Firm-level uncertainty and output prices

BANCA D'ITALIA

Elena Mattevi & Tullia Padellini

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PRELIMINARY AND INCOMPLETE

Outline

Subjective **uncertainty** impact firms' decisions regarding **investment, employment** and **capacity utilization**[1]

- ? Does it affect selling prices too?

[1] Guiso and Parigi 1999, Fiori and Scoccianti 2023, Bloom 2009, Bachmann and Bayer 2013 and many more

Outline

Subjective **uncertainty** impact firms' decisions regarding **investment, employment** and **capacity utilization**[1]

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What we analyse the effect of firms' **uncertainty** on their **pricing** strategies both in terms of **intensive** and **extensive** margins

How we use **quantitative** information on firms' **expected price variation** from the Bank of Italy's *Survey on Inflation and Growth Expectations (SIGE)* and a new firm-specific measure of uncertainty

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Background

Two theoretical mechanisms for analysing how uncertainty affects pricing:

wait and see - *uncertainty does not lead to price adjustment*

adjusting prices is subject to at least some fixed costs, firms may want to “wait and see” (menu cost price setting models)

volatility - *uncertainty increases the likelihood of price adjustment*

higher volatility makes price adjustment of firms more likely as firms on average are hit by larger shocks

Background

Higher global volatility is associated to larger inflation

Joseph Vavra. Inflation dynamics and time-varying volatility: New evidence and an ss interpretation. The Quarterly Journal of Economics, 129(1):215–258, 2014.

- when including both menu cost and volatility effect in the model, the second is shown to be dominating, supporting the volatility channel as the predominant one

- Overall uncertainty
- Observed prices

Background

Empirically, higher volatility is associated to more frequent and larger price changes

Rüdiger Bachmann, Benjamin Born, Steffen Elstner, and Christian Grimme. *Time-varying business volatility and the price setting of firms*. Journal of Monetary Economics, 101:82–99, 2019.

- the propensity to **change prices increases with volatility**, measured by a proxy of expectation errors based on the qualitative information from the *IFO Business Climate Survey*
- by merging the uncertainty measure with data underlying the German CPI, they also find that **uncertainty leads to larger price changes**

- Multiple source of data, not really comparable at firm level

Background

A shift to a high-uncertainty regime incentivizes firms to invest in their ability to adjust prices

Makram Khalil and Vivien Lewis. Product turnover and endogenous price flexibility in uncertain times. Deutsche Bundesbank Discussion Paper, 2024.

- When **uncertainty rises 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, giving rise to higher inflation.

- Indirect effect, only through investments in price flexibility

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1. Define a *probabilistic* firm-level measure of **ex ante uncertainty** on the economic environment in which they operate;

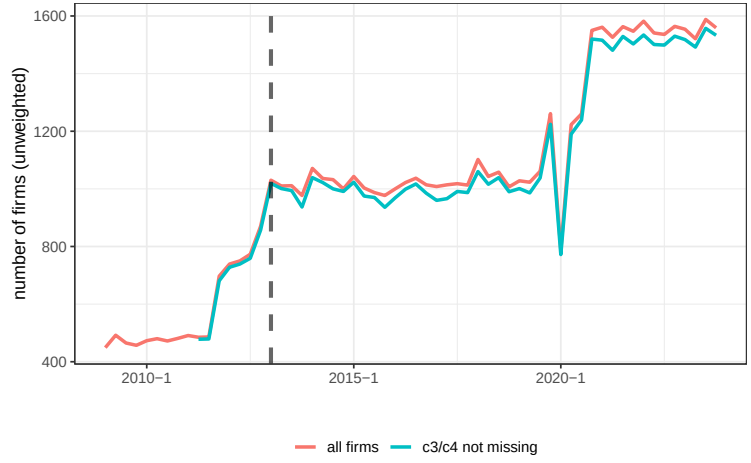
2. assess whether firms' **extensive** and **intensive** margins of **expected** price variation are affected by their perceived uncertainty;

3. analyse the impact of the **respondent's business state** (which we call **"mood"**), i.e. the prevailing expectations on the development of business conditions.

