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Belief-dependent pricing decisions☆

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ABSTRACT

How do inflation and idiosyncratic cost expectations affect firms' price-adjusting decisions? Evidence on micro price adjustment has emphasized that price changes follow a fixed adjustment schedule, i.e., time-dependent pricing, or that they respond to the state of the economy, i.e., state-dependent pricing. We use firm expectation survey data to argue that price-adjustment decisions are also belief-dependent. While controlling for time- and state-dependent factors, we find that for the decision to adjust prices, inflation expectations do not play any role, but firms' beliefs about their overall costs do. This highlights a robust correlation between idiosyncratic expectations and economic decisions. We show that the expectation channel is heterogeneous across firms and operates with a delay. When studying firms' expected magnitude of price changes, the relevance of current inflation expectations is recovered apart from costs. Our findings provide empirical support for the belief-driven nature of pricing decisions and their economic implications.

1. Introduction

Economic decisions are forward-looking. Future expected changes are relevant as they should immediately affect decisions. Price adjustment decisions should respond not only to their current conditions but also to what firms expect to happen in the near future. This is the central question that this paper aims to answer. How do inflation and idiosyncratic cost expectations affect firms' price adjustment decisions? Empirical evidence supporting forward-looking pricing is crucial as it directly speaks to the presence of price-adjustment frictions at the firm level. However, the lack of firm-level data on price-adjustment decisions *augmented* with firm's beliefs about future aggregate and idiosyncratic conditions challenges this task. This paper aims to fill this gap in the literature by using a long and unique survey of firms' expectations in Uruguay. This data provides empirical support to argue that price-adjustment decisions respond to firms' beliefs.

Evidence on micro price adjustment has emphasized that price changes follow a fixed adjustment schedule, i.e., time-dependent pricing, or that they respond to the state of the economy, i.e., state-dependent pricing.[1] In this paper, we argue that price-adjustment decisions are also *belief-dependent*. We provide empirical evidence supporting this third channel as an important driver of price adjustments. Through the survey, we collect firms' predictions about the expected evolution of inflation and how much firms expect their costs to change in the near future. Evidence about pricing decisions combined with firms' time-invariant characteristics allows us to assess the role of aggregate and idiosyncratic beliefs separately.

We find empirical support for forward-looking behavior at the firm level. We show that one year ahead expectations significantly matter for price-adjustment decisions. On the one hand, we show that idiosyncratic beliefs about the future evolution of costs matter for this decision. On the other hand, inflation expectations do not seem to play a significant role. The distinction between expectations for inflation and cost growth has been previously pointed out by Coibion, Gorodnichenko, Kumar, and Pedemonte (2020a). Our results confirm the low correlation between the two expectations and highlight the role played by costs and their expectations on firms' decisions. Moreover, we document that the effect of expectations operates with a *delay*. We found that if firms believe there would be a 1% increase in their costs in the next twelve months, this would significantly increase the probability of a 0.8% price adjustment after three months. We confirm

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[1] See for example, Taylor (1980), Calvo (1983), Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008) and Vavra (2013) among others.

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this result and its timing by adding a special question for one month of the survey. The evidence gathered with our special question could be interpreted as the existence of price rigidities: the firms take, on average, between two or three months to implement a price change, once decided.

Moving beyond the extensive margin, we also explore how expectations relate to firm beliefs about future price changes. We show that current inflation and cost expectations positively correlate with the expected intensive margin of price changes. These results complement recent findings by Andrade et al. (2022) studying how industry-specific and aggregate shocks shape firms' expectations about expected price changes. Our results suggest that while total cost expectations matter for the decision to actually change prices, the effect is different when we pair such expectations with *future* price decisions. Finally, we show that the expectations effect is highly *heterogeneous* across firms. In particular, the idiosyncratic belief channel is only present for large firms. Moreover, forward-looking behavior is present, particularly for multi-product firms facing a large number of competitors. The evidence is consistent for both the extensive and the intensive margin.

The effect of beliefs is significant while controlling for both time-dependent and state-dependent variables. One of the main challenges we face is that we do not have information about firms' costs. This could cause problems in our empirical pricing model as we omit a critical variable. In accordance with Carlsson and Skans (2012), we construct a detailed cost index for each firm; using balance-sheet information, we keep the firm's production structure constant while varying its input prices. With it, we build a proxy for the growth rate of costs at the firm level, which we then add to our estimations to control for firms' costs.

While the existing literature has documented the central role of idiosyncratic costs in rationalizing firms' pricing decisions and their dynamics, we see our belief-dependent channel as a natural extension of these results. Based on large idiosyncratic shocks, Midrigan (2011) argues that price-adjustment decisions are driven mostly by idiosyncratic rather than aggregate shocks. Our results speak to this evidence as current price-adjustment decisions respond to cost expectations, while they do not react to changes in beliefs about inflation. According to Nakamura and Zerom (2010), there is evidence of a delayed effect of costs on prices. The authors report that while a cost increase leads to a posterior price increase, the price adjustment occurs with a delay of at least one quarter. Similarly, Dias et al. (2011) finds significant evidence of short-run delays in price adjustments using a detailed survey of Portuguese firms. Our results support these findings since the estimated timing and reaction of cost expectations are in the same direction as the existing evidence. In this sense, only a few studies have rich information about the role of cost expectations on firms' decisions. Possibly the closest paper to ours is Riggi and Tagliabracci (2022), which documents that firms' beliefs about future developments in their output prices matter for current pricing choices.

There is also a growing literature on sticky information (or information rigidity) versus sticky prices (or price rigidity) to model inflation. For instance, Casarin et al. (2021) show the importance of considering the correlation of price stickiness and information stickiness to model a dual stickiness Phillips curve. In particular, they assume a positive correlation between setting prices and updating information and find that their model outperforms previously sticky price and pure sticky information models. Arslan (2010) combine a sticky price and a sticky information model of price setting and estimate the resulting Sticky Price-Sticky Information Phillips curve using data from the US. The results confirm that both types of models are important when modeling US inflation, but sticky price firms are dominant in the US economy. Finally, Arslan (2008) integrates a sticky information Phillips curve into an otherwise standard DSGE model and compares the dynamic responses for a cost-push shock versus monetary or productivity shocks. Results suggest that both models (sticky prices and sticky information) exhibit inflation persistence to a cost-push shock. Still, persistence is higher in the sticky information model because expectations rely more on past information.

Departing from price rigidity, the muted reaction of price revisions to aggregate expectations calls for further attention. Using our constructed cost index, we show that the volatility of costs relative to inflation is persistently higher. This is also true when we look at its expectations counterpart. We argue that our results are consistent with the theoretical predictions of "rationally inattentive" price setters as discussed by Maćkowiak and Wiederholt (2009). As inflation is high but stable in Uruguay, we conjecture that this reduces firms' incentives to pay attention to its evolution, deciding to learn about and react more to idiosyncratic – and more volatile – costs.[2] Rather than framing our results within price or information rigidities specifically, we interpret them as evidence that both of these rigidities coexist at the firm level, supporting theories that combine these two frictions when modeling price-setting decisions such as Alvarez et al. (2011) and Angeletos and La'O (2009).

While there is a growing literature on how expectations are formed, (Coibion and Gorodnichenko, 2012; Andrade and Bihan, 2013; Frache and Lluberas, 2019; Giacomini et al., 2020; Basdevant, 2005; Kabundi et al., 2015), there is much less evidence on how expectations correlate with economic decisions. This is partly because most of the literature studying expectations relies on professional forecasts. The representativeness of these forecasters and the implications of their projections on the economy are at least questionable. Nevertheless, the number of surveys asking for expectations from the relevant economic actors, such as firms or households, has increased over the last decade. For instance, Coibion et al. (2022) study how different forms of monetary policy communication affect households' inflation expectations while D'Acunto et al. (2019) show how prices faced by households on their shopping behavior affect their inflation expectations. Relative to firms, Boneva et al. (2020) document several stylized facts about how firm expectations are formed. That paper found a significant relationship between past expected prices and wage increases. Coibion, Gorodnichenko, and Ropele (2020b) show that firms' higher inflation expectations significantly affect their pricing, hiring, and credit decisions. Our paper contributes to this literature by separating the effect of aggregate and idiosyncratic beliefs and stressing the heterogeneity in the effect of expectations on pricing decisions across firms.

The rest of the paper is organized as follows. In Section 2, we introduce the survey we use throughout the paper. In Section 3, we discuss the main stylized facts of the survey. In Section 4, we introduce the estimation procedure and the main results of the empirical analysis regarding firms' expectations and pricing decisions. In Section 5, we study the potential heterogeneous effect of expectations based on firm characteristics. In Section 6, we discuss the interplay between expectations and news; finally, in Section 7, we conclude.

