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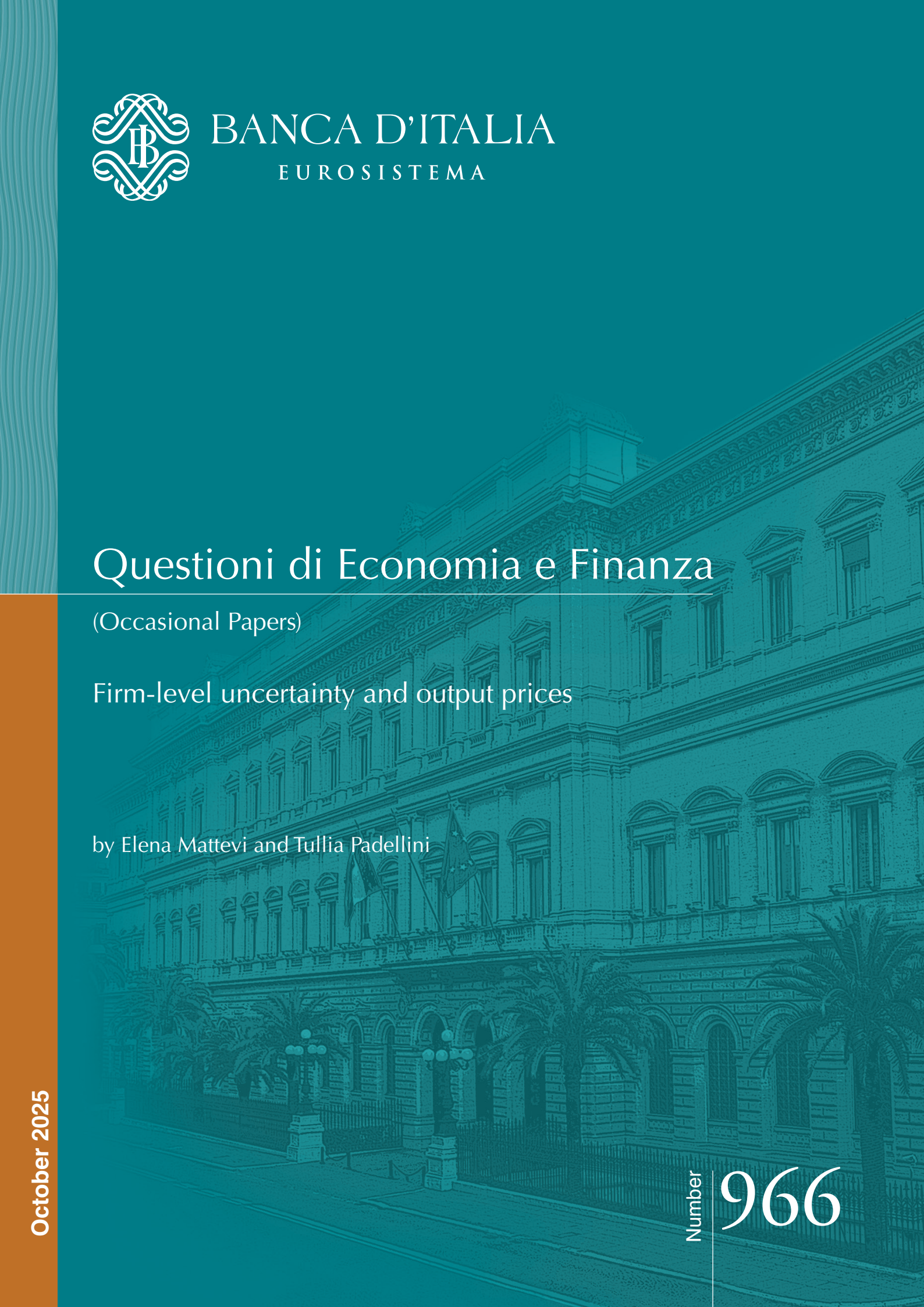

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Firm-level uncertainty and output prices

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FIRM-LEVEL UNCERTAINTY AND OUTPUT PRICES

by Elena Mattevi* and Tullia Padellini*

Abstract

Based on the unique information provided by Banca d'Italia's Survey on Inflation and Growth Expectations, we develop an indicator of firm-level *ex ante* uncertainty on future business conditions and use it to estimate the relationship between uncertainty and the expected development of each firm's selling prices. We find evidence that price flexibility increases with uncertainty: firms facing uncertainty both show a higher propensity to introduce price changes in the following months (extensive margin) and to make larger price changes compared with the other firms (intensive margin). This evidence suggests that price stickiness may ease in times of high uncertainty.

JEL Classification: C81, C83, D22, D80, E3.

Keywords: prices, uncertainty, firms, expectations, business survey.