Data I - survey

We use data from the *Survey on Inflation and Growth Expectations (SIGE)*

- **Time resolution:** Quarterly running since 1999 (2016 in our analysis)
- **Reference population:** firms with more than 50 employees in industry (including construction) and non-financial services
- **Sample design:** stratification by area, sector and size



Sample size

Data II - strenghts

1. **Quantitative** data on expected and observed selling price variation as well input prices
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2. Very rich information set on firms' status and perspective
   - ➔ control for **many confounders**

3. Almost **10 years** of data
   - ➔ analyse the phenomenon in periods of **high** and **low inflation**

Data III - uncertainty question

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: Probabilistic assessments of firms

- firms are *uncertain* when they think that an improvement, a worsening or a stability of their own operating conditions are equally likely

Distribution of firms entertaining only one type of future scenarios

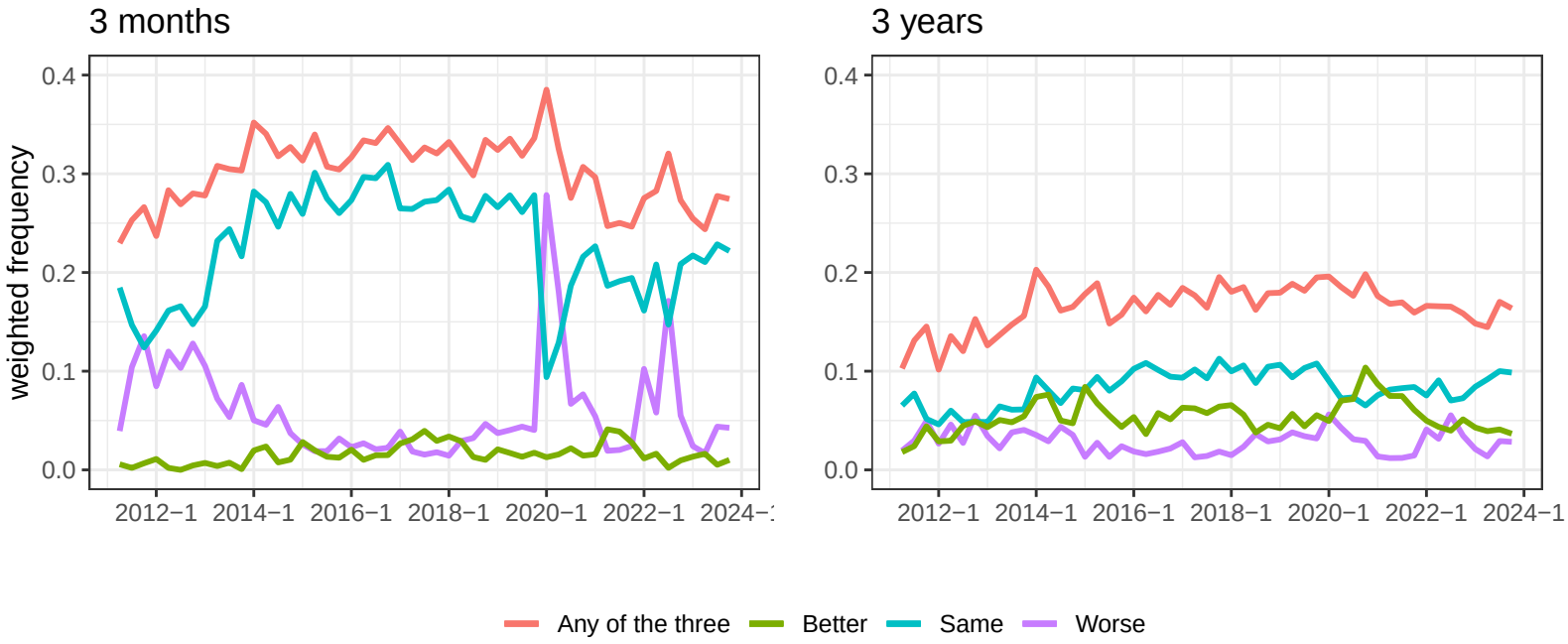


Figure: Share of firms that assigned all the mass to only one category when asked to distribute 100 points over the three possible forecasts for the next three months (on the left) and for the next three years (on the right).