2. Data

Our firm expectations survey takes place in Uruguay. This country has high but stable inflation, with an annual average of 8% over the past decade. The studied survey is carried out by the National Statistical Institute (INE), commissioned by the Central Bank of Uruguay (BCU), and was initially designed to track firms' inflation expectations. The firm panel is conducted monthly, and the survey is representative at both country and sector levels, which is not common in these surveys. Every month, firms are asked about their inflation expectations, i.e., the expected annual change in the Consumer Price Index, along with their cost expectations, i.e., the expected change in their total production

[2] This interpretation thus reinforces theories of inattention as an important constraint faced by firms, which can help further understand the process by which firms acquire information, consistent with recent evidence (Coibion et al., 2018).

costs. These questions are asked for different time horizons: the current calendar year, the next 12 months, and the next 24 months. Every two months, all surveyed firms must also report the magnitude of expected price changes over the next 12 months. Thus, we also have information about the expected intensive margin of price changes. The person answering the questionnaire is supposed to be responsible for the firm's pricing decisions but could also be the owner, a general, or an area manager.[3] For a more detailed comparison, in Appendix 8.1, we contrast the main features of our novel Uruguayan survey of firms with surveys from other countries: the US, the UK, and New Zealand. Moreover, in Appendix 8.1, we add more specific details about the survey and its representativeness.

Starting in July 2017, firms have also been asked whether and if so when they changed their main product's price. It is a closed-end question with the following options: this month, a month ago, two months ago, three months ago, four months ago, five months ago, six months ago, and seven or more months ago. We consider that a firm changed the price of its main product if they refer to "this month" as the last time they made a price change.

As the question regarding the extensive margin of price changes has only been available since July 2017, our estimations for the extensive margin of price changes use data from this month until September 2020, which includes the first months of the COVID-19 pandemic. This period is characterized by a persistent increase in inflation with an average of approximately 8%. Hence, the empirical analysis throughout the paper is based on this specific time window. The *only* moment when we will use a longer time frame is when we study the effects of expectations on the expected price change – i.e., expected intensive margin – in Section 4.3. In this specific case, we have data running back to 2010. As discussed, the questions about the expected price change have been asked irregularly since the start of our survey. Then, we prefer to conduct these estimations by relying on a sample with more observations.

Let us now frame our survey within the Uruguayan context. Fig. 2.1 shows the evolution of mean inflation expectations, mean own costs expectations, and observed inflation between October 2009 and September 2020. Inflation has fluctuated around 8% during the period covered by the survey with a break at the beginning of 2016 when inflation started to increase, reaching 11% in May, and declining to just above 5% a year later. Overall, inflation during our sample period has been relatively high but stable.

2.1. A firm-level cost proxy

Although we have rich monthly information about firms' expectations from the survey, we do not have specific information about their actual costs every month. This is important not only to assess the quality of firms' expectations about their costs but also as we do not want to omit such a relevant variable when we aim to understand firms' price adjustment decisions. For these reasons, we construct a firm-specific cost index.

Using the balance sheet information from the 2012 "Annual Survey of Economic Activity", we compute the cost structure for each firm. In particular, we use granular information about salaries, inputs, expenses, and goods originally bought by each firm and then resold without transformation. To compute the cost structure for each firm, we collect information for more than 1000 inputs for which we assign a price index. We assign a different price index for *each* input, and when a suitable index is unavailable, we replace it with the general CPI. Given that we keep the 2012 cost structure for each firm fixed, the evolution of input prices will give the projected cost variation. Hence, our cost proxy is constructed by keeping each firm's production scale and, thus, total production constant. Therefore, our projected costs index $C_{i,t}$ is defined as:

$$C_{i,t} = \sum_{j=1}^{J} PI_{jt} W_{ij2012} \tag{1}$$

$PI_{j,t}$ is the price index of input j at time t and W_{ij2012} is the weight of input j in total costs for firm i in 2012. We define $W_{ij2012} = C_{ij2012}/C_{i2012}$, where C_{ij2012} is the cost of input j for firm i in 2012, and C_{i2012} is total production cost of firm i in 2012. This index $C_{i,t}$ is later used as a proxy for the unobserved costs in Section 4. We use 2012 balance sheet information to construct the cost structure as it is the only available wave of the survey with that level of granularity. Using the following survey waves, we confirm that assuming a constant structure is valid as the firm's cost components do not vary substantially over the subsequent years. For more details, see Appendix 8.4.

Table 3.1
Summary statistics: Expectations and price changes.

	Small	Medium	Large	All
Expectations				
Inflation expectations (in %)	9.2	8.9	8.6	8.9
Cost expectations (in %)	10.5	10.0	9.3	9.9
Prices				
Proportion of firms changing prices (in %)	10.5	14.3	27.8	17.5
Number of price changes	3.4	4.6	8.9	5.6
Expected price change (in %)	9.1	8.5	7.9	8.5
Firm characteristics				
Average number of products	2.6	3.7	4.6	3.6
Proportion of multiproduct firms (in %)	55.0	79.4	76.0	71.5
Average number of competitors	36.9	14.3	90.2	48.5
Average age (in years)	25.1	29.5	35.7	31.2
Costs proxy (in %)	8.2	8.2	8.0	8.2

Notes: This table reports sample means for small, medium and large firms (see text for details) as well as for the whole sample. The sample period considered is between July 2017 to September 2020.

3. Stylized facts

Table 3.1 shows summary statistics for the entire sample and firm size. We divided the sample into three groups according to size and categorized firms into small, medium, and large.[4]

The average annual expected inflation is 8.9%, which is in line with the historical inflation in the country. The degree by which firms expect their cost to rise is nevertheless higher, reaching almost 10%. The fact that firms expected higher costs relative to overall prices is also consistent with the evidence of Riggi and Tagliabracci (2022) for firms in Italy. Regarding the cost proxy, we notice that costs have increased by 8.2% on average per year, which is more consistent with inflation.

[3] In March 2016, we asked the respondents about their roles within the firm and found that 42% were directors, general managers, or area managers; 19% economic analysts; 12% consultants; and 28% had different roles within the firm.

[4] We call the first group of firms *small*, but it is worth noting that the survey sample is representative of firms with more than 50 employees, and thus, we should not consider "small" firms as being literally small. We construct the size variable by merging the expectation survey and the 2012 "Annual Survey of Economic Activity", which includes the firm's balance sheet information. We rely on total income sales at the firm level as a proxy for size in this particular year. Unfortunately, balance sheet information is only available yearly and, for most years, only for a sub-sample of firms. However, the 2012 wave contains detailed information for almost all the firms in our sample. Implicitly, we assume that the distribution of firm sizes does not change substantially over time.

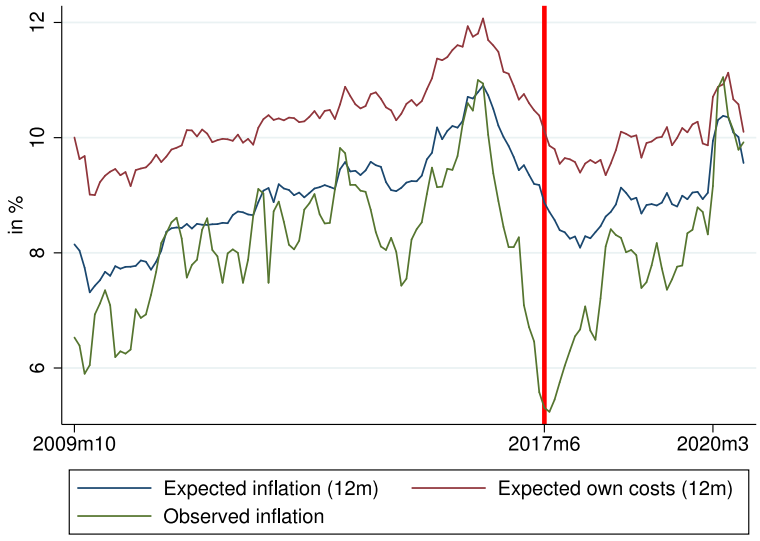
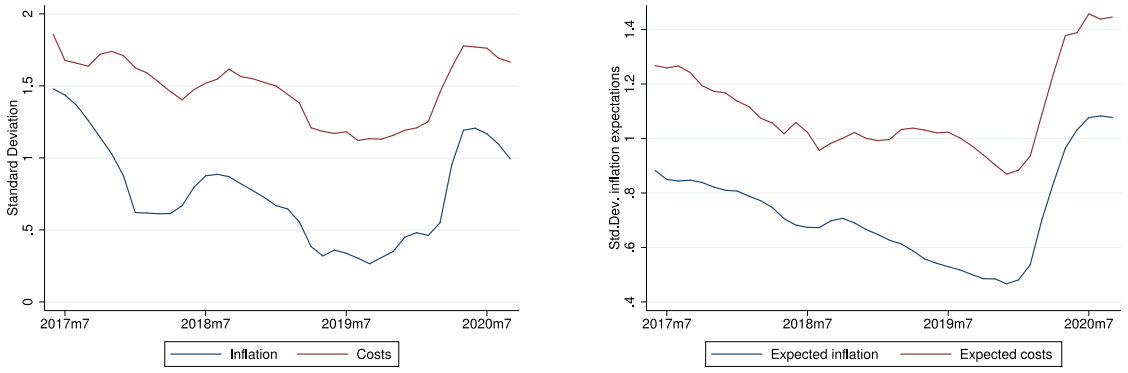


Fig. 2.1. Mean inflation and own costs expectations and observed inflation.
Notes: The figure shows observed inflation, and cross-sectional mean of firms' inflation and own costs expectations from October 2009 to September 2020. The vertical line indicates July 2017, when the extensive margin question became available.



