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Abstract

This paper studies the effects of inflation and idiosyncratic cost expectations on firms' price-adjusting decisions. Evidence of price-settings frictions using micro data has been studied through the lens of both time-dependent and state-dependent models. Using data from a unique survey, we argue that price-adjustment decisions are also belief-dependent. While controlling for time- and state-dependent factors, we find that, for the extensive margin of price-changes, expectations of inflation do not play any role, but firms' beliefs about their overall costs do. The expectation channel is, however, heterogeneous across firms, driven exclusively by large companies, and operates with a delay. Nonetheless, when looking at firms' beliefs about the intensive margin of price-changes, besides costs, the relevance of current inflation expectations is recovered. Our evidence supports the presence of price rigidities at the firm level but is also consistent with theories of limited attention.

JEL: D22, D84, E31.

Keywords: inflation expectations, cost expectations, firm surveys, price adjustments.

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1 Introduction

Economic decisions are forward-looking. Future expected changes are relevant as they should have an immediate effect on decisions. For price-setting decisions, any canonical New Keynesian Phillips Curve (NKPC) model would include an equation where the current optimal price is determined by a discounted sum of firms' future beliefs on the aggregate price level and the expected evolution of marginal costs. While most of the empirical evidence about the effects of expectations on pricing decisions are typically at the macro level, Gali and Gertler (1999), Gali et al. (2005) and Sbordone (2005), the evidence is scarcer at the micro-level, Carlsson and Skans (2012). Empirical evidence on forward-looking pricing is crucial as it directly speaks to the presence of price-setting 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. Thus we aim to answer the following questions: do firm's expectations *matter* for price-adjustment decisions? Is the response to aggregate and idiosyncratic expectations similar? Is the effect of beliefs heterogeneous across firms?

Evidence of price-setting frictions using micro-data has been studied through the lens of both time-dependent and state-dependent models.[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 revisions. Through the survey, we collect firms' predictions about the expected evolution of inflation along with how much they expect their costs to change in the near future. Evidence about the extensive margin of price changes along with firms' time-invariant characteristics allows us to assess the role of aggregate and idiosyncratic beliefs separately on pricing decisions. We estimate a reduced-form version of the pricing equation used in any stylized NKPC model while controlling for both time- and state-dependent characteristics.

We find empirical support for forward-looking behavior at the firm level, which highlights the role of expectations on firm decisions. We show that one year ahead expectations significantly *affect* current 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

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

role. While these results speak directly to the presence of price-rigidities at the firm level, they also have implications for the effects of monetary policy. In particular, further evidence on the potential differential effects of inflation expectations vis-a-vis cost expectations on price-adjustment decisions can also shed light on the transmission mechanism and the timing of monetary shocks on firms' pricing decisions. Moreover, we document that the effect of expectations operates with a *delay*. We show that if firms believe their costs would increase by 1% a year in the future, this significantly increases the probability of adjusting prices by 0.6% after three months. We confirm this result and its timing by adding a special question for one month of the survey.

Besides studying the implications of firms' expectations on extensive margin decisions, we also assess how expectations affect firm's beliefs about future price changes. In this case, both current inflation and cost expectations positively correlate with the expected intensive margin of price changes. These results complement recent findings by Andrade et al. (2020) 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 paired such expectations with *future* price decisions. In particular, inflation and cost expectations together affect the magnitude of price revisions once this decision is made. Finally, we show that the expectations effect is highly *heterogeneous* across firms. In particular, the idiosyncratic belief channel of price revisions is only present for large firms. Small and medium sized firms do not seem to react to expectations. Moreover, the forward-looking behavior is present particularly for multi-product firms facing a large number of competitors. To the best of our knowledge, there is no empirical evidence studying the potential heterogeneous effects of beliefs on firms' decisions.

The effect of beliefs is significant while controlling for both time-dependent (fixed and exogenous price-adjustment plans at the firm level) and state-dependent variables. Exploiting the panel structure of our database, we can also control for unobserved time-invariant firm-level characteristics. One of the main challenges we face is that we do not have information about firms' costs. This could cause problems to our empirical pricing model as we are omitting an important variable. In accordance with Carlsson and Skans (2012), we construct a detailed cost index for each firm, using balance-sheet information where we keep the firm's production structure constant while varying its input prices. We construct a proxy for the growth rate of costs at the firm level through the cost index, which we add in our estimations to control for firms' costs.

While the existing literature has documented the central role of idiosyncratic costs to rationalize 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. Midrigan (2011) also shows that the distribution of price changes does not change from low to high inflation periods. 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. The delayed effect of costs on prices is documented by Nakamura and Zerom (2010). The authors report that while an increase in costs leads to a posterior increase in prices, the price adjustment occurs with a delay of at least one quarter. The presence of menu costs is essential to rationalize the short-run delayed pass-through of costs to prices. 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.

Departing from price rigidity, the muted reaction of price revisions to aggregate expectations calls for further attention. It is not obvious why, in a country as Uruguay where inflation is stable but high, inflation expectations affect the future path of price changes but does not alter the decisions to change prices. Using our constructed cost index, we show that the volatility of costs relative to inflation is persistently higher over time. This is also true when we look at its expectations' counterpart. Thus, we argue that our results are also consistent with the theoretical predictions of "rationally inattentive" price setters as documented 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. This interpretation thus reinforces theories of inattention as an important constraint faced by firms, which can help to understand further the process by which firms acquire information, consistent with recent evidence Coibion et al. (2018). 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).

The paper also contributes to the vast literature on the micro evidence of price-adjustment decisions, Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008), Midrigan (2011) to name a few. Concerning the determinants of price-adjustments decisions, Lein (2010) argues that besides time-dependent pricing rules, the evidence supports the presence of state-dependent price-adjusting decisions. Bachmann et al. (2019) argues that idiosyncratic business volatility positively affects the extensive margin of prices, allowing the volatility effect to dominate the potential "wait-and-see" effect. This paper complements this evidence by arguing that the expectation channel is also a relevant determinant behind the frequency of price changes.

While there is a growing literature on how expectations are formed, Coibion and Gorodnichenko (2012), Andrade and Bihan (2013), Frache and Lluberas (2019), and Giacomini et al. (2020), there is much less evidence on how expectations correlate with economic decisions. This is partly because most of the literature studying expectations relies on forecasts from professionals. How representative these forecasters are and the implications of their forecasts on the economy are at least questionable. Surveys asking for expectations from relevant economic actors such as firms or households are much scarcer. Coibion et al. (2019) studies how different forms of monetary policy communication affect households' inflation expectations while D'Acunto et al. (2019) shows how prices faced by households on their shopping behavior affect their inflation expectations. Relative to firms, Boneva et al. (2019) documents several stylized facts about how expectations across firms are formed. That paper found a significant relationship between past expected prices and wage increases. Coibion et al. (2020) shows that firms' higher inflation expectations have a significant effect on their pricing, hiring, and credit decisions. Our paper contributes to this literature by separating the effect of aggregate and idiosyncratic beliefs as well as 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 that we use throughout the paper. In Section 3, we discuss the main stylized facts of the survey. Section 4 introduces the estimation procedure and the main results of the empirical analysis regarding firms' expectations and pricing decisions. Section 5 studies the potential heterogeneous effect of expectations based on firm characteristics, and finally Section 6 concludes.