Measuring uncertainty

$X_i = (W_i, S_i, B_i)$ probability distribution elicited by the i-th firm

- W_i probability that business condition will worsen;
- B_i probability that business condition will improve;
- S_i probability that business condition will stay the same.

We define uncertainty as the variabily of X_i, measured through its **entropy:**

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

The models

Intensive margin - Linear regression

Response variable: Y_{it} expected price variation for the following 12 months expressed by firm i in t

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

Extensive margin - Logistic regression

Response variable: p_{it} the probability that Y_{it} is not 0

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

Shared components:

- **Variable of interest**: uncertainty U_{it}
- **Controls:** Z_{it}

More about Z_{it}

Variable	(1)	(2)	(3)	(4)	(5)	(6)	Description	Type
Uncertainty	X	X	X	X	X	X	Entropy over the following 3 months	numeric
Demographics		X	X	X	X	X	size, area, sector	categorical
Seasonality		X	X	X	X	X	year, quarter	categorical
Input costs			X	X	X	X	observed and expected input price variation	numeric
Firms' environment			X	X	X	X	demand, investment conditions, credit, mood, ...	categorical
Price variation					X	X	observed in the last 12 months	numeric
External factors						X	exchange rates, liberalization, oil prices, ...	categorical

Extensive margins

Logistic regression over dummy variable of expected price change

	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.752***	0.725***	0.680***	0.774***	0.762***	0.755***
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000
Expected input costs' variation			0.056***	0.056***	0.059***	0.053***
			p = 0.000	p = 0.000	p = 0.000	p = 0.000
Observed input costs' variation			0.012***	0.012***	−0.004	−0.006**
			p = 0.00001	p = 0.00001	p = 0.142	p = 0.024
Price variation in the last 12 months					0.051***	0.057***
					p = 0.000	p = 0.000
Constant	0.344***	−0.050	−0.226***	−0.250***	−0.243***	−0.198*
	p = 0.000	p = 0.512	p = 0.005	p = 0.002	p = 0.003	p = 0.089
Observations	38,725	38,725	37,333	37,333	37,333	27,715

Result 1: Firms that are more uncertain about their future business conditions are more likely to plan a price variation.

Intensive margins

Linear regression over expected price change

	(1)	(2)	(3)	(4)	(5)	(6)
Uncertainty	0.511***	0.389***	0.425***	0.475***	0.288***	0.315***
	p = 0.000	p = 0.00000	p = 0.000	p = 0.000	p = 0.0002	p = 0.0003
Expected input costs' variation			0.310***	0.310***	0.329***	0.318***
			p = 0.000	p = 0.000	p = 0.000	p = 0.000
Observed input costs' variation			0.021*	0.021*	−0.086***	−0.083***
			p = 0.070	p = 0.069	p = 0.000	p = 0.00000
Price variation in the last 12 months					0.283***	0.258***
					p = 0.000	p = 0.000
Constant	1.667***	0.322**	−0.097	−0.103	−0.012	0.129
	p = 0.000	p = 0.019	p = 0.445	p = 0.412	p = 0.919	p = 0.424
Observations	38,725	38,725	37,333	37,333	37,333	27,715
R^2	0.001	0.074	0.259	0.259	0.368	0.358
Adjusted R^2	0.001	0.073	0.258	0.258	0.368	0.357

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

Result 2: Firms that are more uncertain about their future business conditions are more likely to plan to increase their prices.