(a) Observed *(b) Beliefs*

Fig. 3.1. Average volatility of own costs and aggregate inflation.
Notes: Panel (a) shows the standard deviation of inflation and firms' costs computed on a 6-month rolling window. Panel (b) shows the mean across firms' standard deviation of inflation and cost expectations computed on a 6-month rolling window. Both panels exhibit the calculations between July 2017 and September 2020.

3.1. Stylized fact 1: Forecast accuracy and reaction to information

An interesting initial question is how Uruguayan firms form expectations and react to information. The panel structure of our database allows us to study how forecast errors relate to expectation revisions at the aggregate and the firm level. Initially, we follow Coibion and Gorodnichenko (2015) and analyze if forecast errors are predictable from forecast revisions by running the following regression:

$$FE_t^X = \alpha + \beta Rev_t^X + \epsilon_t$$

FE_t^X is the average forecast error and Rev_t^X is the average forecast revision across firms. Specifically, we define $FE_t^X = \frac{1}{N}\sum_{i=1}^{N}\left[X_{t+12} - E_{i,t}(X_{t+12})\right]$ where $X = [\pi, C^i]$. Although not flawless, we rely on the cost index $C_{i,t}$ to construct the accuracy of cost expectation (in Section 4.2.1, we further discuss the validity of such proxy). We define $Rev_t^X = \frac{1}{N}\sum_{i=1}^{N}\left[E_{i,t}(X_{t+12}) - E_{i,t-1}(X_{t+12})\right]$. If $\beta = 0$, forecast revisions do not predict forecast errors. In that case, we can state that the full information rational expectations (FIRE) hypothesis holds, and forecast errors are random. On the other hand, if $\beta < 0$, firms' consensus forecasts overreact relative to FIRE, and if $\beta > 0$, it underreacts. The first two columns of Table 3.2 summarize the results.

For inflation and costs, β is not statistically different from 0 in columns (1) and (2), suggesting that forecast errors are not predictable from consensus forecasts' revisions. However, average forecast errors are negatively biased as the constant is negative and significant at a confidence level of 1%. This evidence suggests that firms systematically over-predict the forecasted variable, either aggregate inflation or own costs.

As discussed by Bordalo et al. (2020), when individual forecasters behave rationally and update their expectations from noisy idiosyncratic signals, results can differ from consensus forecast. To test this, we rely on individual-level regressions, assuming common coefficients or running firm-by-firm regressions to obtain different coefficients for each firm. The first approach implies running the following regression by pooling the firm-level data to get a common coefficient β^P for all firms: $FE_{i,t}^X = \alpha^P + \beta^P Rev_{i,t}^X + \epsilon_{i,t}$, where $FE_{i,t}^X = X_{t+12} - E_{i,t}(X_{t+12})$ and $Rev_{i,t}^X = E_{i,t}(X_{t+12}) - E_{i,t-1}(X_{t+12})$. For the second approach, we obtain a coefficient for each firm $i = 1, 2, \ldots, N$ in our sample by running the following firm-level regression: $FE_{i,t}^X = \alpha^i + \beta^i Rev_{i,t}^X + \epsilon_{i,t}$. At the individual level, rational expectations imply $\beta^P = 0$ or $\beta^i = 0$. If $\beta^P < 0$, then the average firm overreacts to its information, and if $\beta^P > 0$, it underreacts. The interpretation of the results is the same for β^i. Estimations at the individual level (columns (3) and (4) of Table 3.2)

Table 3.2
Forecast errors and forecast revisions.

	Consensus		Individual									
	FE_t^{π} (1)	FE_t^{C} (2)	FE_{it}^{π} (3)	FE_{it}^{C} (4)	FE_{it}^{P} (5)	FE_{it}^{C} (6)	FE_{it}^{P} (7)	FE_{it}^{P} (8)	FE_{it}^{C} (9)	FE_{it}^{C} (10)	FE_{it}^{π} (11)	FE_{it}^{π} (12)
Rev_t^{π}	0.468		−0.473***				−0.339***		−0.364***			
	(0.942)		(0.027)				(0.061)		(0.026)			
Rev_t^{C}		−0.273		−0.493***				−0.218***			−0.062***	
		(1.036)		(0.014)				(0.043)			(0.013)	
Rev_t^{P}										−0.091***		−0.032***
										(0.012)		(0.004)
micro news					−0.493***	−0.486***						
					(0.014)	(0.008)						
macro news					−0.272**	0.274***						
					(0.119)	(0.071)						
Constant	−0.724***	−1.319***	−0.638***	−1.201***	−0.995***	−1.185***	−0.932***	−0.937***	−1.198***	−0.733***	−0.645***	−0.468***
	(0.138)	(0.179)	(0.130)	(0.185)	(0.066)	(0.029)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	131	131	42,902	40,471	12,603	36,687	13,746	13,746	40,471	19,808	42,728	21,189
R-squared	0.003	0.001	0.356	0.309	0.068	0.043	0.003	0.005	0.005	0.003	0.004	0.003

Notes: This table reports estimates of the association between mean forecast errors and mean forecast revisions. Columns (1) and (2) show the consensus forecast estimates. Each observation corresponds to a month. The dependent variable is the 12-month ahead average forecast error for aggregate inflation (FE_t^{π}) and firms' costs (FE_t^{C}). Columns (3) to (12) show the estimations at the individual level. The dependent variables are the 12-month ahead average forecast error for aggregate inflation (FE_{it}^{π}), firms' costs (FE_{it}^{C}), and firms' prices (FE_{it}^{P}). The table reports, in parentheses, robust standard errors. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

suggest that firms overreact to new information. Moreover, the median coefficients in the regressions by firm are −0.458 for inflation and −0.487 for costs.

To further explore how forecast accuracy and firm's information are related, we follow Born et al. (2023a) and explore how micro and macro news affect forecast errors on firms' idiosyncratic variables.[5] Firms tend to overreact to micro news when forming future prices and cost expectations. On the other hand, while firms exhibit overreaction to macro news when forming expectations about their prices, they underreact when considering their costs. This last piece of evidence is consistent with Born et al. (2023a).

Finally, from columns (7) to (12), we study whether the revisions on micro variables (own costs and prices) are related to macro errors (aggregate inflation), and viceversa.[6] Once more, the evidence indicates that firms' expectation formation process, for both micro and macro variables, tends to overreact to new information. These results are consistent with Bordalo et al. (2020) and Born et al. (2023a).

3.2. Stylized fact 2: Expectation volatility

The second stylized fact is related to the firm-level volatility of aggregate and idiosyncratic expectations. Having information about both aggregate and idiosyncratic expectations in these surveys is not common. Besides the mean, it is interesting to explore the relative volatility of these two variables. A highly volatile cost expectation for a specific firm can shed light on the idiosyncratic uncertainty surrounding a firm's decisions, particularly about its price-setting ((Vavra, 2013), and Bachmann et al. (2019)).

While we anticipate that inflation expectations will be relatively stable, given the overall stability of inflation in Uruguay, the volatility of cost expectations is less obvious. We then measure cost ($Std_{i,t}^{C}$) using our cost proxy $C_{i,t}$, and inflation volatility ($Std_{i,t}^{\pi}$) as the standard deviation computed on a 6-month rolling window.[7]

Fig. 3.1(a) shows the time series for the two volatility measures. For the cost volatility, the figure shows the average of $Std_{i,t}^{C}$ across firms. Consistently across the sample, the idiosyncratic conditions are more volatile than the aggregate ones. As conjectured, this is not surprising due to the stability of inflation in Uruguay. In Fig. 3.1(b), we compute the same standard deviations for inflation and cost expectations.[8] According to the results, the persistent higher volatility of idiosyncratic conditions relative to inflation translates into similar patterns for firms' beliefs.

Concerning firms' specific characteristics, Fig. 8.1(a) in Appendix 8.2 exhibits the ratio of the average volatility of own costs to inflation, conditioning on the three firm sizes. We show that idiosyncratic conditions are more variable than inflation for all firms, but the ratio is greater for large firms. A very similar pattern appears when we look at the volatility in firms' beliefs about idiosyncratic and aggregate conditions; see Fig. 8.1(b) in Appendix 8.2.