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1 Introduction [1]

Over the past few years, the global economy has been affected by a number of large shocks, which have increased economic agents' uncertainty over future outcomes (the pandemic, the surge in inflation, the geopolitical tensions that have turned into wars or trade disruptions). Such heightened uncertainty in the macroeconomic environment has led policymakers to reassess the tools available for stabilization policies, including monetary policy.[2] In the theoretical framework of a menu cost model for price setting, which is the main one used for explaining how demand shocks affect output (see Barro (1972), Dotsey et al. (1999), Golosov and Lucas Jr (2007), Dotsey et al. (1999), Midrigan (2011) and Nakamura and Steinsson (2013) for a review), uncertainty is expected to have two opposed effects on price dynamics (Vavra (2014)): on the one hand, the increase in volatility enlarges the inaction region for price changes through real option effects, thus producing a wait-and-see behaviour and more price stickiness; on the other hand, higher volatility implies that firms are on average hit by larger shocks and thus makes price adjustments more likely. Hence, the effect of uncertainty on the extent of price stickiness is not obvious and – as a consequence – it is not clear how monetary policy effectiveness is affected by heightened uncertainty. The aim of this paper is to contribute to the knowledge of this issue and to study which one of the effects is dominating, by investigating the empirical relationship between uncertainty and price changes at the individual level. Despite the increasing use of microdata in the literature on price-setting determinants (see for example Nakamura and Steinsson (2013), Gautier et al. (2023) and Fabiani and Porqueddu (2015) for analyses at the product-level; Bachmann et al. (2019) and Fabiani et al. (2006) for analysis at the

[1]The opinions expressed are those of the authors and do not necessarily reflect the views of the Bank of Italy. We would like to thank Alfonso Rosolia, Andreas Dibiasi, Silvia Fabiani and Concetta Rondinelli for their helpful comments.

[2]See, for example, the speeches by the ECB Executive board member Schnabel (2024) *Reassessing monetary policy tools in a volatile macroeconomic environment*, Schnabel (2022) *Monetary policy and the Great Volatility*, or Reihart (2003) *Making monetary policy in an uncertain world.*

firm-level) and on the effects of uncertainty on economic activity (Guiso and Parigi (1999) or Fiori and Scoccianti (2023)), empirical evidence on the association between individual uncertainty and pricing decisions is rare. Possibly, this owes to the difficulty in finding data containing information on uncertainty and pricing decisions at the firm level.[3] In this work, we use the very rich information set embedded in the Bank of Italy's Survey on Inflation and Growth Expectations (SIGE), which allows us to calculate a measure of individual uncertainty and link it to the quantitative measures of price changes expected or realized by the same firms. The SIGE has been collecting firm-level quantitative information on realized and expected price changes since 2002, making it a unique data source for this type of analysis. In addition, since 2011, it has included a probabilistic assessment of firms' expectations about the development of their own business conditions in the next 3 months and 3 years. Based on these subjective probability distributions, we define a firm-specific measure of uncertainty built on the idea that uncertainty can be defined in terms of concentration of the distribution of expectations; we assume that a firm is the least uncertain when it concentrates all its forecasts on one of the three proposed scenarios (improvement, stability, or worsening), while it is most uncertain when it considers equally likely all the scenarios presented. With about a decade of quarterly data, the uniquely rich time series of the SIGE-based indicator allows us to analyze the impact of uncertainty over a long time span, which also includes episodes of high volatility such as the pandemic, the surge in inflation and the geopolitical tensions.

To our knowledge, the paper closest to ours is Bachmann et al. (2019), who find that the propensity to change prices increases with volatility, where the latter is defined by a qualitative proxy of forecast errors based on the (qualitative) information in the IFO Business Climate Survey; by merging this uncertainty measure with the

[3] A distinct strand of the literature adopts a macroeconometric approach on these issues; see, for example Andreasen et al. (2024) who suggest that uncertainty reduces the effectiveness of monetary policy in stabilizing output during recessions, or Nucera (2025), who focuses on the impact of increased oil price uncertainty on market-based inflation.

aggregate data underlying the German CPI, they also find that uncertainty leads to larger price changes. Our work improves on this empirical approach by using individual quantitative measures of price changes as well as *ex ante* uncertainty based on probability distributions elicited directly by the same firms. Like Bachmann et al. (2019), we find that uncertainty is associated to more frequent and larger price adjustments, which points to higher price flexibility. As far as the theoretical models that relate uncertainty to price setting, our results are consistent with Vavra (2014), who proposes increases in firm-level volatility as a driving force that increases the frequency of adjustment as well as price change dispersion in uncertain times, as observed on micro data underlying the US CPI index. As in Bachmann, Vavra's empirical exercise shows that the volatility effect dominates over the wait-and-see effect, thus allowing to replicate the positive correlation between extensive margin and price dispersion in the US consumer prices. The theoretical framework developed in Khalil and Lewis (2024), who model a firm's investment decision in a technology that allows the firm to change its price in response to shocks, also predicts a positive relationship between uncertainty and price flexibility. They show that when uncertainty increases and shocks are larger on average, more firms are willing to invest in price flexibility, and this reduces product exit and output losses in the wake of negative productivity shocks. At the same time, producer prices respond more markedly, leading to higher inflation.

This work is structured as follows. In Section 2 we describe the data and define a new measure of firm-level uncertainty and in Section 3 we link this indicator to selling price expectations, in order to assess whether firms' extensive and intensive margins of price variation are affected by their perceived uncertainty on the economic environment in which they operate. In Section 4 we conclude.

2 Data

The Survey on Inflation and Growth Expectations (SIGE) is a quarterly survey carried out by the Bank of Italy on a sample of roughly 1500 Italian firms with 50 or more workers operating in industry and non-financial private services. Since its first wave in 1999, the main aim of the survey has been to collect information on firms' expectations on inflation, the general economic situation and own-product prices. Most of the data are qualitative and refer to firms' opinions in the reference quarter and looking ahead. However, information on the changes in realized and expected selling prices and input costs over the last/coming 12 months is quantitative. To our knowledge, this survey is the longest-running survey that regularly collects quantitative information on past and expected own selling price changes, as well as point expectations of firms about consumer price inflation at several horizons (see, for example, Bartiloro et al. (2019) and Bottone and Rosolia (2019)). Since 2016, the survey has also collected quantitative information on past and expected input price changes; given that input prices are a significant determinant of price setting (Lein, 2010), most of our empirical analysis will be based on the years 2016-2024. The main limitation of the data, for the analysis presented here, is that price changes refer to the overall output sold by the firm and not to single products. Starting from 2011, the survey questionnaire has included a short section collecting a probabilistic assessment of firms' expectations on the development of their own business conditions in the coming quarter and in the coming 3 years (Figure 1), based on which we define a new firm-specific measure of uncertainty.