2 The Survey

Our firm expectations survey takes place in Uruguay. This country is characterized by having high but stable inflation, with an average of 8% over the past decade. Figure 7.1 in the Appendix compares Uruguayan historical inflation with that of three other countries: the US, the UK, and New Zealand. The common feature of these four countries is there is longitudinal survey data on firms' expectations.

The studied survey is carried out by the National Statistical Institute (INE), commissioned by the Central Bank of Uruguay (BCU), and was originally 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 a common feature in these types of 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 costs. These questions are asked for different time horizons: the current calendar year, the next 12 months, and the next 24 months.[2] Moreover, every two months, all surveyed firms must report the magnitude of expected price changes over the next 12 months. Thus, through the survey, we also have information about the expected intensive margin of prices.

Starting in June 2017, firms have also been asked whether and if so when they have changed the price of their main product. 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.

Our data is quite unique in several dimensions. Table 2.1 compares the Uruguayan survey with other common surveys of firms' expectations. The most distinct feature of our survey is the possibility of having quantitative information on inflation expectations *and* idiosyncratic costs for different time horizons paired with data on price decisions with a monthly frequency.

Using the New Zealand survey, the existing literature has found several interesting results regarding the process of how firms form their expectations and the policy implications of such process, see for example Coibion et al. (2018) or Kumar et al. (2015). This survey, however, is not conducted on a regular basis as in Uruguay and does not have periodic information on beliefs about inflation or the firms' own costs together combined with information on their economic decisions. The monthly panel structure of the Uruguayan survey is a relevant feature that we exploit to assess the belief-dependent channel. The Atlanta FED Business Inflation Expectation (BIS) survey also collects information monthly, but it is only representative of six states in the US. Finally, besides being muted about cost expectations, both the UK and the Italian

[2] More details about the survey can be found in Frache and Lluberas (2019).

survey collect only quarterly information about yearly inflation.[3] Another important survey, which has been used extensively for this type of analysis, is the *Ifo Business Climate Survey* in Germany, see Bachmann and Elstner (2015), and Bachmann et al. (2019). However, as in this paper we focus on the quantitative implications of expectations, we prefer to omit this Survey from Table 2.1 due to the qualitative nature of the responses.

Table 2.1: *Common Surveys of Firms' Expectations*

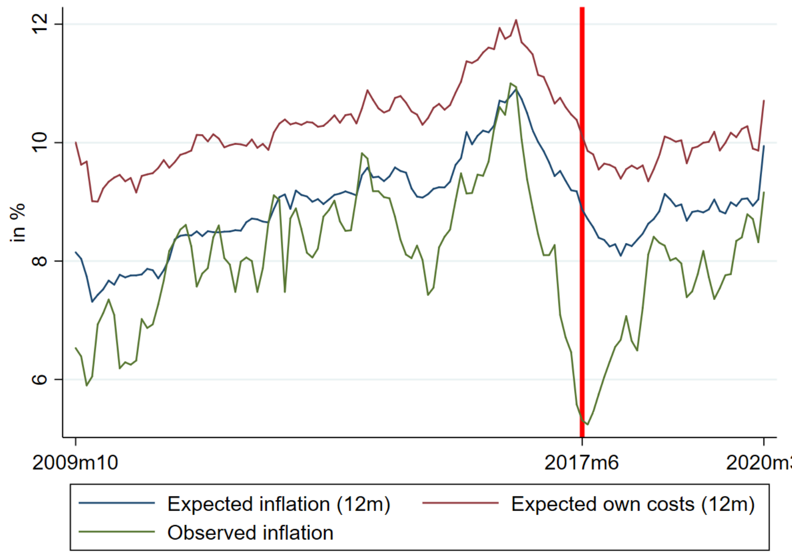
	Uruguay	USA	New Zealand	United Kingdom	Italy
First Survey	2009	2011	1987	2008	1999
Frequency	M	M	Q	Q	Q
Inflation expectations	✓	×	✓	✓	✓
Cost expectations	✓	✓	×	×	×
Forecasted horizon	Year, 12m, 24m	12m	3m, 12m	12m	12m
Bins	Open	5	Open	4	Open
Institution	Central Bank	Atlanta Fed	Central Bank	CBI	Central Bank

Notes: The table compares the main features of different surveys of firms used by the literature. Relative to *Frequency*, M stands for monthly while Q is for quarterly frequency. *Forecasted horizon* stands for the different time horizons for the different expectations asked of in each survey. Finally, Bins represents whether the answers are closed or open ended. In the former case the number of bins is given.

Let us now frame our survey within the Uruguayan context. Figure 2.1 shows the evolution of mean inflation expectations, mean own costs expectations, and observed inflation for the period between October 2009 and March 2020, just when the COVID-19 pandemic started in Uruguay. As mentioned, 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. As the question regarding the extensive margin of price changes is only available since July 2017 (vertical red line in Figure 2.1), our estimations are based on data from the period between June 2017 and March 2020. This period is characterized by a persistent increase in inflation with an average of approximately 8%. From now on, unless mentioned otherwise, the empirical analysis is based on this specific time window. Moreover, while we have forecasts for several horizons, we will focus exclusively on 12 month predictions throughout the paper.

[3]The UK survey has been recently studied by Boneva et al. (2019) while see Coibion et al. (2020) for evidence using the Italian survey.

Figure 2.1: *Mean Inflation and Own Costs Expectations and Observed Inflation*



3 Stylized Facts

In this Section we document relevant stylized facts about firms' expectations for aggregate prices and own costs, as well as their pricing decisions. We also explore firm heterogeneity in terms of size measured by sales. Table 3.1 shows summary statistics for the entire sample and also by firm size. We divide the sample into three groups according to size and categorize firms into small, medium, and large.[4] The size variable is constructed after merging the expectation survey with information from the 2012 "Annual Survey of Economic Activity," which contains 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, thus we use this. Implicitly we are assuming that the distribution of firm sizes does not change substantially over time.

[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.