3.3. Stylized fact 3: Frequency of price adjustments

Turning to pricing decisions at the extensive margin, each month, around 17% of firms are changing their prices; see Table 3.1. Fig. 3.2(a) shows the evolution of inflation and the proportion of firms changing their prices every month. We notice a slight positive correlation between price adjustment and inflation. As inflation increased in the second semester of 2018, the proportion of firms changing prices also increased. In that line, when inflation sharply increased in March 2020, that group of firms also increased substantially. There is also a clear pattern of seasonality as a significant proportion of price adjustments occur during January and July, which is consistent with findings for other countries (see for example Nakamura and Steinsson (2008)) and related to wage indexation and utility price adjustments as documented by Frache and Lluberas (2019). As shown in 3.2(b), pricing-adjustment decisions are also heterogeneous across firm sizes, as large firms are the ones that are changing prices more frequently.[9]

The middle block of Table 3.1 shows the proportion of firms that change their prices, the average number of price changes, and the expected price change according to firm size. On average, 28% of large firms change their prices monthly, but only 14% and 10% of medium

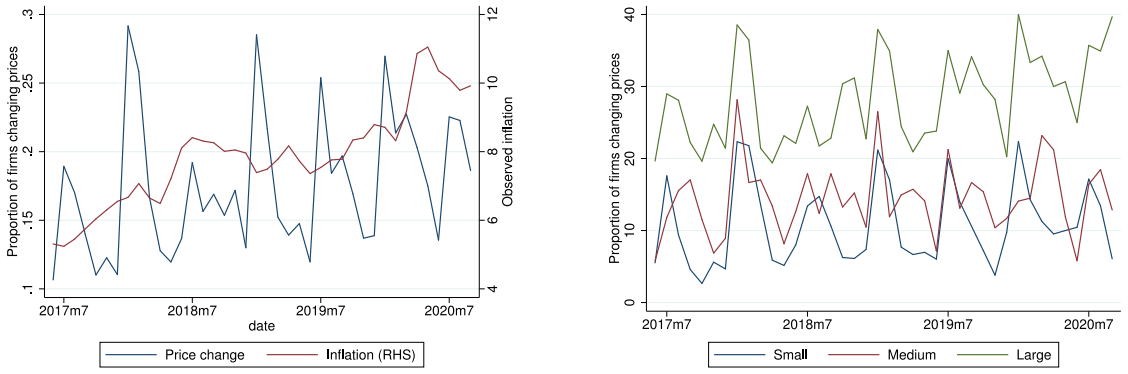
[5] Details on how we construct these, and the other results of Table 3.2, are in Appendix 8.5.

[6] We want to thank an anonymous referee for suggesting this analysis.

[7] Further details on how we compute the volatility measures are presented in Appendix 8.2 in the Appendix.

[8] We use the same formulas as in (8.1) and (8.3) but replacing $C_{i,t}$ and π_t with the 12 months ahead expectation for costs $E_{i,t}(C_{12m})$ and inflation $E_{i,t}(\pi_{12m})$, respectively.

[9] Regarding seasonality, Appendix 8.3 shows the proportion of price changes for each month of the year for all firms and also conditioning on size.



(a) All firms (b) Sizes

Fig. 3.2. Proportion of firms changing prices (by month).
Notes: Panel (a) shows the monthly proportion of firms changing prices and observed inflation. Panel (b) shows the monthly proportion of firms changing prices by size. Both panels exhibit the computations between July 2017 and September 2020.

and small firms do. Over 40 months, large firms changed their prices nine times, medium firms changed their prices four times, and small firms changed only three times. This finding is consistent with results shown in Lein (2010), which finds that the probability of price change increases with firm size measured by the number of employees. On the other hand, using the information on the expected intensive margin question, we find that large firms anticipate smaller price changes than medium and small firms. Hence, while large firms change prices more frequently, the expected magnitude of revision is smaller than the rest of the firms in the sample.

4. Belief-dependent pricing decisions

In this Section, we exploit the information available in our dataset and provide a complete picture of the role of inflation and cost expectations on firms' price variations. We start by studying the effect of expectations on firms' price adjustment decisions. Then, we assess their interplay with the rate by which firms expect to change their prices.

4.1. Extensive margin of price adjustments

We describe the empirical baseline specification we estimate using a linear panel data model.

$$AdjPrice_{it} = \mathbf{x}_{it}\boldsymbol{\beta} + \mu_i + \eta_t + \upsilon_{it} \tag{2}$$

The dependent variable is an indicator variable that takes the value of one if firm i at time t decided to adjust the price of their main product. The independent variables comprise $\mathbf{x}_{it}$, which corresponds to a vector of explanatory variables including current and lagged values of firm's i inflation and cost growth expectations (for the next 12 months) $E_{i,t}(.)$, actual inflation at time t and its first lag, the time t and four lags of the cost index proxy at the firm level (described in Section 3.2), and a set of Taylor variables, which controls for time-dependent price adjustments.[10] These variables account for the fact that some firms may adjust their prices following predetermined pricing plans. In particular, the variable $Taylor_{j,it}$ takes the value of one if, at time t, firm i changed its price for the last time j months ago and zero otherwise. We construct 12 different Taylor dummies to capture any fixed price-adjustment schedule, i.e., $j = 1, \ldots, 12$. In the regression, we also include firm and time (month and year) fixed effects, μ_i and η_t respectively. The idea is to capture any state-dependent pattern in price adjustments.

[10] We include only one lag of actual inflation given that Uruguayan inflation persistence is 0.95.

Table 4.1
Probability of price adjustments.

	(1)	(2)	(3)	(4)
$E_{it}(\pi_{12m})$	0.0006	0.0019	0.0026	0.0001
	(0.0041)	(0.0047)	(0.0057)	(0.0047)
$E_{it-1}(\pi_{12m})$		0.0018	0.0035	−0.0005
		(0.0043)	(0.0053)	(0.0045)
$E_{it-2}(\pi_{12m})$		−0.0016	−0.0008	−0.0033
		(0.0040)	(0.0044)	(0.0039)
$E_{it-3}(\pi_{12m})$		−0.0063	−0.0091*	−0.0070
		(0.0049)	(0.0052)	(0.0049)
$E_{it-4}(\pi_{12m})$		0.0036	0.0042	0.0027
		(0.0049)	(0.0047)	(0.0049)
$E_{it}(C_{12m})$	0.0027	−0.0022	−0.0004	−0.0027
	(0.0025)	(0.0035)	(0.0041)	(0.0035)
$E_{it-1}(C_{12m})$		0.0026	0.0022	0.0025
		(0.0022)	(0.0027)	(0.0023)
$E_{it-2}(C_{12m})$		0.0012	0.0021	0.0013
		(0.0022)	(0.0023)	(0.0023)
$E_{it-3}(C_{12m})$		0.0080***	0.0077***	0.0080***
		(0.0023)	(0.0026)	(0.0024)
$E_{it-4}(C_{12m})$		0.0008	−0.0008	0.0008
		(0.0026)	(0.0028)	(0.0027)
Cost index proxy	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Taylor dummies	✓	✓	×	✓
Time FE	✓	✓	✓	×
R^2	0.1444	0.1464	0.0275	0.1333
Observations	9665	8498	8498	8498

Notes: This table reports panel fixed effects OLS estimates associating aggregate and idiosyncratic expectations on price-adjustment decisions. The dependent variable in all columns is an indicator variable that takes the value of one if firm i in month t decided to adjust its price. Column (1) uses only current inflation and cost expectations, and column (2) includes up to four lags of those variables. Columns (1)–(2) include firm-, month- and year-fixed effects (constants not reported). Columns (3) and (4) explore the time- and state-dependent channel by removing the Taylor group of variables (which controls for time-dependent price adjustments) or the time-fixed effects, respectively. All specifications include inflation at time t and its first lag, and a time t and four lags of a cost index proxy at the firm level, not reported. The table reports, in parentheses, robust and clustered (by firm) standard errors. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 4.1 shows the marginal effect of a firm's expectations on the probability of price adjustment. Relying on the linear probability model (LPM), we control for firms' fixed effects. Column (1) uses only current expectations about inflation and costs, while column (2) controls for lagged values of these two expectations to capture potential dynamic belief patterns on adjustment decisions. Both specifications control for time-dependent and state-dependent effects.