For each of the above forecasts imagine there are 100 points available; distribute them among the possible forecasts according to the probability assigned to each one. How do you think business conditions for your company will be:

	Better SITM3M SITM3A			The same SITU3M SITU3A			Worse SITP3M SITP3A			Total		
C3. In the next **3 months**										1	0	0
C4. In the next **3 years**										1	0	0

Figure 1: Probabilistic assessments by firms

For each firm, we observe a discrete probability distribution over three values

Better, *Same*, *Worse*. In a spirit similar to that of Claveria et al. (2019), we define uncertainty in terms of concentration, considering as the least uncertain those firms that are confident in one specific outcome and put all the probability mass in one of the options, that is, firms for which the probability distribution over the three outcomes has zero variance. Instead, we consider the most uncertain firms to be those that assign equal probabilities to the three scenarios (situation improving, worsening or remaining the same). Only a small share of firms assign all probability to one single bin, and even among them, there is quite a bit of heterogeneity in the responses considering both the cross-sectional and the time dimension (Figure 2), validating the use of this question to build a measure of *subjective and time-varying* uncertainty. Selecting only one possible outcome does not seem to be attributable to the burden of the question, as firms that foresee only one possible scenario over the next 3 months frequently assign nonzero probabilities to differing scenarios over the following 3 years, and, additionally, the pattern over time is consistent with business cycle conditions (as an example, the quarters when more firms considered plausible only a worsening of their situation were at the beginning of the COVID-19 pandemic and during the energy crisis).

Let $X_i = (W_i, S_i, B_i)$ the probability distribution elicited by the i-th firm, where W_i denotes the probability assigned by the firm to a worsening of the business conditions, B_i the probability assigned to an improvement and S_i the probability that the situation will stay the same, respectively. Naturally, $W_i + S_i + B_i = 1$. We will consider as a measure of uncertainty the *entropy* of the probability distribution, a measure of variability that, for a generic discrete random variable X with support $\{x_1, \ldots, x_k\}$ and probability mass $\{P(x_1), \ldots, P(x_k)\}$, with $P(x_j) > 0, \forall j = 1, ..., k$, can be defined as:

$$H(X) = -\sum_{i=1}^{k} P(x_i) \log P(x_i).$$

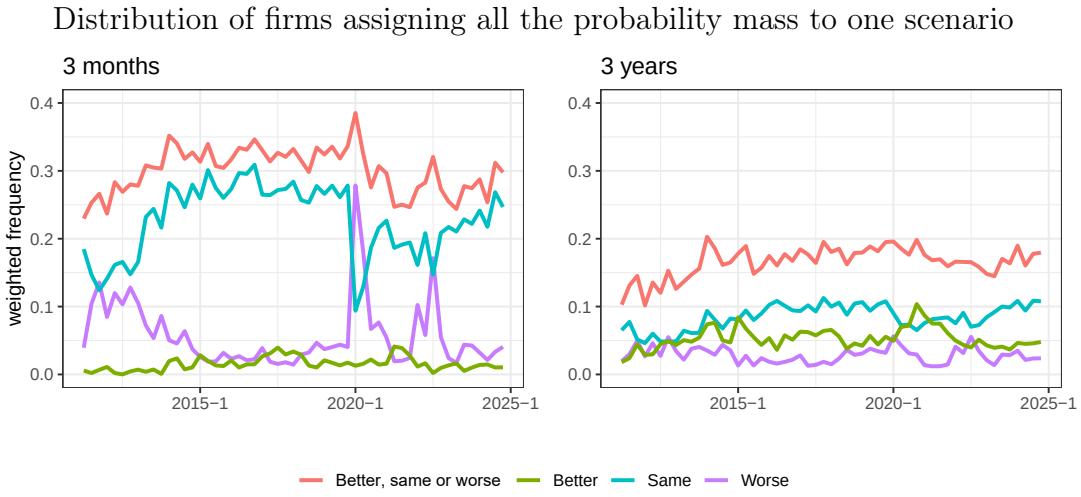

Figure 2: Share of firms that assigned all the mass to only one category when asked to distribute 100 points over the three possible forecasts for the next 3 months (on the left) and for the next 3 years (on the right).

In our case this corresponds to, for each firm i:

$$H(X_i) = -(W_i \log W_i + S_i \log S_i + B_i \log B_i).$$

Entropy is maximized when all the modalities have the same probability, that is when the probability distribution of X is uniform, which is our definition of highest uncertainty.[4]

Figure 3 shows the aggregate quarterly behavior of uncertainty over the last 10 years.[5] As expected, uncertainty is higher over longer time horizons; the indicator based on expectations over 3 years is always higher than that over 3 months, as firms tend to be less confident in one single scenario over longer time horizons, as seen in

[4]Entropy is computed only on elements of the support with positive probability, meaning that when all the mass is concentrated on only one of the possible scenarios, for example $B_i = 1$, we have that $H(X_i) = 1 \log(1) = 0$, which is the minimum value entropy can take. When the distribution is uniform, that is all bins are been assigned equal probability, entropy is $-\log(1/3) \approx 1$.