Table 3.1: *Expectations and Price Changes*

	Small	Medium	Large	All
Expectations				
Inflation expectations (in %)	9.0	8.7	8.5	8.7
Cost expectations (in %)	10.4	9.8	9.2	9.8
Forecast errors (abs. value)	2.5	2.2	2.0	2.2
Proportion of accurate firms (in %)	22.8	28.4	40.6	30.5
Prices				
Proportion of firms changing prices (in %)	10.5	14.3	27.1	17.3
Number of price changes	3.0	4.2	8.2	5.1
Expected price change (in %)	8.2	8.6	7.8	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 %)	8.1	8.1	7.7	8.0

3.1 Stylized Fact 1: Expectations and Firm Size

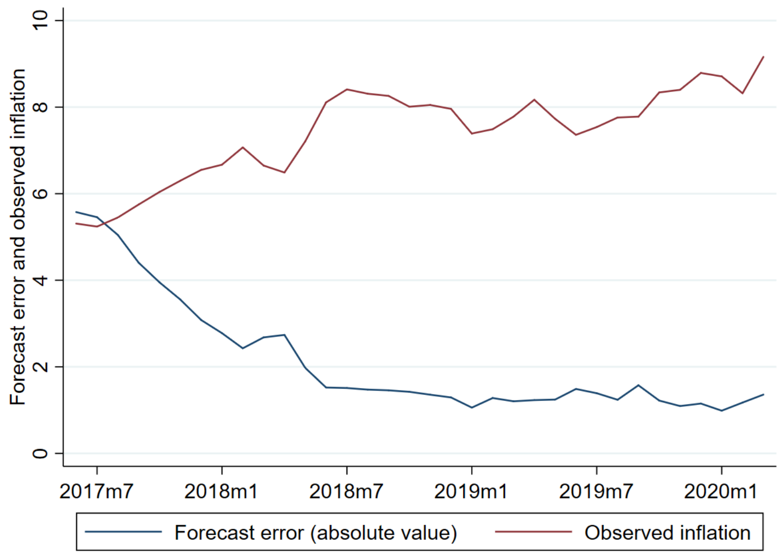
Initially we focus on the average quality of firms' expectations given by their accuracy, i.e. their forecast error, as a function of size. We define the absolute value of forecast error for firm i at time t, as the difference (in absolute value) between its 12-months ahead inflation expectation at time t, $E_{i,t}(\pi_{t+12})$, and the actual inflation during that period π_{t+12}, i.e., $FE^{\pi}_{i,t} = |\pi_{t+12} - E_{i,t}(\pi_{t+12})|$. Note that even though the expectation and the actual inflation refer to the same time period, whilst $E_{i,t}(\pi_{t+12})$ is observed at time t, inflation between t and $t+12$, π_{t+12}, is observed at time $t+12$, once it is realized.

Figure 3.1 shows the average inflation forecast errors across firms for each month of the sample period.[5] Neither the increase in observed inflation between mid-2015 and mid-2016 nor the decline between late 2016 and late 2017 were anticipated by firms (see Figure 2.1), so at the beginning of our estimation sample in June 2017 forecast errors are quite substantial. When inflation starts returning to the historical average of 8%, forecast errors converge to less than 2 percentage points. Although average expectations exhibit some persistence, using the same sample for a more extended period, Frache and Lluberas (2019) show that firms in Uruguay are much better predictors of inflation than surveyed firms in countries with lower inflation such

[5] From a broader perspective, on average, forecast errors are close to zero until 2017 and start to increase thereafter when inflation becomes, momentarily, much more volatile.

as New Zealand, Kumar et al. (2015).

Figure 3.1: *Mean Forecast Error and Observed Inflation*



We also look at accuracy in predicting inflation by firm size. The first block of Table 3.1 shows inflation's absolute-value forecast errors according to firm size together with the average 12-months-ahead inflation and own cost expectations. On average, large firms expect a slightly lower inflation and anticipate a smaller adjustment in their own costs relative to medium and small firms. In addition, it seems that larger firms are better forecasters than medium and small firms. To assess this, we follow Bachmann and Elstner (2015) and run the following regression for each firm i: $FE^{\pi}_{i,t} = \alpha_i + error_{i,t}$. If α_i is statistically not different from zero, we classify that firm as accurate. As shown in Table 3.1, only 30% of the firms in the sample are considered accurate with important differences across firm size. While around 23% of small firms are classified as accurate, this number rises to 28% for medium and 41% for large firms. As shown in the bottom part of Table 3.1, large firms are also generally the oldest ones, 36 years in the industry compared to 30 and 25 years for medium and small firms, respectively. We conjecture that their better accuracy in predicting inflation might be related to their long experience and knowledge of the market.

3.2 Stylized Fact 2: Expectation Volatility

The second stylized fact is related to the firm-level volatility of aggregate and idiosyncratic expectations. As having information about both aggregate and idiosyncratic expectations in these surveys is rare, 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 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. Although cost expectations are, to some extent, a projection of current costs, without specific information about actual costs, it is hard to assess if the variability is a reliable reflection of actual costs. To check this, we construct a firm-specific cost index as described below.

Using the balance-sheet information taken from the 2012 "Annual Survey of Economic Activity," we compute the cost structure for each firm. In particular, we rely on granular information about salaries, inputs, expenses, and goods that are originally bought by each firm and then resold without transformation. To compute the cost structure for each firm, we have information for more than 1,000 inputs that are assigned to a price index. We assign a different price index for each input, but when a suitable index is not available, the general CPI is used. Given that we keep the 2012 cost structure for each firm fixed, the variation of the projected cost will be given by the evolution of input prices. Hence, our cost proxy is constructed by keeping each firm's production scale and thus total production constant. In line with this last point, this index $C_{i,t}$ is later used as a proxy for unobserved cost in Section 4.

We measure cost volatility as the standard deviation of idiosyncratic conditions defined as:

$$Std^{C}_{i,t} = \sqrt{\frac{1}{6}\sum_{j=0}^{5}(C_{i,t-j} - \overline{C}_{i,t-5})^2} \tag{3.1}$$

Where $C_{i,t-j}$ is our *projected* cost index constructed for firm i at time $t-j$ and $\overline{C}(.)$ is the average cost for firm i between t and $t-5$. By computing equation (3.1) through a rolling window, we get a firm level time-series for cost volatility. Without any specific information about firms' costs, the projected cost $C_{i,t}$ is defined as:

$$C_{it} = \sum_{j=1}^{J} PI_{jt} W_{ij2012} \tag{3.2}$$

Where $PI_{j,t}$ 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.