According to the results, current expectations about inflation or costs do not significantly influence the decision to change prices. When we add lagged expectations, we observe that, while inflation expectations still do not correlate with this decision, there is a significant effect of lagged cost expectations. Our results align with those in Meyer and Sheng (2021) and Riggi and Tagliabracci (2022), who found that price changes are uncorrelated to firms' inflation expectations. If firms expect a 1% increase in their costs, this increases the probability of a price adjustment by approximately 0.8% three months from that moment. With an average cost expectation of about 10%, the magnitude is meaningful, as the unconditional probability of a price adjustment was approximately 17%, as discussed in Section 3.3. To understand the long-run effects of cost expectations, we calculate the sum of the coefficients on lagged cost expectations from $t-1$ to $t-4$. The sum equals 0.013 and is statistically different from zero (with a p-value of 0.002), further supporting the relevance of cost expectations of firm decisions. Moreover, the results are consistent with the existing empirical evidence studying beliefs' relevance to understanding pricing decisions. Relying on a survey of firms in Italy, Coibion, Gorodnichenko, and Ropele (2020b) report that firm expectations effectively cause price adjustment decisions. Using the ifo Survey in Germany, Enders et al. (2022) show that an increase in production expectations positively affects current production and prices.[11] While confirming their importance, we provide further evidence about which *type* of expectation is relatively more important for these decisions. The results reinforce why it is important to collect information about inflation and cost expectations separately. The fact that inflation and cost growth expectations are conceptually distinct has already been suggested by Coibion, Gorodnichenko, Kumar, and Pedemonte (2020a). Our results confirm the lack of correlation between the two expectations by showing that they bring different implications for price adjustment decisions.

While we cannot claim causality, our findings hold after controlling for firms and time-fixed effects, the cost proxy, Taylor dummies, and further macro controls. To stress the importance of time- and state-dependent channels, we repeat the previous specification in column (3) but remove the Taylor dummies. In contrast, in (4), we remove the state-dependent controls instead. Consistent with Lein (2010), the model's overall fit decreases when we omit either of these two. In particular, the worsening of the R^2 coefficient in column (3) supports time-dependent rules being a central component behind firms' price-adjustment decisions. We follow Lein (2010) in interpreting the fact that the estimated coefficients on the Taylor dummies are statistically significantly different from zero together with the seasonality in price changes shown in Table 8.4 in the Appendix as suggesting that time-dependent factors are important in explaining firms' price changes.[12] The fact that the belief-dependent channel is present even when we control for time- and state-dependent variables confirms and highlights the relevance of this third channel as an additional driver of such decisions.

Our results are interesting since we can connect further existing results in the pricing literature with the expectation channel. Using detailed micro-level price data, Midrigan (2011) highlights the critical role that large idiosyncratic shocks play in rationalizing price adjustments. Midrigan (2011) also shows that the probability of price revisions stays constant independently of whether the economy is in a low or a high inflation state. Our evidence supports the relevance of idiosyncratic relative to aggregate expectations to understand the extensive margin of prices. Moreover, our findings suggest that the decision to adjust prices is orthogonal to firms anticipating either a low or high growth in the price level. Although evidence about firms' forward-looking behavior underscores the importance of price rigidities, it is not easy to disentangle the potential reasons behind the different responses of the two expectations. As shown in Fig. 3.1 and 8.1, the cost volatility is persistently more significant than the inflation one. Maćkowiak and Wiederholt (2009) argues that a rationally inattentive price-setter will dedicate most of his limited attention to learning about the idiosyncratic (and more volatile) shocks at the expense of committing less attention to any aggregate shocks before setting prices.[13] Our results can, therefore, be interpreted through the lens of this theory and suggest the concurrent presence of both rigidities – prices and information – as relevant constraints that firms face when deciding whether to change their prices or not.[14] We cannot rule out the possibility that firms are reacting to news about future cost changes that materialize later. We further explore this in Section 6.

Besides the heterogeneous effects of inflation and cost expectations on pricing decisions, a second novel fact is the evidence of the delayed effect of this latter expectation. As we mentioned, we interpret the delayed impact of cost expectations as further evidence suggesting the presence of price-adjustment frictions at the firm level. Nakamura and Zerom (2010) emphasize the critical role of price rigidities in explaining the sluggish reaction of prices to changes in marginal costs. Using granular data from the coffee industry, these authors show that an increase in commodity costs leads to an increase in prices that will materialize over the subsequent six quarters, where more than half of the price adjustments happen with a delay of one quarter or more. Motivated by this evidence and intending to validate the delayed effect of expectations further, we decided to actively collect additional evidence to test this result in our data. In June 2019, we could add two other questions to the survey. Specifically, we asked: *"On average, how long does it take your firm to change prices when: (1) inflation increases and (2) costs increase?"* Firms were asked to provide an open answer measured in the number of weeks. Our goal was to get a clearer insight into how quickly firms can adjust their prices without explicitly referring to the expectation channel. We present the results of the additional questions in Fig. 4.1.

The results of our special questions speak directly to these findings and allow us to extend the dynamic considerations of this reaction through the expectation channel. Most surveyed firms responded that a price adjustment would happen approximately 11 (10.5) weeks following a change in inflation (costs). As firms report their expectations for the next 12 months, the significant reaction suggests that the expected cost adjustment could be permanent. Hence, while leveraging short-run dynamics, a forward-looking firm facing price rigidities will choose to adjust its prices in the near future.

4.2. Robustness exercises

In light of the previous results, we present some robustness exercises to evaluate our findings' extent further.

[11] In a similar fashion, other papers have found a significant effect of expectations on firms' decisions, such as Bachmann and Zorn (2020) or Gennaioli et al. (2016). See Born et al. (2022) for a more detailed survey.

[12] As shown in Table 8.4 in the Appendix, after controlling for monthly dummies, the sign and value of the Taylor coefficients suggest an increasing price hazard rate, consistent with results obtained by Borraz and Zipitria (2012) using Uruguayan data. This evidence would be inconsistent with Calvo's and Taylor's time-dependent pricing models. Our Taylor dummies aggregate firms from different sectors and then heterogeneous patterns of price adjustment, resulting in a hazard function that might not be constant.

[13] Cuitino et al. (2022) study the exchange rate pass-through to domestic prices in a New Keynesian DSGE model in which they consider imperfect credibility of central bank policy in Uruguay. In this setting, expectation formation and learning are critical, and inflation expectations anchoring depends on the degree of credibility of the central bank.

[14] We also computed a correlated random effects probit model as an alternative specification that allows us to control for firm's fixed effects. All the described results remain under this model and are available upon request.

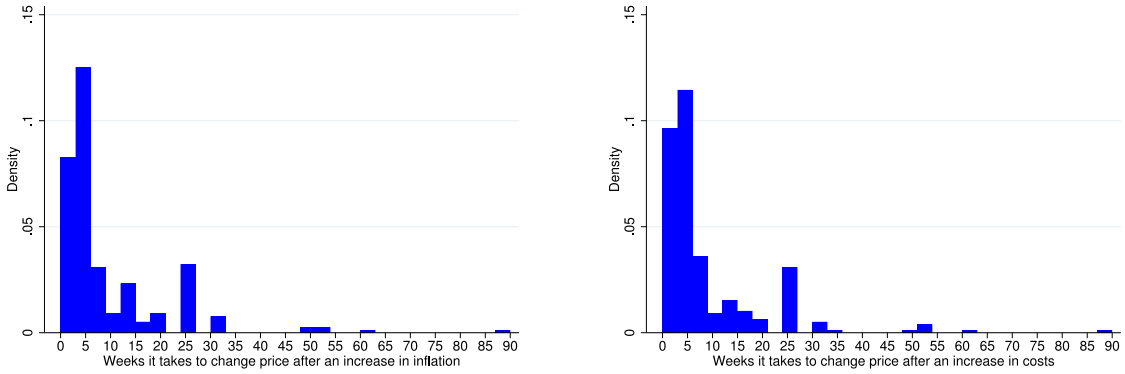


Fig. 4.1. Sluggish price adjustments (added questions).
Notes: The figure shows the results of a special, one-time, question added to the survey. The left figure shows the histogram of the reported number of weeks it takes a firm to change prices after an increase in inflation, while the right figure shows the same after an increase in costs. Firms' answers were specifically the number of weeks they needed to change prices effectively.

4.2.1. Validity of the cost proxy

We rely on the constructed cost proxy $C_{i,t}$ as an additional covariate in the specifications. As our proposed cost measure is not flawless, it could raise concerns about its validity in capturing the actual monthly costs at the firm level. Although total cost information at this frequency is unavailable outside the firm, we use balance sheet information from the Annual Survey of Economic Activity to compute firms' actual total costs yearly and find that the correlation between our cost proxy and the annual cost is 0.63. Moreover, while the annual costs increased by 8.55% on average during the analyzed years, our cost proxy increased by 8.2%. In addition, there could be concerns about the extent to which cost expectations capture something different from actual costs. In this sense, cost expectations could be a projection of current cost, and therefore, the two series will share a high correlation. In Appendix 8.4 we discuss this possibility and show that the correlation between $C_{i,t}$ and $E_{i,t}(C_{i,t+12})$ is negligible in our sample. Meanwhile, the correlation between the cost proxy and inflation is high and significant. This evidence is not surprising as the measure builds on the evolution of input prices while leveraging firms' specific production functions. We will refer to Appendix 8.4 for a more detailed explanation and further evidence to support our measure as a valid proxy of actual costs.