[5]To better understand what is captured by this measure of uncertainty around the development in the own business conditions, we estimated a time-varying coefficients regression of the uncertainty measure on the factors that will affect the firm's activity in the short run, according to respondents opinions collected in the same survey (see Figure A1 for the complete questions). Results show that changes in uncertainty follow both individual-specific business developments (like changes in demand) and development in the macroeconomic environment (like political and economic uncertainty).

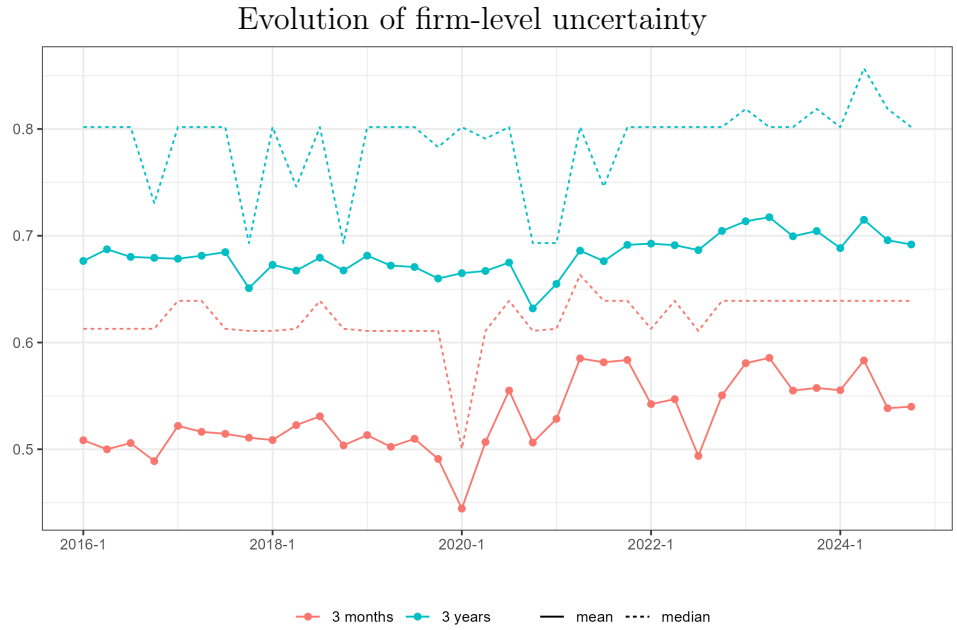

Figure 3: Average and median entropy for the 3 months and 3 years horizons. Weighted average of the individual uncertainty indicators.

Figure 2. Since the correlation between the two measures is high (roughly 0.75), we will mainly use the uncertainty measure based on 3-months-ahead expectations in the analysis, and will conduct robustness checks using also the indicator of uncertainty over the longer time horizon.

3 Uncertainty and price setting

We analyse the impact of uncertainty on both the *extensive margin* (whether firms adjust prices more frequently) and *intensive margin* (whether price changes are larger) of expected price changes using regression models. More specifically, extensive margins of price changes are modeled through a logistic regression, while intensive margins are modeled through a linear regression, with uncertainty as main regressor of interest. We consider the following specifications:

Model 1 - Extensive margin

$$\text{logit}[p_{it}|U_{it}, Z_{it}] = \alpha + \beta U_{it} + \gamma Z_{it}$$

Model 2 - Intensive margin

$$\mathbb{E}[Y_{it}|U_{it}, Z_{it}] = \alpha + \beta U_{it} + \gamma Z_{it}$$

Where Y_{it} is the expected price change for the following 12 months expressed by firm i in t[6], Y^*_{it} a binary variable equal to 1 when $Y_{it} \neq 0$ and 0 otherwise, and p_{it} the probability that Y^*_{it} is 1; U_{it} is a measure of uncertainty for the $i-th$ firm observed at time t and Z_{it} is a matrix of controls accounting for the structure of the firm (e.g. its size, sector of activity and geographical area) and for its business conditions (e.g. access to credit and demand expectations) at time t. We also include in Z_{it} a dummy encoding the year and the quarter, in order to adjust for seasonal components of price settings, and a "mood" dummy encoding the overall optimism/pessimism of each firm.[7] A complete description of the different specifications of Z_{it} can be found in Table 1.

Table 2 shows the coefficients and relative p-values for different choices of Z_{it} on price changes.[8] Results point to the evidence that firms' short term price choices are affected by uncertainty, and that heightened uncertainty is associated to more frequent and larger price changes. This strong association, which can be seen in the unadjusted model of column (1) persists when adjusting for seasonality and structural firms' characteristics (such as size, area and sector of activity), as shown in column (2) and when including time dependent firms' judgments on the general as well as their

[6]Price expectations refer to the following question in the SIGE questionnaire: *"For the next 12 months, what do you expect will be the average change in your firm's prices?"*

[7]See Appendix C for more details on the construction of this variable.

[8]Results here and in all following tables are robust when, instead of entropy, we consider alternative measures of uncertainty introduced in Appendix B and that are found to comove strongly (Table B1 and Figure B1).

own expected economic conditions (columns (3) and (4)). The size of the uncertainty coefficients is very similar across specifications. Selling price expectations covary strongly with input cost expectations; as shown in column (5), which represents our reference model, the expected input prices are a key component in order to understand both intensive and extensive margins, but the expected pass-through is not complete (a 1 per cent variation of expected input costs would result in roughly 0.3 per cent variation in expected selling prices).