As in (3.1), we define the firm level inflation volatility as:

$$Std_t^{\pi} = \sqrt{\frac{1}{6}\sum_{j=0}^{5}(\pi_{t-j} - \overline{\pi}_{t-5})^2} \tag{3.3}$$

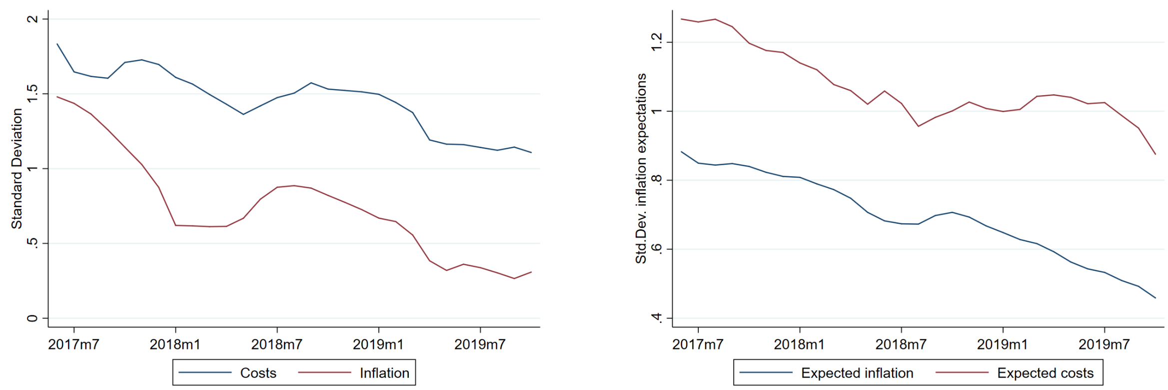
Where π_{t-j} is the inflation rate in Uruguay at time $t-j$ while $\overline{\pi}_{t-5}$ is the average inflation between months t and $t-5$. The time-series for the two volatility measures are shown in Figure 3.2a. For the cost volatility, the figure shows the average of $Std_{i,t}^{C}$ across firms. 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 Figure 3.2b, we compute the same formulas as in (3.1) and (3.3) 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. According to the results, the persistent higher volatility of idiosyncratic conditions relative to inflation, translates into similar patterns for firms' beliefs.

As a second stylized fact, we showed that firms' costs are more volatile than inflation, which is also the case for firms' beliefs about idiosyncratic and aggregate conditions. Figure 3.3a shows the ratio of the average volatility of own costs to inflation, conditioning on the three firm sizes. Idiosyncratic conditions are more variable than inflation for all firm sizes, but the ratio is larger for large firms. A very similar pattern is also found when we look at the volatility in firms' beliefs about idiosyncratic and aggregate conditions, see Figure 3.3b.

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. Figure 3.4a shows the evolution of inflation and the proportion of firms that are changing

Figure 3.2: *Average Volatility of Own Costs and Aggregate Inflation*



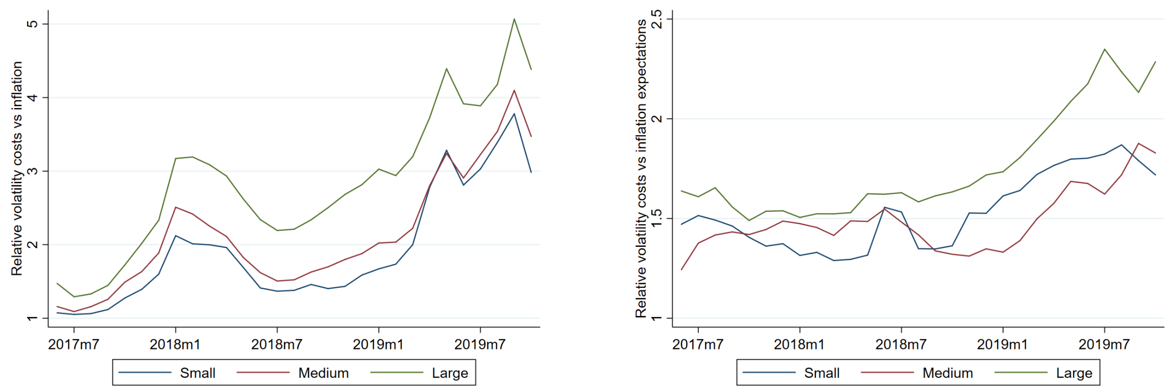
(a) Observed *(b) Beliefs*

their price every month. We notice that there is 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 are concentrated during January and July, 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 3.4b, pricing-adjustment decisions are also heterogeneous across firm sizes as large firms are the ones that are changing prices more frequently.[6]

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, 27% of large firms change their prices every month, but only 14% and 10% of medium and small firms do. Over a 34 month period, on average large firms changed their prices eight times, medium firms changed their prices four times, and small firms 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 information on the expected intensive margin question, we find that large firms anticipate smaller price

[6]Regarding seasonality, Appendix 7.2 shows the proportion of price changes for each month of the year. This is shown for all firms and also conditioning on size.

Figure 3.3: *Relative Dispersion in Own Costs and Inflation by Firm Size*



(a) Observed *(b) Beliefs*

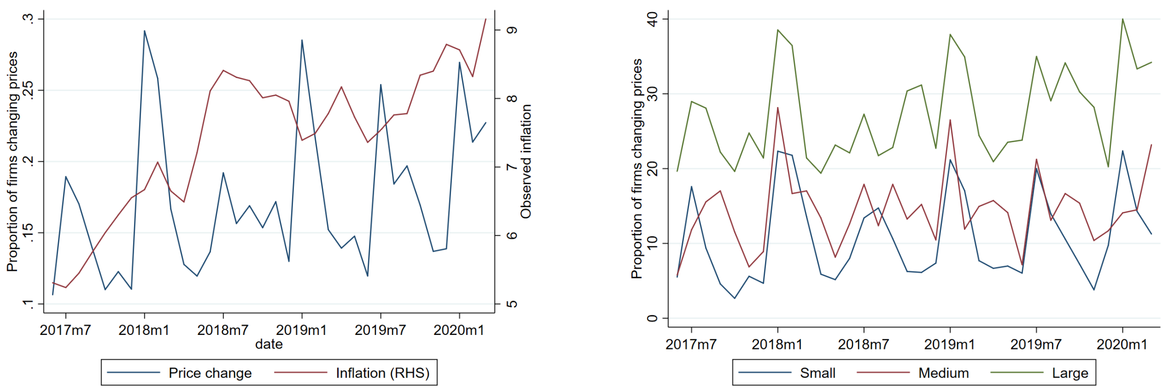
changes compared to medium and small firms. Hence, while large firms are changing prices more frequently, the expected magnitude of revision is smaller compared to the rest of the firms in the sample.

3.4 Stylized Fact 4: Number of Products and Competitors

The last stylized fact is related to the number of products that firms sell and the number of competitors they face in their respective markets. This is shown in the final block of Table 3.1. We notice a clear positive correlation between firm size and the number of products they offer. While small and medium firms sell an average of three products, large firms have five products. Around 55% of small firms sell more than one product, for medium and large ones, the proportion of multi-product firms rises to 75%. Circling back to the accuracy implications, the task of having to constantly price different products could be one of the reasons why large firms are more accurate in predicting inflation. Relying on US data, Bhattarai and Schoenle (2014) shows that the frequency of price changes increases with the number of goods sold by the firm. This evidence is consistent with the Uruguayan data as bigger firms, whose prices are relatively less sticky, are the ones that sell, on average, more products.