4.2.2. Firms' fixed effects

The lack of significance of current and lag expectations may raise concerns about the variability of these two variables, which could then affect the precision of the estimation. Coibion et al. (2018) shows that firms' fixed-effects capture a significant part of the variability of the one-year ahead inflation expectations. To address this potential concern, we only regress each expectation on time and firm fixed-effects for our analyzed sample. Then, we compute the residual variation of these two auxiliary models, which are 1.89 and 3.28 for inflation and cost expectations, respectively. If we contrast these numbers with the unconditional standard deviation of these expectations, 1.93 and 3.31, respectively, we notice that unobserved firms' characteristics do not absorb the variation in the covariates of interests, supporting the relevance of expectations on the probability of price revisions.

4.2.3. Additional exercises

For further robustness, we also compute our baseline estimation with a two-way cluster-robust standard error at the firm and month level and add fixed-effects interactions between sectors and time. Our results are robust to all these alternative specifications. On top of that, we also confirmed that our results are robust to excluding statistically insignificant variables in the baseline specification, the omission of the month or Taylor dummies, or even firm fixed effects. These additional exercises are shown in Table 8.5 in Appendix 8.7.

4.3. Expected intensive margin

Departing from the decision to change prices, we now study the possible correlation between expectations and the magnitude by which firms *expect* will adjust their prices in the future. As discussed in Section 2, every two months, firms provide an estimate of the magnitude by which they think their main product's price will change, on average, over the next 12 months in their local and external markets. Given previous results, we will study the potential effects of current and lagged beliefs on the expected magnitude of price changes. We estimate:

$$E(\Delta p_{it+12}) = \mathbf{x}_{it}\boldsymbol{\beta} + \mu_i + \eta_t + \epsilon_{it} \tag{3}$$

where $E(\Delta p_{it+12})$ is the expected magnitude by which firm i will adjust the price of its main product a year from now. As before, the independent variables $\mathbf{x}_{it}$ include both current and lagged values of firm i inflation and cost growth expectations for the next 12 months. We also control for current and lagged values of the cost proxy and add firm and time-fixed effects. Table 4.2 shows the results of model (3) for the domestic and the external markets.[15]

Related to internal prices, *current* expectations for both inflation and costs positively correlate with the expected intensive margin. Both aggregate and idiosyncratic expectations play an important role in determining the expected magnitude of price adjustments once the decision to revise prices has (hypothetically) been made. However, two main facts arise. First, the current cost expectation is more relevant as its marginal effect is more than twice that of inflation expectations. Secondly, and in contrast with the extensive margin results, lagged expectations for either inflation or cost do not seem to play a role in determining the expected intensive margin. This fact speaks to the findings of Andrade et al. (2022) on the determinants of expected price changes at the firm level. Using a French survey of firms, Andrade et al. (2022) shows that firms' expectations about their future price changes respond more rapidly to industry-level inflation than aggregate inflation. These authors claim that after an industry-specific shock, firms immediately anticipate they will increase prices. In contrast, the expectation adjustment is muted and delayed after an aggregate shock occurs. In line with these findings, model results (3) suggest that expected prices also respond to aggregate and idiosyncratic beliefs besides shocks. Rational Inattention models of price setting suggest

[15] As a significant number of firms does not export their products, the sample size considerably decreases when estimating the results for the external prices.

Table 4.2
Expected intensive margin.

	Internal prices		External prices	
$E_{it}(\pi_{12m})$	0.2241***	0.2128***	−0.0549	0.1105
	(0.0605)	(0.0548)	(0.1054)	(0.0950)
$E_{it-1}(\pi_{12m})$		0.0583		−0.1458*
		(0.0492)		(0.0766)
$E_{it-2}(\pi_{12m})$		−0.0203		−0.0665
		(0.0455)		(0.0858)
$E_{it-3}(\pi_{12m})$		−0.0189		−0.0000
		(0.0368)		(0.0969)
$E_{it-4}(\pi_{12m})$		−0.0077		0.0070
		(0.0360)		(0.0758)
$E_{it}(C_{12m})$	0.5302***	0.4767***	0.4507***	0.3093***
	(0.0514)	(0.0472)	(0.0940)	(0.0680)
$E_{it-1}(C_{12m})$		0.0061		0.1144**
		(0.0316)		(0.0515)
$E_{it-2}(C_{12m})$		0.0404*		0.0655***
		(0.0240)		(0.0216)
$E_{it-3}(C_{12m})$		0.0294		0.0418
		(0.0219)		(0.0259)
$E_{it-4}(C_{12m})$		−0.0148		−0.0356
		(0.0273)		(0.0245)
Cost index proxy	✓	✓	✓	✓
Firms FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	18,597	14,473	7608	5893

Notes: This table reports panel fixed effects OLS estimates associating aggregate and idiosyncratic expectations on the expected magnitude of the price adjustment. The dependent variable is the expected intensive margin of the price adjustment. In columns (1)–(2), the price adjustment is for local markets, and in columns (3)–(4) for external ones. All specifications include a time t and four lags of a cost index proxy at the firm level, firm, month, and year fixed effects. The table reports, in parentheses, robust and clustered (by firm) standard errors. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

that firms should allocate more of their limited attention toward more volatile variables. Using the same rationale consistent with the results in Section 3.2, we can rationalize the larger effect of cost expectations relative to inflation in determining the expected magnitude of price changes. The results of Andrade et al. (2022) are also interpreted through the lens of Rationally Inattentive price setters, which confirms our results.

Interestingly, comparing the results between internal and external prices, we find that expectations about inflation in the home country are not relevant in explaining the expected intensive margin of external prices. Regarding expectations, only the internal cost is significant for expected price increases in external markets. This result suggests that firms can distinguish between the potential irrelevance of the aggregate expected growth rate of internal prices to explain further the future path of prices set to foreign customers.

5. Heterogeneous effects of cost expectations

We now explore the effect of cost expectations by studying potential sources of heterogeneity at the firm level. For this purpose, we interact the current and lagged inflation and cost expectations values with the firm's time-invariant characteristics and assess their relevance for the extensive and the expected intensive margins. In line with Table 3.1, those characteristics are a dummy for each firm size (small, medium, and large), the number of competitors, and a variable that accounts for whether the firm has to price one or more products. We explore each possibility, one by one, while controlling for the remaining explanatory variables.

5.1. Firm size

We interact the three time-invariant categories for firm size with the current and lagged values of the two expectations. When adding the interactions, the models mentioned above for the extensive and the intensive margins are estimated with the small firms as the omitted category. Table 5.1's first two columns show the marginal effects of the extensive margin across medium and large firms, separated between aggregate and idiosyncratic expectations. Similarly, Table 5.2 shows the results for the expected intensive margin.

The null effects of current and lagged inflation expectations remain even when we condition on medium and large firms. However, while cost expectations do not play a significant role for medium firms, large firms are concentrating the forward-looking pricing behavior. The marginal probability of adjusting prices significantly increases by an average of 0.95% after a 1% revision in cost expectations for large firms. As in the baseline scenario, the effect operates with delay. While all types of firms face frictions in the price-adjustment process, the evidence of forward-looking behavior holds only across large firms. As shown in Fig. 3.1, larger firms' costs are more volatile than small and medium firms over time. A low cost persistence should translate into prices that change more frequently on average. Thus, intending to anticipate highly volatile costs in the near future, the expectations of bigger firms tend to affect today's price adjustment decision more, in line with our findings.

Related to the intensive margin, current cost, and inflation expectations matter for the expected price adjustment. However, the effect's magnitude is stronger for larger firms for the two expectations. Interestingly, consistent with the extensive margin results, the three-month lagged cost expectations also significantly affect only large firms.

5.2. Number of competitors

In a similar spirit as the previous exercise, we now split the sample based on the number of direct competitors reported by each firm. Using quantiles, we ended up with three categories: "few" (<5), "average" (between 5 and 10), and "many" (>10) competitors. We interact these categories with the expectations, omitting the "few" category. The results are shown in the third and fourth columns of Tables 5.1 and 5.2. Although the number of competitors is highly correlated with firm size, all the results control for firms' fixed effects and all the remaining explanatory variables as in the baseline specification.