Cost pressures resulting from changes in input prices over the last 12 months seem to be mostly absorbed by sales price variation in the same period.[9] Finally, the impact of uncertainty remains significant even in the robustness analysis of column (6), where we include as controls some categorical variables indicating the direction and intensity with which some given factors will affect the firm's activity in the next 3 months, according to the respondent (demand, prices, access to credit, uncertainty due to political and economic factors, exchange rate, oil price, international trade; see Appendix A for the exact wording of the question). Because the sample size is greatly reduced due to the shorter time series available for these controls, our preferred specification remains Model (5).

Firms who changed their prices more substantially over the last 12 months are more likely to continue to do so in the next year, hinting at some persistence of price adjustments. When examining the intensive margin, we see that previous price adjustments spill also over the magnitude of the expected change, analogously to what found in Riggi and Tagliabracci (2022) with respect to observed prices.

[9]The association between the probability of a price change and input price changes is confirmed when we take absolute values for the latter.

Table 1: Specifications of the linear predictors

Variable	(1)	(2)	(3)	(4)	(5)	(6)	Description	Ref. Category
Uncertainty	X	X	X	X	X	X	Entropy over the following 3 months	—
Price variation in the last 12 months					X	X	Change in your firm's selling prices in the last 12 months	—
Observed input costs' variation			X	X	X	X	Variation of input prices in the last 12 months	—
Expected input costs' variation			X	X	X	X	Expected variation of input prices over the next 12 months	—
Firm size		X	X	X	X	X	Firm size	Small
Year		X	X	X	X	X	2016-2024	
Quarter		X	X	X	X	X		
Area		X	X	X	X	X	1=North-West; 2=North-East; 3=Centre; 4=South and Islands	1=North-West
Sector		X	X	X	X	X	1=industry excluding construction; 2=services; 3=construction	2=services
Judgments on the dynamics of the following factors:								
General economic situation			X	X	X	X	Italy's general economic situation compared with the previous 3 months (1=Worse; 2=The same; 3=Better)	2=The same;
Change in demand			X	X	X	X	Change in total demand for firm's products compared with the previous 3 months (1=Decreased; 2=Unchanged; 3=Increased)	2=Unchanged
Expected change in demand			X	X	X	X	Expected change in total demand for firm's products in following 3 months (1=Decrease; 2=No change; 3=Increase)	2=No change;
Investment conditions			X	X	X	X	Current conditions for investment compared with the previous 3 months (1=Worse; 2=The same; 3=Better)	2=The same;
Access to credit			X	X	X	X	Current conditions of access to credit for the first compared with the previous 3 months (1=Worse; 2=The same; 3=Better)	2=The same
Overall mood				X	X	X	Categorical variable encoding the direction of the uncertainty over the following 3 months	Stationary
Impact on your business in the next 3 months of the following factors:								
Imp. Demand						X	Changes in demand	Not relevant
Imp. Prices						X	Changes in your prices	Not relevant
Imp. Access to credit						X	Availability and the cost of credit	Not relevant
Imp. Global uncertainty						X	Uncertainty due to econ. and political factors	Not relevant
Imp. Exchange rates						X	Exchange rate dynamics	Not relevant
Imp. Liberalizations						X	Tensions on international trade	Not relevant
Imp. Oil price						X	Oil price dynamics	Not relevant

Covariates included in the different specifications of Models 1-2. In addition to the variables indicated, an intercept is always included. For each of the model specifications (1)-(6) only variables marked with "X" are included as predictors.

Table 2: Impact of uncertainty on extensive and intensive margins of expected price change

	Extensive Margins					
	Logistic regression over dummy variable of expected price change					
	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.74***	0.71***	0.66***	0.75***	0.74***	0.75***
	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)	(0.06)
Expected input costs' variation			0.06***	0.06***	0.06***	0.05***
			(0.004)	(0.004)	(0.005)	(0.005)
Observed input costs' variation			0.01***	0.01***	−0.003	−0.01**
			(0.003)	(0.003)	(0.003)	(0.003)
Price variation in the last 12 months					0.05***	0.06***
					(0.004)	(0.005)
Constant	0.38***	−0.07	−0.25***	−0.27***	−0.26***	−0.20*
	(0.02)	(0.06)	(0.09)	(0.09)	(0.10)	(0.12)
Observations	43,362	43,362	41,847	41,847	41,847	27,715
	Intensive margins					
	Linear regression over expected price change					
	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.46***	0.35***	0.38***	0.42***	0.24***	0.31***
	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)
Expected input costs' variation			0.31***	0.31***	0.33***	0.32***
			(0.004)	(0.004)	(0.004)	(0.004)
Observed input costs' variation			0.02**	0.02**	−0.09***	−0.08***
			(0.003)	(0.003)	(0.003)	(0.003)
Price variation in the last 12 months					0.30***	0.26***
					(0.003)	(0.004)
Constant	1.71***	0.35***	−0.07	−0.07	0.04	0.13
	(0.04)	(0.14)	(0.13)	(0.13)	(0.12)	(0.17)
Observations	43,362	43,362	41,847	41,847	41,847	27,715
R^2	0.001	0.07	0.25	0.25	0.37	0.36
Adjusted R^2	0.001	0.07	0.25	0.25	0.37	0.36

