_{\beta_1}}{Var(s_t)\frac{V_{\beta_1}}{Var(FR_t^{j,r})}} \\ &= \varpi_q \bar{v}\left[1 - \Upsilon(1+\beta_1)\right].\end{aligned}$$

The derivative of β_2 w.r.t. Υ is therefore

$$\frac{\partial \beta_2}{\partial \Upsilon} = -\varpi_q \bar{v} \left(1 + \beta_1 + \Upsilon \frac{\partial \beta_1}{\partial \Upsilon}\right),$$

where $\frac{\partial \beta_1}{\partial \Upsilon} > 0$ was derived above. Regarding the size of β_1, note that

$$\beta_1 = \frac{\Lambda X_1 \sigma_a^2 \varpi_a (1-\Upsilon)}{X_1^2 \sigma_a^2 + (K_\nu)^2 \sigma_\nu^2} > -1$$
$$X_1 \sigma_a^2 \left[X_1 + \Lambda \varpi_a (1-\Upsilon)\right] > -(K_\nu)^2 \sigma_\nu^2.$$

Since we have shown that inequality (A-24) holds, we also know that $X_1 + \Lambda\varpi_a(1-\Upsilon) > 0$, such that $\beta_1 > -1$ and

$$\frac{\partial \beta_2}{\partial \Upsilon} < 0.$$

Hence, a higher degree of island illusion (a lower Υ) leads to a larger underreation to macro news (a higher β_2). ■

(b) Lower expected profits

As usual, the firm's maximization problem states that profits are maximized if the price is a fixed markup over marginal costs. In linearized form

$$p_t^{j,r} = mc_t^{j,r},$$

where $mc_t^{j,r}$ are marginal costs, given by

$$mc_t^{j,r} = w_t - a_t^r + \frac{1-\alpha}{\alpha}(y_t^{j,r} - a_t^r)$$
$$= w_t + \frac{1-\alpha}{\alpha} y_t^{j,r} - \frac{1}{\alpha} a_t^r.$$

Since the wage w_t and technology a_t^r are known at the time when prices are set (and independent of Υ), we have

$$mc_t^{j,r} - E_{t|2}^{j,r} mc_t^{j,r} = \frac{1-\alpha}{\alpha}(y_t^{j,r} - E_{t|2}^{j,r} y_t^{j,r}) = \frac{1-\alpha}{\alpha} FE_{t+1}^{j,r}.$$

The forecast error $FE_{t+1}^{j,r}$ is given by equation (A-20). Its expected value is zero and its variance is minimal at $\Upsilon = 1$, see below. Hence, expected profits are also at their maximum at $\Upsilon = 1$. Furthermore, given that the profit function (at the point of approximation) is concave in $P_t^{j,r}$, the larger the distance to the optimal price, the lower realized profits. ■

(c) A larger variance of the firm-specific forecast error

The forecast error $FE_{t+1}^{j,r}$ is given by equation (A-20). Its variance results as

$$Var(FE_{t+1}^{j,r}) =$$

$$\Lambda^2\sigma_a^2\left[(1-\delta_x^p)^2\varpi_a + (\delta_x^p)^2(1-\varpi_a)\right] + Var(s_t)\left[(1-\rho_q^p)^2\varpi_q\bar{v} + (\rho_q^p)^2(1-\varpi_q\bar{v})\right] + \sum_{\{m|r\in\mathcal{B}_t^m\}}\frac{\bar{q}_t^k}{n}$$

$$= \Lambda^2\sigma_a^2\varpi_a\left[(1-\Upsilon)^2\varpi_a + 1 - \varpi_a\right] + Var(s_t)\varpi_q\bar{v}\left[(1-\Upsilon)^2\varpi_q\bar{v} + 1 - \varpi_q\bar{v}\right] + \sum_{\{m|r\in\mathcal{B}_t^m\}}\frac{\bar{q}_t^k}{n},$$

such that

$$\frac{\partial Var(FE_{t+1}^{j,r})}{\partial\Upsilon} = -2(1-\Upsilon)\left[\Lambda^2\sigma_a^2\varpi_a^2 + Var(s_t)(\varpi_q\bar{v})^2\right].$$

Hence, $Var(FE_{t+1}^{j,r})$ is minimal at $\Upsilon = 1$ and rises as $|1-\Upsilon|$ increases. ■

Proof of Proposition 3

As shown in the proof of Proposition 2 *a)*, β_2 can be written as

$$\beta_2 = \varpi_q\bar{v}\left[1 - \Upsilon(1+\beta_1)\right],$$

such that

$$\frac{\partial\beta_2}{\partial\varpi} = \bar{v}\left[1 - \Upsilon(1+\beta_1)\right] > 0,$$

where we have used the result $\beta_1 > -1$ from the same proof. That is, a higher attachment to the business cycle (a higher ϖ) leads to a larger underreaction to macro news (a larger β_2). ■