Concerning the number of competitors, the relationship between this variable and firm's size exhibits a U-shaped relationship. While small firms report having 37 competitors on average, medium-size firms report

Figure 3.4: *Proportion of Firms Changing Prices (By Month)*



(a) All firms

(b) Sizes

14 competitors. Finally, as expected, large firms report the most competitors with an average of 90.

4 Belief-Dependent Pricing Decisions

This Section introduces the main results about forward-looking pricing at the firm level. We start by describing the empirical baseline specification that we estimate by a linear panel data model.

$$AdjPrice_{it} = \mathbf{x}_{it}\boldsymbol{\beta} + \mu_i + \eta_t + v_{it} \tag{4.1}$$

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 include $\mathbf{x}_{it}$, 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.[7] 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

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

different Taylor dummies in order 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 of this last set of explanatory variables is to capture any state-dependent pattern in price adjustments.

4.1 Belief-Driven Price Adjustments

We next address the effects of both aggregate and idiosyncratic expectations on price-adjustment decisions. Table 4.1 shows the marginal effect of firm's expectations on the probability of price adjustment. Relying on the linear proability model (LPM), we control for firms' fixed effects. Column (1) uses only current expectations about inflation and costs while (2) controls for lagged values of these two expectations to capture potential dynamic belief patterns on adjustment decisions. The two specifications control for time-dependent and state-dependent effects. According to the results, current beliefs do not significantly affect the decision to change prices. However, when we add lagged expectations, we observe that, while inflation expectations do not affect this decision, there is a significant effect of lagged cost expectations. Whenever firms believe their costs would increase in the future, they effectively decide to adjust their prices three months from that moment. If firms expect a 1% increase in their costs, this increases the probability of a price adjustment by approximately 0.6% on average. The magnitude is meaningful as the unconditional probability of a price adjustment was approximately 17% as discussed in Section 3.3. The effect of beliefs on actions, however, operates with a delay of three months.

Table 4.1: ***Probability of Price Adjustments***

	(1)	(2)	(3)	(4)
$E_{it}(\pi_{12m})$	-0.0008	0.0009	0.0019	-0.0008
	(0.0049)	(0.0054)	(0.0067)	(0.0055)
$E_{it-1}(\pi_{12m})$		0.0020	0.0041	0.0004
		(0.0050)	(0.0062)	(0.0051)
$E_{it-2}(\pi_{12m})$		-0.0038	-0.0030	-0.0047
		(0.0044)	(0.0050)	(0.0043)
$E_{it-3}(\pi_{12m})$		-0.0012	-0.0033	-0.0021
		(0.0054)	(0.0057)	(0.0055)
$E_{it-4}(\pi_{12m})$		-0.0012	-0.0017	-0.0025
		(0.0058)	(0.0056)	(0.0056)
$E_{it}(C_{12m})$	0.0014	-0.0036	-0.0020	-0.0043
	(0.0029)	(0.0040)	(0.0048)	(0.0041)
$E_{it-1}(C_{12m})$		0.0028	0.0029	0.0028
		(0.0024)	(0.0031)	(0.0025)
$E_{it-2}(C_{12m})$		0.0014	0.0028	0.0019
		(0.0024)	(0.0025)	(0.0024)
$E_{it-3}(C_{12m})$		0.0059**	0.0047*	0.0060**
		(0.0024)	(0.0027)	(0.0025)
$E_{it-4}(C_{12m})$		0.0029	0.0015	0.0030
		(0.0028)	(0.0029)	(0.0030)
Cost index proxy	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Taylor Dummies	✓	✓	×	✓
Time FE	✓	✓	✓	×
R^2	0.1511	0.1506	0.0276	0.1374
Observations	8,553	7,553	7,553	7,553

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.

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. In particular, Coibion et al. (2018) shows that firms' fixed-effects capture a significant part of the variability of the one year ahead expectations of inflation. To address this potential concern, we 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 two 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.

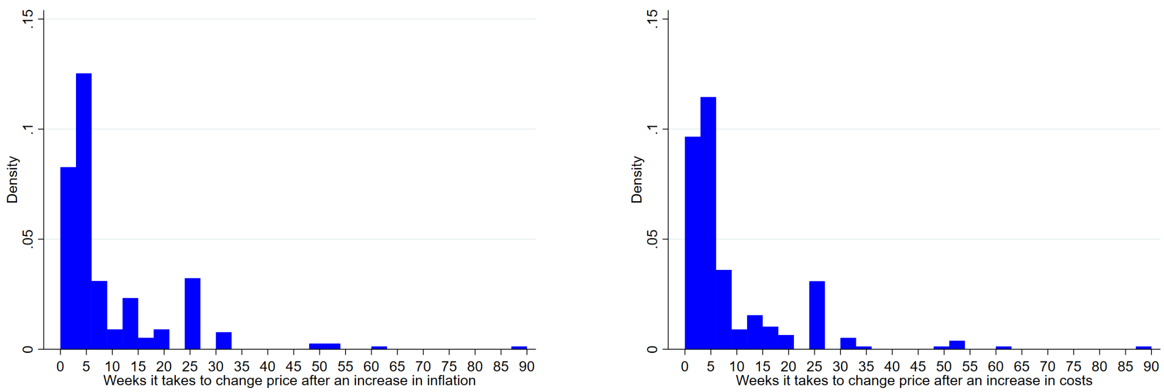
To stress the importance of time- and state-dependent channels, in column (3) we repeat the previous specification but remove the Taylor dummies, while in (4) we remove the state-dependent controls instead. Consistent with Lein (2010), the overall fit of the model decreases when we omit either of these two. In particular, the worsening of the R^2 coefficient in (3) supports time-dependent rules being a central component behind firms' price-adjustment decisions. 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 price-adjustment decisions.

As discussed, in the specifications we use the constructed $C_{i,t}$ variable as an additional covariate. As our proposed cost measure is not flawless, it could raise concerns about its validity to capture the unobserved costs at the firm level. In Appendix 7.3 we discuss further evidence to support our measure as a valid proxy of actual costs. For further robustness, we also compute our baseline estimation with a two-way cluster-robust standard error at the firm and month level, along with adding fixed-effects interactions between sectors and time. Our results are robust to all these alternative specifications. This is shown in Table 7.4 in Appendix 7.5.

Given the dynamic effect of idiosyncratic expectations, we decided to actively collect further evidence to further test this result. In June 2019, besides the regular questions, we added two additional questions to the survey. Specifically, we asked the following questions: *"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 number of weeks. Our goal was to get a clearer insight into how quickly firms can effectively adjust their prices without explicitly referring to the expectation channel. The results of these additional questions are presented in Figure 4.1.