Note: *p<0.1; **p<0.05; ***p<0.01

Model (1) includes as predictor only entropy over the next three months, observed and predicted input costs and no additional control. Model (2) includes the uncertainty measure, observed and predicted input costs and additionally it adjusts for wave characteristics (year and quarter) and for firm characteristics (size, geographical, area, sector of activity). Model (3) includes all the covariates of model (2) and indicators of the economic conditions of the firm (opinion on the general economic situation in the last quarter, access to credit, changes in observed and expected demand and investment conditions). Model (4) additionally includes a categorical variable encoding the direction of uncertainty. Model (5) includes all controls of Model (4) and sales price changes over the last 12 months. Model (6) accounts for factors expected to affect business conditions over the following 3 months, specifically changes in demand and own prices, access to credit, political and economical uncertainty, exchange rate and oil price dynamics and tensions on liberalization policies of international trade. Robust standard error and weighted statistics.

In order to test the strength of our results, we performed an extensive set of robustness analyses starting from the specification of Model (5), with the addition of: (i) firms' inflation expectations over the next 12 months; (ii) uncertainty over the next 3 years instead of uncertainty over the next 3 months (iii-v) lags of uncertainty over the following 3 months and (vi) firm-specific fixed effects to account for other unobservables. Results shown in Table D1 are similar to those shown for our preferred Model (5) both in size and statistical strength for all these variations. The robustness of the results with the addition of inflation expectations reassures us that firms' price expectations reflected their pricing strategies rather than overall expected price changes. Interestingly, when considering uncertainty over a longer time horizon the association remains statistically significant although it becomes weaker.

In order to understand whether the expected effect of uncertainty actually occurs, we replicate the analysis in Table 2 using realized prices changes as a dependent variable. More specifically, we regress observed price variation in the last 12 months on the same covariates shown in Table 2 as reported one year before. Despite the considerably smaller sample size, results in Table E1 show how the association between uncertainty and prices remains significant, strengthening our key message that price flexibility increases with uncertainty.

4 Concluding remarks

In this work, we leverage the rich dataset from the Bank of Italy's SIGE to create a new measure of firm-level *ex ante* uncertainty. We then use this measure to estimate the empirical link between uncertainty and firms' expectations regarding their own output price changes. Our findings show that price flexibility tends to increase during periods of high uncertainty. Specifically, we observe that both the likelihood of changing prices (*extensive margin*) and the size of price changes (*intensive margin*) are greater for

firms facing higher uncertainty. Given that price stickiness is the main mechanism used to explain monetary non-neutrality, our results suggest that the propagation of demand shocks to the real economy may become weaker during times of heightened uncertainty. Our results can also be interpreted in the light of the traditional time- vs state-dependent models of price adjustment. We find that both previous adjustments and current uncertainty about business conditions are associated with pricing decisions, consistently with a time- *and* state-dependent framework for price-setting.

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A Question wording

Please indicate whether and with what intensity the following FACTORS will affect your firm's business **in the next 3 months**.

Factors affecting your firm's business In the **next 3 months**	***Effect on business***			***Intensity*** *(if not nil)*		
	Negative	*Nil*	*Positive*	*Low*	*Average*	*High*
C5.1 Changes in demand **DISIT**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.2 Changes in your prices **PRSIT**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.3 Availability and the cost of credit **CRSIT**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.4 Uncertainty due to econ. and political factors **POLIT**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.5 Exchange rate dynamics **TACAM**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.6 Oil price dynamics **PRPET**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|
C5.7 International trade and investment policies **POSCA**	1|__|	2|__|	3|__|	1|__|	2|__|	3|__|

Figure A1: Questions investigating the determinants of firms expectations on their business conditions.

B Alternative definitions of uncertainty

In order to show the robustness of our findings with respect to the measure of uncertainty, we compare results obtained using alternative measures of variability. We consider in particular a fully probabilistic measure, that is the Total Variance as well as two measures introduced by Claveria et al. (2019) that also take uncertainty to be best captured by the concentration of the distribution. More specifically we consider:

- **Total Variance**. Let W_i, S_i and B_i be the probability distribution of a multinomial random variable; we can measure the uncertainty of this distribution with the total variance of the multinomial, that is the sum of the variance of each component, $p(1-p)$. In our case

$$TV(X_i) = W_i(1-W_i) + S_i(1-S_i) + B_i(1-B_i)$$

- **Disconformity Coefficient**. Another way of assessing the heterogeneity of a distribution over the categories "Worse", "Same" and "Better" is to compute the balance between the probability of improvement and that of worsening, $B_i - W_i$. In order to quantify the variability of this measure, one approach is to

use defined the following "variance":

$$VB(X_i) = B_i + W_i - (B_i - W_i)^2$$

- **Geometric Concentration (Claveria et al., 2019)**. The rationale behind this indicator is that $X_i = (W_i, S_i, B_i)$ can be considered as a point on a triangle. Intuitively the closer the point is to the vertices of the triangle, the more concentrated the distribution would be, whereas the closer the point is to the centre of the triangle, the more uncertainty there is. Claveria proposed to use as concentration measure the distance from the centre of the triangle

$$C_i = \frac{\sqrt{(B_i - 1/3)^2 + (S_i - 1/3)^2 + (W_i - 1/3)^2}}{\sqrt{2/3}}$$

normalized so that it can be defined between 0 and 1. C_i will be 1 when all the probability mass is concentrated on only one of the modalities and 0 when the probability distribution is uniform across the three categories. The corresponding measure of "firm-specific" heterogeneity, which we will take as a proxy for uncertainty, is $D_i = 1 - C_i$.