Facing a large number of competitors is related with the presence of forward-looking behavior. As before, the effect of the extensive margin only exists for cost, not for inflation expectations. Based on this evidence, we can further rationalize the reasons behind the dynamic responses of prices to cost expectations. Strategic complementarities in pricing among firms can contribute to the delay in price adjustments given price rigidity. Using the same survey as we do, Frache and Lluberas (2019) gives evidence of strategic complementarities among Uruguayan firms, though at a lower degree than firms in New Zealand reported by Afrouzi (2023). While firms expect to experience a persistent change in their marginal costs, the effect on actual price revisions is delayed due to the incentives to coordinate the timing of price adjustments with the competitors. The complexity of the coordination task rises as the number of competitors increases, further contributing to the adjustment delay.[16]

A rise in current cost expectations leads to an increase in the expected intensive margin. The effect is only mildly significant for inflation expectations. Based on the results, we conjecture that facing fewer competitors, i.e., having more market power, allows firms to anticipate more considerable price adjustments in response to cost expectations. Again, as with larger firms, lagged values of costs also matter for the intensive margin.

[16] Kano (2013) studies a state-dependent pricing model under different market structures. The results suggest that prices in an oligopolistic market could be much more rigid than in a monopolistically competitive framework. Strategic interaction among brands in the oligopolistic version could distort the estimations of menu costs and, with this, the implications for price rigidity.

Table 5.1
Extensive margin: Size, Competitors and Multi-product firms.

	Firm size		Number of competitors		Multi-product
	Medium	Large	Average	Many	
$E_{it}(\pi_{12m})$	0.0023	0.0107	−0.0023	0.0124	0.0042
	(0.0076)	(0.0117)	(0.0066)	(0.0123)	(0.0059)
$E_{it-1}(\pi_{12m})$	−0.0049	0.0016	0.0058	0.0066	−0.0018
	(0.0077)	(0.0084)	(0.0068)	(0.0080)	(0.0051)
$E_{it-2}(\pi_{12m})$	−0.0022	0.0076	0.0014	−0.0093	0.0034
	(0.0071)	(0.0093)	(0.0072)	(0.0063)	(0.0046)
$E_{it-3}(\pi_{12m})$	−0.0068	−0.0163*	−0.0138*	−0.0065	−0.0125**
	(0.0084)	(0.0093)	(0.0075)	(0.0103)	(0.0055)
$E_{it-4}(\pi_{12m})$	0.0046	0.0141*	0.0093	−0.0079	0.0109**
	(0.0094)	(0.0085)	(0.0071)	(0.0111)	(0.0054)
$E_{it}(C_{12m})$	−0.0075	0.0033	−0.0017	0.0016	0.0003
	(0.0066)	(0.0063)	(0.0055)	(0.0056)	(0.0041)
$E_{it-1}(C_{12m})$	0.0082	0.0003	0.0021	−0.0020	0.0013
	(0.0055)	(0.0038)	(0.0037)	(0.0031)	(0.0026)
$E_{it-2}(C_{12m})$	−0.0069	−0.0004	0.0018	−0.0007	−0.0007
	(0.0081)	(0.0038)	(0.0039)	(0.0035)	(0.0028)
$E_{it-3}(C_{12m})$	0.0062	0.0095***	0.0090**	0.0112**	0.0095***
	(0.0078)	(0.0029)	(0.0040)	(0.0045)	(0.0030)
$E_{it-4}(C_{12m})$	0.0089	0.0010	−0.0005	0.0013	0.0014
	(0.0057)	(0.0040)	(0.0043)	(0.0053)	(0.0031)
Firm FE	✓		✓		✓
Taylor dummies	✓		✓		✓
Month FE	✓		✓		✓
Year FE	✓		✓		✓
N	8,498		8,498		8,498
R^2	0.1505		0.1487		0.1488

Notes: The table shows the marginal effects of inflation and cost expectations on the probability of price adjustments conditioned on firm size, number of competitors, and multi-product firms. Each column shows the estimated coefficients with the corresponding standard error below in parentheses.

Table 5.2
Expected intensive margin: Size, Competitors and Multi-product firms.

	Firm size		Number of competitors		Multi-product
	Medium	Large	Average	Many	
$E_{it}(\pi_{12m})$	0.2053**	0.3355***	0.1527*	0.1401*	0.1755***
	(0.1044)	(0.1030)	(0.0880)	(0.0851)	(0.0615)
$E_{it-1}(\pi_{12m})$	0.0924	0.0748	0.0134	0.0977	0.0521
	(0.0958)	(0.0871)	(0.0685)	(0.0926)	(0.0574)
$E_{it-2}(\pi_{12m})$	0.0326	−0.0739	0.0336	−0.1649**	−0.0062
	(0.1005)	(0.0725)	(0.0816)	(0.0701)	(0.0556)
$E_{it-3}(\pi_{12m})$	0.0299	−0.0405	−0.0624	0.0668	−0.0911**
	(0.0798)	(0.0697)	(0.0449)	(0.0742)	(0.0462)
$E_{it-4}(\pi_{12m})$	−0.1159**	0.0650	0.0221	0.0742	0.0559
	(0.0522)	(0.0766)	(0.0580)	(0.0663)	(0.0463)
$E_{it}(C_{12m})$	0.4256***	0.4789***	0.5463***	0.5002***	0.4841***
	(0.0526)	(0.0956)	(0.0968)	(0.0773)	(0.0600)
$E_{it-1}(C_{12m})$	−0.0211	0.0026	0.0092	0.0168	0.0102
	(0.0433)	(0.0622)	(0.0517)	(0.0600)	(0.0393)
$E_{it-2}(C_{12m})$	0.0507	0.0634	0.0232	0.0642	0.0707**
	(0.0407)	(0.0469)	(0.0350)	(0.0601)	(0.0324)
$E_{it-3}(C_{12m})$	−0.0359	0.0875***	0.0941**	−0.0031	0.0320
	(0.0525)	(0.0321)	(0.0387)	(0.0401)	(0.0290)
$E_{it-4}(C_{12m})$	0.1073**	−0.0677	−0.0529	−0.0545	−0.0511
	(0.0544)	(0.0473)	(0.0520)	(0.0515)	(0.0341)
Firm FE	✓		✓		✓
Taylor dummies	×		×		×
Month FE	✓		✓		✓
Year FE	✓		✓		✓
N	14,473		14,473		14,473
R^2	0.3217		0.3216		0.3189

Notes: The table shows the marginal effects of inflation and cost expectations on the expected magnitude of price adjustments conditioned on firm size, number of competitors, and multi-product firms. Each column shows the estimated coefficients with the corresponding standard error below in parentheses.

Table 6.1
Marginal effects: Accuracy of expectations.

	Extensive margin			Expected intensive margin		
	Realists	Optimist	Pessimists	Realists	Optimist	Pessimists
$E_{it}(C_{12m})$	−0.0050	−0.0076	0.0022	0.3932***	0.4849***	0.5031***
	(0.0050)	(0.0078)	(0.0047)	(0.0724)	(0.0571)	(0.0594)
$E_{it-1}(C_{12m})$	0.0069	0.0019	0.0017	−0.1205**	0.0846**	0.0339
	(0.0054)	(0.0065)	(0 .0027)	(0.0502)	(0.0358)	(0.0373)
$E_{it-2}(C_{12m})$	−0.0025	0.0053	0.0020	−0.0175	0.0531	0.0594*
	(0.0054)	(0.0042)	(0.0027)	(0.0256)	(0.0359)	(0.0313)
$E_{it-3}(C_{12m})$	0.0092	−0.0024	0.0102***	0.0226	0.1039**	−0.0126
	(0.0071)	(0.0037)	(0.0027)	(0.0282)	(0.0425)	(0.0286)
$E_{it-4}(C_{12m})$	0.0021	0.0084	−0.0022	0.0452	−0.0748	−0.0025
	(0.0043)	(0.0051)	(0.0036)	(0.0387)	(0.0489)	(0.0281)
N		8472			14,450	
R^2		0.1476			0.3316	

Notes: The first three columns of the table show the marginal effects of cost expectations and their lags on the probability of price adjustment according to firm groups classified by forecasting accuracy. The last three columns show the marginal effect of cost expectations and their lags on the expected intensive margin for those firms selling in the internal market.

5.3. Multi-product firms

We define a dummy variable to identify firms that sell more than one product. As before, the dummy variable interacts with both inflation and cost expectations. The estimated coefficients are reported in the last column of Tables 5.1 and 5.2. As in all the previous cases, we keep the same explanatory variables while controlling for time-invariant characteristics.

According to the results, lagged cost expectations for multi-product firms are positively and significantly related to the probability of price adjustments. In line with the empirical evidence, price changes synchronize across firms that sell several products, (Lach and Tsiddon, 1996). This fact is also implied in a model with a multi-product firm facing a menu cost as proposed by Alvarez and Lippi (2014). They conclude that the frequency of price adjustments increases with the number of products. As the costs of adjusting prices can rise exponentially with the number of products produced, this type of firm has further incentives to behave in a forward-looking fashion consistent with our results. In addition, the probability of price adjustment is higher across multi-product firms and is also compatible with other surveys of firm expectations, such as Yang (2022), which finds similar results based on pricing information from firms in New Zealand. Finally, our results are compatible with findings by Bhattarai and Schoenle (2014), who find that the frequency of price changes increases, but the size decreases with the number of products the firm sells.