The majority of the surveyed firms responded that a price adjustment will happen approximately 11 (10.5) weeks following a change in inflation (costs). The delayed effect of costs on prices speaks directly

Figure 4.1: *Sluggish Price Adjustments (added questions)*



Inflation *Costs*

Notes: The figure shows the results of special, one-time, questions added to the survey. The left figure shows the histogram of the number of weeks that it takes a firm to change prices after an increase in inflation, while the right figure shows the same but after an increase in costs. Firms' answers were specifically the number of weeks they need to effectively change prices.

to 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. 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. As firms report their expectations for the next 12 months, the significant reaction suggests that the expected cost adjustment can be interpreted as permanent. Hence, while leveraging short-run dynamics, a forward-looking firm facing price rigidities will choose to adjust its prices in the near future. Adding our cost measure into the estimations is important to control for the fact that the delayed reaction of cost expectations could be driven by an actual change in firms' marginal costs.

Through the muted current and lagged reactions of price revisions to inflation expectations, we anticipate that the probability of price changes is roughly similar during periods of low and high inflation. Midrigan (2011) highlights the critical role that large idiosyncratic shocks play to rationalize price adjustments. Our results extend these findings, not only showing the relevance of idiosyncratic relative to aggregate expectations, but also by showing that *beliefs* about inflation do not affect the degree of price stickiness. Hence, the results support the implications of the non-neutrality of monetary policy in the short run.

While the forward-looking behavior and the delayed price-adjustment dynamics underscore the importance of price rigidities, we are not able to detangle the potential reasons behind the different response to inflation relative to cost expectations. Particularly, as discussed in Section 2, in a country like Uruguay where inflation has been persistently high over time. However, as shown in Figures 3.2 and 3.3, the cost volatility is persistently larger than the inflation one. The results are also consistent with Maćkowiak and Wiederholt (2009) that argues that a rationally inattentive price-setter will decide to dedicate most of his limited attention to learning about the idiosyncratic (and more volatile) shocks, at the expense of dedicating less attention towards any aggregate shocks, before setting prices.

Our results support the concurrent presence of both rigidities – prices and information – as relevant constraints that firms face when deciding whether to change their prices or not.[8]

4.2 Expected Intensive Margin

Besides providing the information about the extensive margin of price adjustments, historically the survey has also asked about the expected magnitude of price adjustments over the next 12 months. Firms must 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. This information is collected every two months. We label this as the internal price expectation. Then we can contrast our findings for the price-adjustment decision with specific quantitative information about the expected intensive margin of prices at the firm level. To explore the potential effects of current and lagged beliefs on the expected magnitude of price changes, we adjust model (4.1) and estimate:

$$E(\Delta p_{it+12}) = \mathbf{x}_{it}\boldsymbol{\beta} + \mu_i + \eta_t + \varepsilon_{it} \tag{4.2}$$

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. The specification is similar to model (4.1), as we rely on the same set of explanatory variables, industries, firm fixed effects and state-dependent variables. Besides the internal price, surveyed

[8]Besides the LPM model, in previous versions of this paper, we also computed a correlated random effects probit model as an alternative specification which allows us to control for firm's fixed effects. All the described results remain under this model and are available upon request.

firms that export their main product are also asked to predict the intensive margin of their main product in the next 12 months for their external market. Therefore we also run a different version of the model using the information about the external price expectation. Table 4.2 shows the results of model (4.2) for the domestic and the external markets.

Related to internal prices, *current* expectations for both inflation and costs positively affect the expected magnitude of future price revisions. However, there is no evidence of a delay when it comes to the effect of beliefs. The different timings of expectations affecting firms' decisions (model (4.1)) compared to the impact on firms' beliefs (model (4.2)), can be interpreted as further evidence supporting the presence of price rigidities at the firm level which prevents a more immediate adjustment.

While only cost expectations affect the actual decision to adjust prices, both aggregate and idiosyncratic expectations play an important role in determining the expected magnitude of price adjustments once the decision to revise prices has been made. However, the current cost expectation is more relevant as its marginal effect is more than twice that for the expectations of inflation.

Table 4.2: ***Expected Intensive Margin***

	Internal Prices		**External Prices**	
$E_{it}(\pi_{12m})$	0.2059***	0.2034***	-0.0943	0.0764
	(0.0612)	(0.0544)	(0.1082)	(0.1082)
$E_{it-1}(\pi_{12m})$		0.0511		-0.1422*
		(0.0507)		(0.0786)
$E_{it-2}(\pi_{12m})$		-0.0069		-0.0888
		(0.0459)		(0.0792)
$E_{it-3}(\pi_{12m})$		-0.0216		-0.0083
		(0.0386)		(0.0930)
$E_{it-4}(\pi_{12m})$		-0.0339		-0.0782
		(0.0381)		(0.0766)
$E_{it}(C_{12m})$	0.5328***	0.4792***	0.4219***	0.2679***
	(0.0511)	(0.0468)	(0.0857)	(0.0427)
$E_{it-1}(C_{12m})$		0.0077		0.1391**
		(0.0315)		(0.0575)
$E_{it-2}(C_{12m})$		0.0370		0.0695***
		(0.0241)		(0.0262)
$E_{it-3}(C_{12m})$		0.0281		0.0416
		(0.0222)		(0.0298)
$E_{it-4}(C_{12m})$		-0.0081		-0.0379
		(0.0275)		(0.0289)
Cost Index Proxy	✓	✓	✓	✓
Taylor Dummies	✓	✓	✓	✓
Firms FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Years FE	✓	✓	✓	✓
Observations	18,417	14,322	7,390	5,829

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 columns (3)-(4) for external ones. Columns (1) and (3) only use current inflation and cost expectations, and columns (2)-(4) include up to four lags of those variables. All specifications include a time t and four lags of a cost index proxy at the firm level, firm, month and year fixed effects (constants not reported); and a set of Taylor dummy variables which control for time-dependent price adjustments (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.

Our results complement the main findings of Andrade et al. (2020) on the determinants of expected price changes at the firm level. Using a French survey of firms, Andrade et al. (2020) 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 adjustment in expectations are muted and delayed after an aggregate shock takes place. In line with these findings, the results of model (4.2) suggest that expected prices also respond to aggregate and idiosyncratic beliefs besides shocks. As mentioned, following Rational Inattention models of price setting, as total attention is scarce, firms should choose to allocate more their limited attention towards more volatile variables. Through the same rationale and consistent with the results in Section 3.2, we can explain the relative higher effect of cost expectations relative to inflation in determining the expected magnitude of price changes. The results of Andrade et al. (2020) are also interpreted through the lens of Rationally Inattentive price setters, which confirms our results.