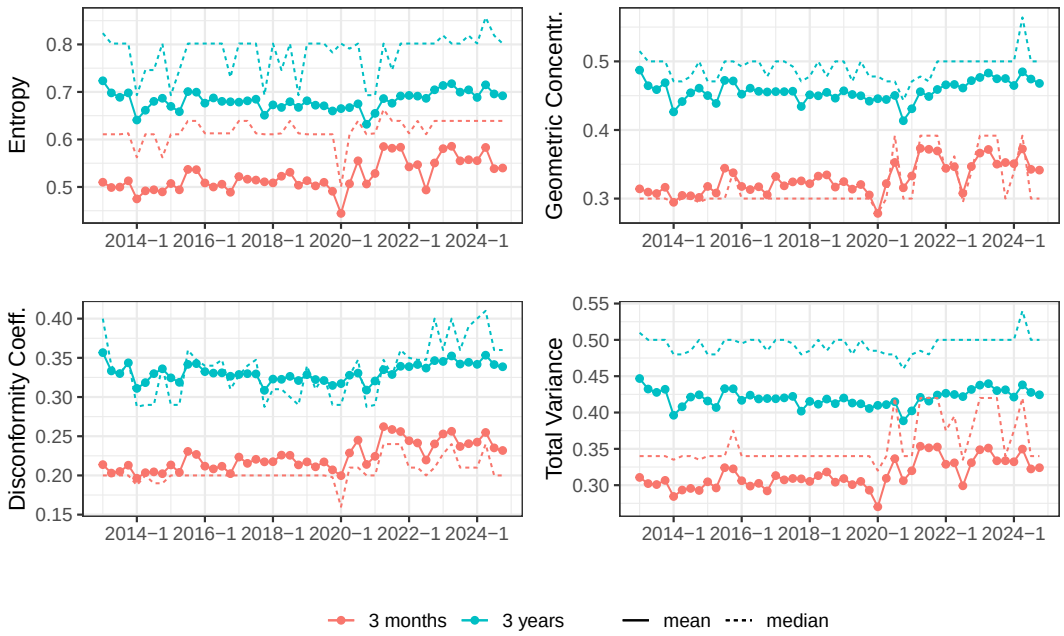

Figure B1: Average and median entropy for the months and years horizons. Weighted average and medians of the individual uncertainty indicators.

Table B1: Robustness with respect to measures of uncertainty

	Extensive margin			Intensive margin		
	(1)	(2)	(3)	(4)	(5)	(6)
Geometric concentration	1.07***			0.39***		
	(0.09)			(0.11)		
Disconformity coefficient		1.48***			0.53***	
		(0.12)			(0.14)	
Total Variance			1.17***			0.41***
			(0.09)			(0.11)
Constant	−0.21***	−0.17**	−0.24***	0.05	0.06	0.04
	(0.09)	(0.09)	(0.09)	(0.12)	(0.12)	(0.12)
Observations	41,847	41,847	41,847	41,847	41,847	41,847
R^2				0.37	0.37	0.37
Adjusted R^2				0.37	0.37	0.37
Note:						*p<0.1; **p<0.05; ***p<0.01

Columns (1)-(3) refer to a logistic regression with response equal to 1 if the firm is expecting to change its selling prices over the following 12 months and 0 otherwise and a measure of uncertainty (respectively total variance, geometric concentration and disconformity coefficient) as variable of interest. Columns (4)-(6) refer to a linear regression with expected price change as response variable and a measure of uncertainty (respectively total variance, geometric concentration and disconformity coefficient) as variable of interest. All regressions adjust for wave characteristics (year and quarter) and for firm characteristics (size, geographical, area, sector of activity), indicators of the economic conditions of the firm (opinion on the general economic situation in the last quarter, access to credit, changes in observed and expected demand and investment conditions) and observed and predicted variations in input costs, a categorical variable encoding the direction of uncertainty and sales price changes over the last 12 months. Robust standard error and weighted statistics.

C Direction of uncertainty

One feature of uncertainty measures, including the one presented in the previous section, is the fact that firms can be equally uncertain about very different possible outcomes, which can affect firm decisions in a heterogeneous way. In order to assess the robustness of our results with respect to the *direction* of uncertainty, we create a qualitative indicator of the "overall-mood". We define as "optimistic" those firms who assign a probability of at least 0.5 to an improvement in the operating conditions, "pessimistic" those that assign more than 0.5 probability to a worsening, "stable" those that assign more than 0.5 to "the same" and "uncertain" all the others, for whom no option has a probability of 0.5 or higher.

The distribution of firms by "mood" for each survey wave is shown in Figure C1. "stable".

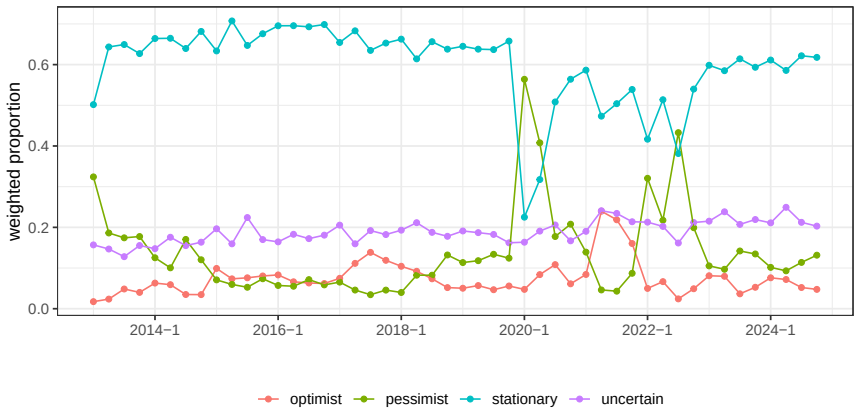

Figure C1: Share of firms expressing each overall mood with respect to their business condition over the next 3 months. Weighted statistics.