Uncertainty direction

Firms can be **equally uncertain about very different possible outcomes**, which can affect firm decisions in a heterogeneous way.

We define firms to be

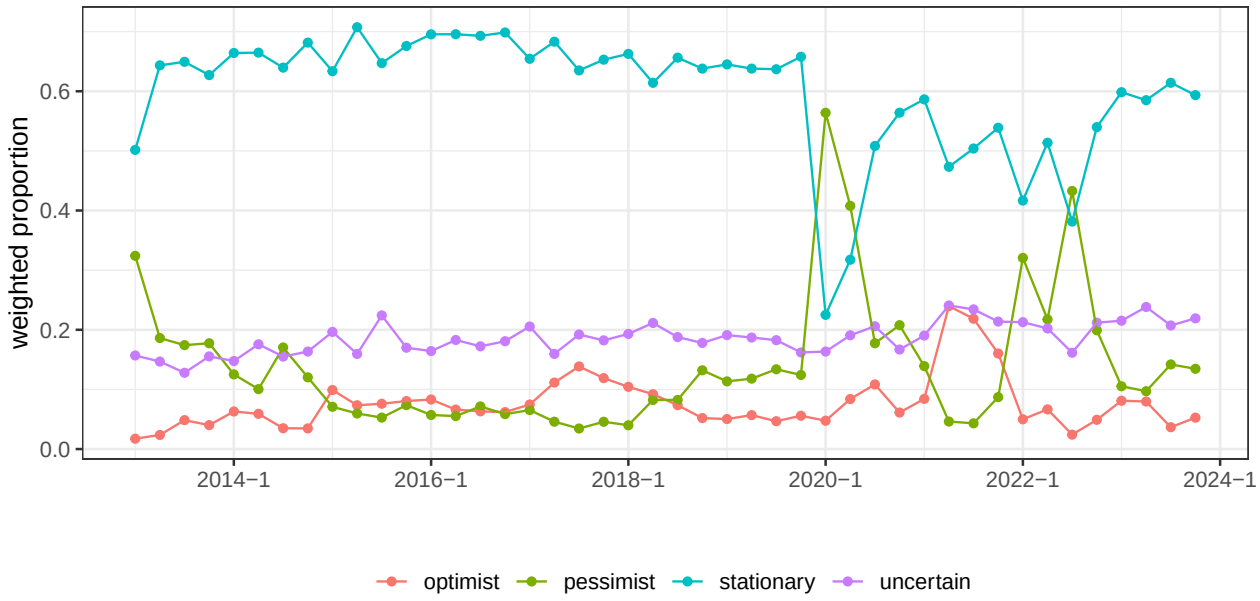
- O = optimist when $P(Bi) > 0.5$
- S = stable when $P(Si) > 0.5$
- P = pessimist when $P(Wi) > 0.5$
- U = unsure otherwise