As before, both inflation and cost expectations correlate with the intensive margin for multi-product firms. Consistently throughout the specifications, cost expectations are, in magnitude, more relevant than inflation beliefs.

6. Accuracy of expectations and news

Up to this point, we have assessed the implications of the belief channel only across observable characteristics of the firm. However, the relation between expectations and pricing decisions could be a consequence of the forecast's "quality" or precision. Suppose a subset of firms produces more accurate predictions about their future cost evolution than the rest. In that case, the observed average reaction of cost expectation may be driven by the natural response of this set of firms. In this Section, we further explore this possibility. For doing so, we aim to classify firms based on their forecasting accuracy. We compute the forecast error FE^i_{t+h} for cost expectations as the difference between the expected value in time t and the realization in $t+12$. In line with the discussion in 4.2.1, we use the cost proxy $C_{i,t}$ to compute FE^i_{t+h} and have an accuracy measure across all firms and months over the entire sample. Following Bachmann and Elstner (2015) we then run regressions at the firm level of the cost forecast errors on a constant, and given the sign of the predicted constant, we classify firms among: "Realists", "Optimists" and "Pessimists". Realists correspond to firms whose estimated constant is not statistically different from zero at the 95% confidence level; i.e., on average, their forecast error is zero. The Optimists group includes firms with a negative average forecast error, i.e., those that expect lower than realized cost changes over the next year. Finally, the pessimist group is composed of firms that expect higher-than-observed costs. While controlling for all the variables mentioned above, we interact the current and delayed cost expectations with a dummy variable that accounts for each of the three groups. Table 6.1 exhibits the estimated coefficients associated with the interaction for each group.

The delayed effect of cost expectations on price adjustments is present across firms that produce non-accurate or biased predictions. Firms that are either pessimistic or optimistic about the evolution of their costs are the ones that tend to revise their prices with a delay as a consequence of their expectations. While we conjecture that prices are revised upward (downward) for pessimist (optimist) firms, we cannot confirm our intuition without knowing the actual sign of the price revision. Nevertheless, the evidence does not support the presence of the belief-dependent channel for the more accurate firms.

Grounded on our special question about the delayed effect of cost and inflation on prices, we interpret the lagged effect of cost expectation as evidence of price rigidities. However, the decision to change current prices could be explained by an adjustment in cost that materialized over the last three months, which was correctly anticipated by firms when they reported their cost expectations three months ago. Hence, the observed reaction is also consistent with firms' having genuine information about cost change in the near future. Through the lens of our results, and in a similar spirit as Enders et al. (2022), we can rely on firms' forecast errors to infer whether cost expectations are carrying news about the future evolution of costs. More than testing for rationality in the expectation formation process of firms, we interpret the realist firms as the ones that hold news about the future evolution of costs, which explains their higher precision. If this is the case, and based on the null effect of cost expectations for the more accurate firms, it does not seem that the delayed effect is related to a reaction to news. The significant pricing reaction for the other two groups could be either a consequence of the unforecastable noise that they experience or could

Table 6.2
Marginal effects: News and beliefs.

	Baseline	News
$E_{it}(\pi_{12m})$	0.0009	0.0009
	(0.0054)	(0.0048)
$E_{it-1}(\pi_{12m})$	0.0020	0.0028
	(0.0050)	(0.0053)
$E_{it-2}(\pi_{12m})$	−0.0038	−0.0037
	(0.0044)	(0.0054)
$E_{it-3}(\pi_{12m})$	−0.0012	−0.0007
	(0.0054)	(0.0051)
$E_{it-4}(\pi_{12m})$	−0.0012	−0.0017
	(0.0058)	(0.0051)
$E_{it}(C_{12m})$	−0.0036	−0.0039
	(0.0040)	(0.0028)
$E_{it-1}(C_{12m})$	0.0028	0.0028
	(0.0024)	(0.0029)
$E_{it-2}(C_{12m})$	0.0014	0.0015
	(0.0024)	(0.0026)
$E_{it-3}(C_{12m})$	0.0059**	0.0066**
	(0.0024)	(0.0027)
$E_{it-4}(C_{12m})$	0.0029	0.0028
	(0.0028)	(0.0025)
$\Delta GasOil_t$		0.0150
		(0.0169)
$\Delta GasOil_{t-1}$		−0.0081
		(0.0108)
$\Delta GasOil_{t-2}$		0.0114
		(0.0123)
$\Delta GasOil_{t-3}$		0.0115
		(0.0126)
$\Delta GasOil_{t-4}$		0.0005
		(0.0129)
$News_t$		−0.0243**
		(0.0111)
$News_{t-1}$		0.0008
		(0.0135)
$News_{t-2}$		−0.0052
		(0.0265)
$News_{t-3}$		0.0284
		(0.0195)
$News_{t-4}$		0.0191
		(0.0179)
N	7553	7426
R^2	0.1460	0.1344

Notes: Column (1) reproduces the second column of Table 4.1. Column (2) adds the change in gas oil prices and oil supply news shock. All specifications include firm-, month- and year-fixed effects. Inflation at time t and its first lag, a time t and four lags of a cost index proxy at the firm level, and constants are not reported. The Table reports, in parentheses, robust and clustered (by firm) standard errors. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

be explained by a persistent bias at the firm level. Unfortunately, our results do not allow us to split these two results apart.[17]

We conduct the following exercise to understand better which elements may be driving our results, either beliefs or news. Like many other countries, Uruguay is a crude oil importer with no domestic production and a strongly regulated fuel market. The government sets and administers retail prices. What is relevant for our exercise is that the timing of the price adjustments is not fixed, and, usually, public opinion starts to speculate when prices will be adjusted. However, the specific date is only known a day or two in advance.

For this additional exercise, we take the specification of the second column of Table 4.1 and augment it with the change in the regulated gasoil price and the oil supply news shocks from Kanzig (2021)[18]; both in time t and up to four lags. The idea is that the monthly growth in gas-oil price captures the moment a relevant component of firm costs changes. Indeed, according to the 2012 balance sheet information, approximately 60% of firms in the sample report expenses on fuel and/or oil derivatives. The second variable aims to account for the surge of news that may affect oil crude prices in the near future. Results of this augmented regression are shown in Table 6.2

The first result is that even after controlling for the price of a critical input for firms and news about the associated supply shock, the coefficient of lagged cost at $t-3$ remains significant, suggesting the belief channel is still present. The coefficients associated with the change in the fuel retail price are not significant. The second result is that news on future oil supply conditions is significant at time t. This fact is interesting as it suggests that the probability of changing current prices decreases when expected future oil conditions improve. We interpret this evidence as firms responding more cautiously to the news, leading them to delay a potential price adjustment decision. Hence, having news about this relevant input price seems to matter intuitively, and, importantly, the belief channel is still present.

7. Conclusion

We assess the role of aggregate and idiosyncratic expectations on firms' price-adjustment decisions. Our results suggest that decisions on price adjustments are also related to firms' beliefs besides time-dependent and state-dependent pricing rules. According to our results, cost expectations matter for pricing decisions, but they operate with a few months' delay. While firms' forward-looking behavior suggests the presence of price rigidities at the firm level, the muted reaction to inflation expectations, especially in a country with high inflation, such as Uruguay, calls for further attention. Our findings of a different response toward costs relative to inflation are also consistent with theories of information rigidity. Regardless of which of the two rigidities plays a more prominent role in the decision to change prices, our results suggest that the belief-dependent channel is an essential mechanism to explain price revisions.

This paper aims to provide further empirical evidence on forward-looking pricing. In particular, we try to understand how firms' expectations shape actions. However, the absence of specific information about the sign of the price change and the actual magnitude of price revisions limits the extent of our conclusions. We conjecture that the belief-dependent channel's importance could be even more pronounced if we could collect such information. We leave these questions for future work. Nonetheless, the evidence presented in this paper justifies adding questions that further explore the relevance of the belief-dependent channel in expectation surveys.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[17] After showing that firms' expectations about future production matter for firms' current production and pricing decisions, Enders et al. (2022) argue that this result holds for expectations that turn to be correct ex-post *and* also for incorrect predictions. Hence, they conclude that while expectations can act as a source of news transmission, they may still bring a noise component that causes a firm to react. Given the different accuracy classification adopted, our results extend these findings regarding the effect of idiosyncratic cost expectations.

[18] Similar to high-frequency identification of monetary policy shocks, e.g., Gertler and Karadi (2015), Kanzig (2021) identifies oil supply surprises from changes in oil future prices in a tight window around OPEC announcements. A positive shock means a negative effect on oil price and a decrease in oil inventories.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econmod.2023.106630.

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