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. In terms of expectations, only the internal cost is significant for expected price increases in external markets. This result reinforces the rationale behind our belief-dependent channel where firms can distinguish between the potential irrelevance of the aggregate expected growth rate of internal prices to further explain the future path of prices set to foreign customers.

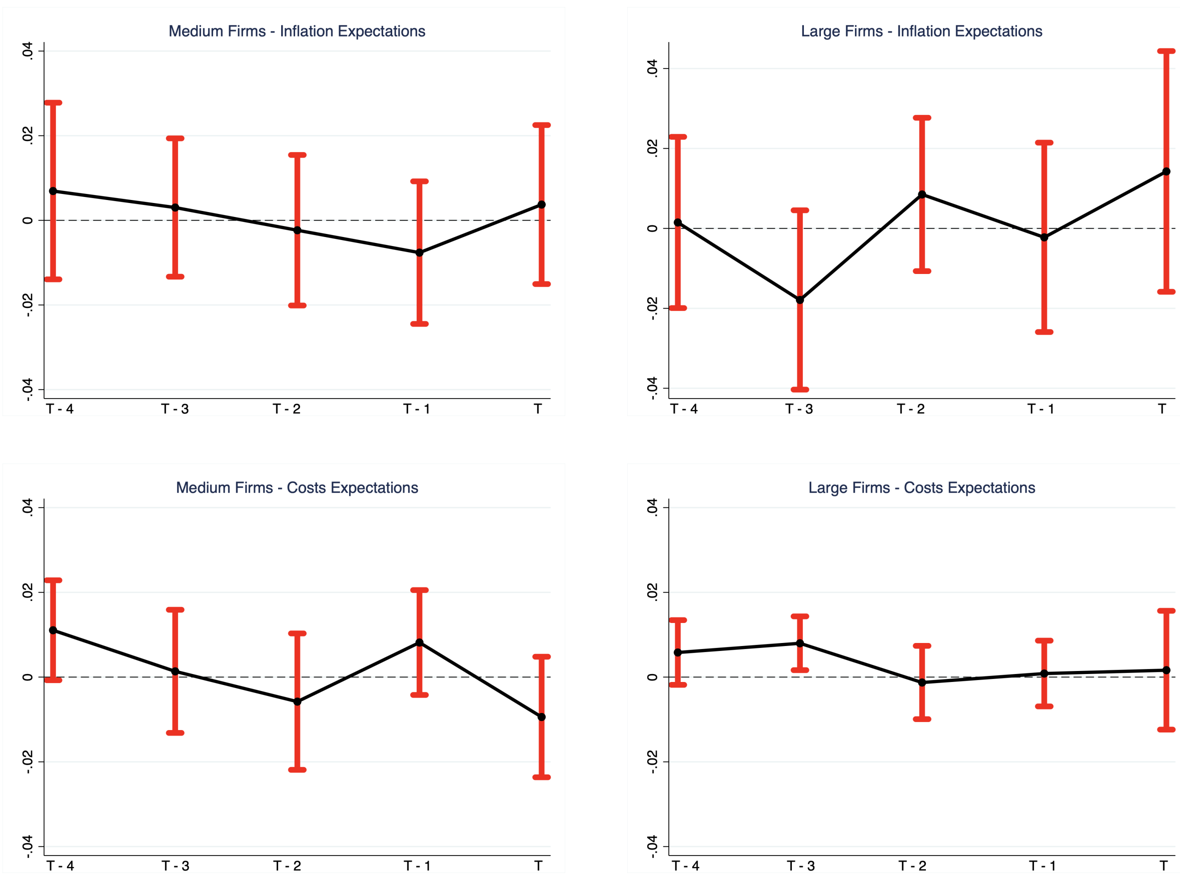
5 On the Heterogeneity of Belief-Driven Price Adjustments

We further explore the delayed effect of cost expectations by studying potential sources of ex-ante heterogeneity that could explain this effect. For this purpose, we interact the current and lagged values of the inflation and cost expectations with firm's time-invariant characteristics. 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 dummy variable that accounts for whether the firm has to price one or more products. We explore each possibility while controlling for the rest of the explanatory variables as in our baseline model.

5.1 Firm Size

The three time-invariant categories for firm size are interacted with the current and lagged values of the two expectations. With the interactions, the baseline model is estimated again, with small firms as the omitted category. The remaining explanatory variables are the same as in the baseline specification. The marginal effects and the confidence intervals for medium and large firms, separated between aggregate and idiosyncratic expectations, are in Figure 5.1.

Figure 5.1: *Marginal Effects: Firm Sizes and Expectations*



Notes: These figures show the marginal effects of both inflation and cost expectations on the probability of price adjustments conditioning on firm size. The first row shows the estimated coefficients (dots) along with their confidence intervals (lines) for inflation expectations while the second row is the results for cost expectations. The results for medium size firms are shown in the first column while the marginal effects for large firms are presented in the second column.

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 seem to play a significant role for medium firms, large firms are driving the forward-looking pricing behavior. The marginal probability of adjusting prices significantly increases by an average of 0.81% after a 1% revision in cost expectations for large firms. As in the baseline scenario, the effect is again delayed. While all types of firms face frictions in the price-adjustment process, the evidence of forward-looking behavior holds only across large firms. As discussed regarding the life cycle of a firm, large firms are generally older. Due to their larger scale and longer experience, and as shown in Section 3, their predictions about inflation are more accurate compared to small and medium sized firms. Despite not having a precise measure of firms' costs, we conjecture that this relatively higher accuracy can be extrapolated to cost expectations as well. The superior accuracy will push this group of firms to rely more on their expectations and behave in a forward-looking fashion.

In Section 7.6 of the Appendix, we present the specific estimated coefficients and alternative versions of the model where we again shut down the time and state-dependent channels.[9]