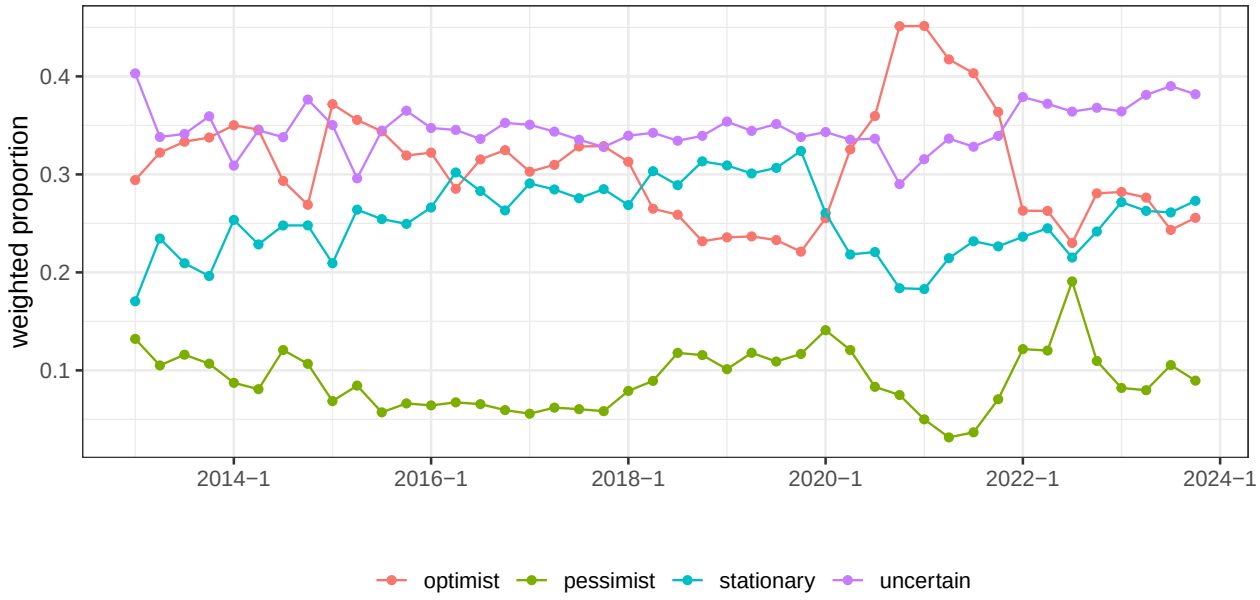
and we estimate *direction specific* models, e.g.:

Intensive margin (same for extensive margins):

$$\mathbb{E}[Y_{it}|U_{it}, Z_{it}] = \alpha + \beta_m U_{it} + \gamma Z_{it} \qquad m = O, S, P, U$$

Mood


weighted proportion
0.0
0.2
0.4
0.6
2014−1
2016−1
2018−1
2020−1
2022−1
2024−1
optimist
pessimist
stationary
uncertain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Intensive Margin

Linear regression over expected price change

	(1)	(2)	(3)	(4)	(5)	(6)
$\beta_{stationary}$	0.355***	0.322***	0.428***	0.358***	0.227***	0.230***
	p = 0.0004	p = 0.001	p = 0.00000	p = 0.00002	p = 0.004	p = 0.010
$\beta_{optimist}$	1.034***	1.027***	0.605***	−0.024	−0.086	−0.021
	p = 0.000	p = 0.000	p = 0.0001	p = 0.910	p = 0.676	p = 0.923
$\beta_{pessimist}$	0.754***	0.203	0.592***	1.115***	0.703***	0.756**
	p = 0.00002	p = 0.239	p = 0.001	p = 0.0003	p = 0.009	p = 0.011
$\beta_{uncertain}$	0.497***	0.374***	0.387***	1.204	0.468	0.739
	p = 0.00000	p = 0.00002	p = 0.00000	p = 0.101	p = 0.460	p = 0.304
Constant	1.666***	0.333**	−0.093	−0.063	0.009	0.159
	p = 0.000	p = 0.015	p = 0.466	p = 0.623	p = 0.941	p = 0.332
Observations	38,725	38,725	37,333	37,333	37,333	27,715
R^2	0.002	0.074	0.259	0.259	0.368	0.359
Adjusted R^2	0.002	0.074	0.258	0.259	0.368	0.357

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

Result 3: firms that "on average" expect things to improve over the short term are the least affected by perspective instability

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- We defined a new **measure of firm-level ex ante uncertainty** and we use it to estimate the **empirical relationship between uncertainty and expected own output price** developments;

- We find evidence that **price flexibility increases when uncertainty is high**. In particular we find that both the propensity to change prices (extensive margin) and the average price change (intensive margin) are larger for more uncertain firms;

- Since price stickiness is the main mechanism through which macroeconomic theory has explained why demand shocks affect real variables, this result implies that the **impact of demand shocks may be weakened in uncertain times**.

Thanks!

elena.mattevi@bancaditalia.it
tullia.padellini@bancaditalia.it