D Robustness with respect to covariate specification

Table D1: Other robustness analyses

	Extensive margins					
	Logistic regression over dummy variable of expected price change					
	(1)	(2)	(3)	(4)	(5)	
Uncertainty 3-months horizon	0.81***		0.53***	0.42***	0.32***	
	(0.05)		(0.05)	(0.06)	(0.07)	
1-year ahead inflation expectations	0.04***					
	(0.01)					
Uncertainty 3-years horizon		0.82***				
		(0.06)				
Uncertainty 3-m lagged by 1 quarter			0.28***	0.13**	0.12	
			(0.04)	(0.06)	(0.06)	
Uncertainty 3-m lagged by 2 quarters				0.28***	0.23***	
				(0.05)	(0.06)	
Uncertainty lagged by 3 quarters					0.17**	
					(0.06)	
Observations	25,749	41,847	31,375	25,748	21,900	
	Intensive margins					
	Linear regression over expected price change					
			OLS			*panel*
	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty 3-months horizon	0.16*		0.28***	0.20*	0.17	0.15*
	(0.09)		(0.09)	(0.10)	(0.11)	(0.08)
1-year ahead inflation expectations	0.10***					
	(0.02)					
Uncertainty 3-years horizon		0.17**				
		(0.07)				
Uncertainty 3-m lagged by 1 quarter			0.15	0.01	0.03	
			(0.08)	(0.09)	(0.10)	
Uncertainty 3-m lagged by 2 quarters				0.25**	0.13	
				(0.09)	(0.10)	
Uncertainty 3-m lagged by 3 quarters					0.18	
					(0.10)	
Observations	25,749	41,847	31,375	25,748	21,900	41,847
R^2	0.35	0.37	0.36	0.34	0.33	0.28
Adjusted R^2	0.35	0.37	0.36	0.34	0.33	0.19

Note: *p<0.1; **p<0.05; ***p<0.01

All models include as controls observed and predicted input costs, wave characteristics (year and quarter), firm characteristics (size, geographical, area, sector of activity), indicators of the economic conditions of the firm (opinion on the general economic situation in the last quarter, access to credit, changes in observed and expected demand and investment conditions), a categorical variable encoding the direction of uncertainty and sales price changes over the last 12 months. Robust standard error and weighted statistics.

E Robustness with respect to realized price changes

Table E1: Impact of uncertainty over ext. and int. margins of realized price change

	Extensive Margins					
	Logistic regression over dummy variable of realized price change					
	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.68***	0.65***	0.61***	0.66***	0.65***	0.65***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)
Expected input costs' variation			0.02***	0.02***	0.02***	0.01***
			(0.003)	(0.003)	(0.003)	(0.004)
Observed input costs' variation			0.01***	0.01***	0.001	−0.0004
			(0.002)	(0.002)	(0.002)	(0.003)
Price variation in the last 12 months					0.03***	0.04***
					(0.003)	(0.004)
Constant	0.43***	0.25**	0.16	0.14	0.15	0.13
	(0.02)	(0.07)	(0.07)	(0.07)	(0.08)	(0.11)
Observations	25,578	25,578	24,690	24,690	24,690	19,214
	Intensive margins					
	Linear regression over relized price change					
	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.71***	0.49***	0.47***	0.38***	0.30**	0.37**
	(0.11)	(0.11)	(0.11)	(0.13)	(0.13)	(0.15)
Expected input costs' variation			0.14***	0.14***	0.15***	0.14***
			(0.01)	(0.01)	(0.01)	(0.01)
Observed input costs' variation			0.07***	0.07***	0.02	0.02
			(0.005)	(0.005)	(0.01)	(0.01)
Price variation in the last 12 months					0.15***	0.12***
					(0.01)	(0.01)
Constant	2.06***	1.07***	0.84***	0.87***	0.93***	0.91***
	(0.07)	(0.22)	(0.22)	(0.22)	(0.22)	(0.32)
Observations	25,578	25,578	24,690	24,690	24,690	19,214
R^2	0.002	0.09	0.14	0.14	0.15	0.15
Adjusted R^2	0.002	0.09	0.14	0.14	0.15	0.15

Note: *p<0.1; **p<0.05; ***p<0.01

Model (1) includes as predictor only entropy over the next three months, observed and predicted input costs and no additional control. Model (2) includes the uncertainty measure, observed and predicted input costs and additionally it adjusts for wave characteristics (year and quarter) and for firm characteristic (size, geographical, area, sector of activity). Model (3) includes all the covariates of model (2) and indicators of the economic conditions of the firm (opinion on the general economic situation in the last quarter, access to credit, changes in observed and expected demand and investment conditions). Model (4) additionally includes a categorical variable encoding the direction of uncertainty. Model (5) includes all controls of Model (4) and sales price changes over the last 12 months. Model (6) accounts for factors expected to affect business conditions over the following 3 months, specifically changes in demand and own prices, access to credit, political and economical uncertainty, exchange rate and oil price dynamics and tensions on liberalization policies of international trade. Robust standard error and weighted statistics.