5.2 Number of Competitors

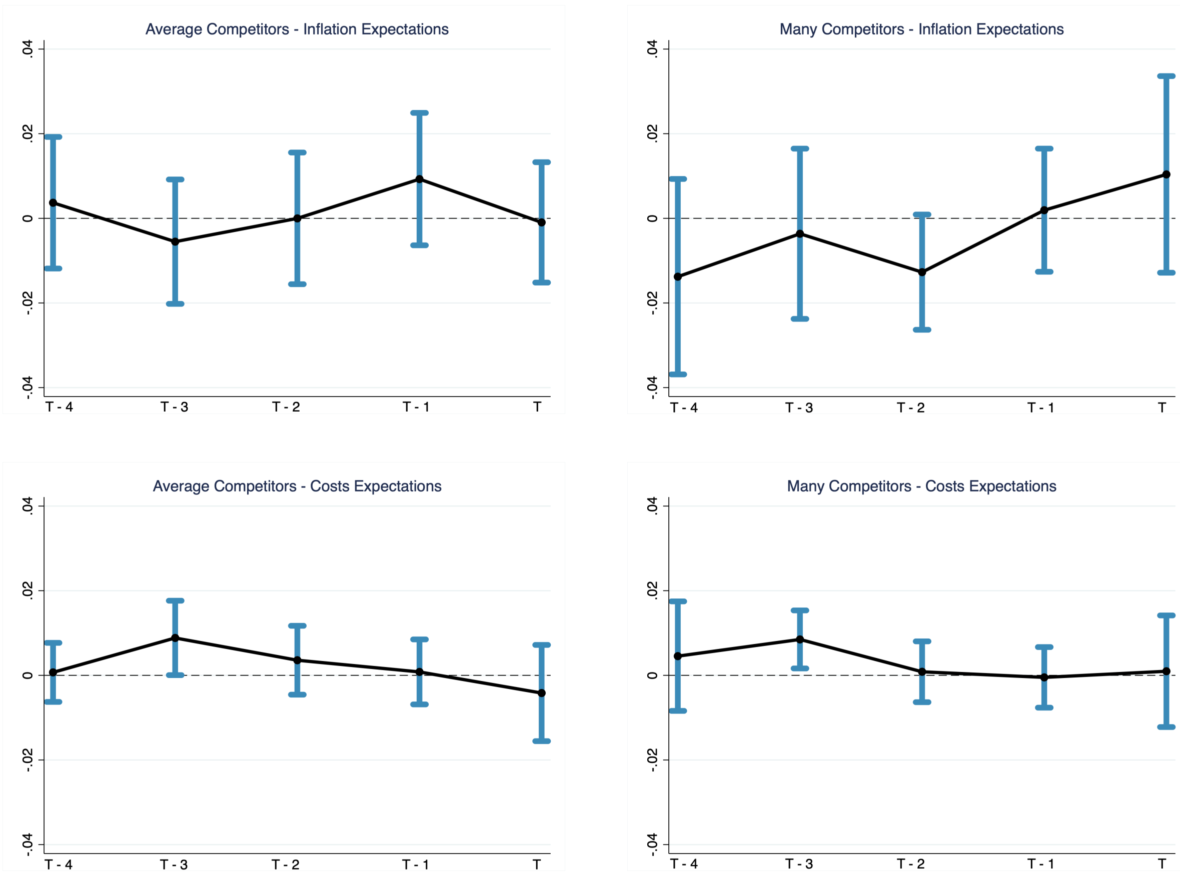
In a similar spirit as the previous exercise, we now split the sample based on the number of direct competitors reported by each firm. Using quantiles we ended up with three categories: "few" (< 5) , "average" (between 5 and 10), and "many" (> 10) competitors. We interact these categories with the expectations,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

Facing a large number of competitors correlates with the presence of forward-looking behavior. As before, the effect only exists for cost not 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 the existence of strategic complementarities among Uruguayan firms, though at a lower degree than firms in New Zealand reported by Afrouzi (2019). 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 given competitors. The complexity in the coordination task becomes more complex as the number of competitors increases, which further contributes to the adjustment delay.[10]

[9] We also try with alternative measures, such as production costs and total costs, to define the size of firms and the results are quantitatively similar.

[10] Kano (2006) 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 a monopolistically competitive framework. Strategic interaction among different brands in the oligopolistic version could distort the estimations of menu costs and, with this, the implications for price

Figure 5.2: *Marginal Effects: Number of Competitors*



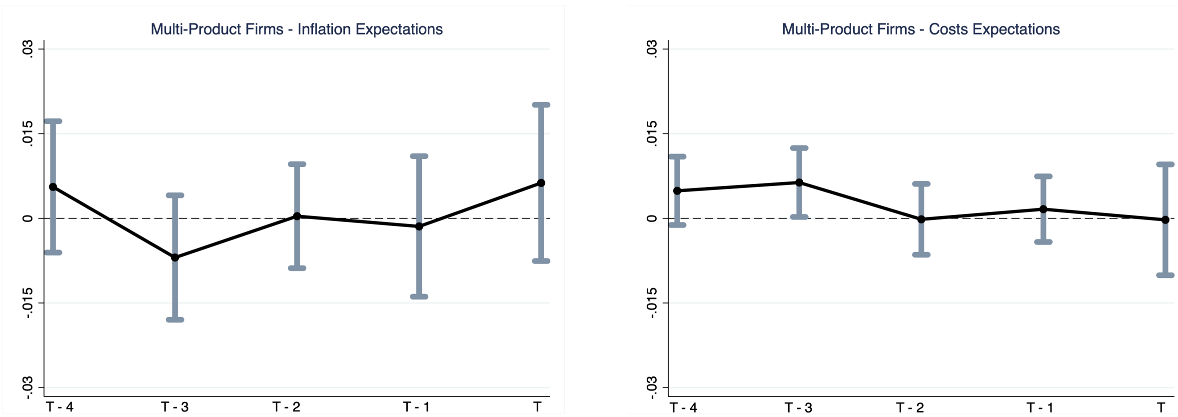
5.3 Multi-Product Firms

In the case of multi-product firms, we define a dummy variable to identify firms that sell more than one product. As before, the dummy variable is interacted with both inflation and cost expectations. The estimated coefficients are reported in Figures 5.3. As in all the previous cases, we keep the same set of explanatory variables while controlling for time-invariant characteristics.

According to the results, lagged cost expectations for multi-product firms positively and significantly affect the probability of price adjustments. In line with the empirical evidence, price changes tend to be synchronized across firms that sold several products, Lach and Tsiddon (1996). As the costs of adjusting prices can rise exponentially with the number of products produced, this type of firm has further incentives to

rigidity.

Figure 5.3: *Marginal Effects: Multi-Product Firms*



Notes: These figures show the marginal effects of both inflation and cost expectations on the probability of price adjustments conditioning on firm selling more than one product. The figure shows the estimated coefficients (dots) along with their confidence intervals (lines) for inflation and cost expectations.

behave in a forward-looking fashion consistent with our results. In addition, the fact that the probability of price adjustment is higher across multi-product firms is also consistent with other surveys of firm expectations such as Yang (2019) who finds similar results based on pricing information from firms in New Zealand.

6 Conclusion

We assess the role of aggregate and idiosyncratic expectations on firms' price-adjustment decisions. Our results suggest that besides time-dependent and state-dependent pricing rules, decision on price adjustments are also affected by firms' beliefs. According to our results, cost expectations affect pricing decisions after a few month 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 as Uruguay, calls for further attention. Our findings of a different reaction towards costs relative to inflation is also consistent with theories on 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 aimed to provide further empirical evidence on forward-looking pricing. In particular, we try to understand the degree to which 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.

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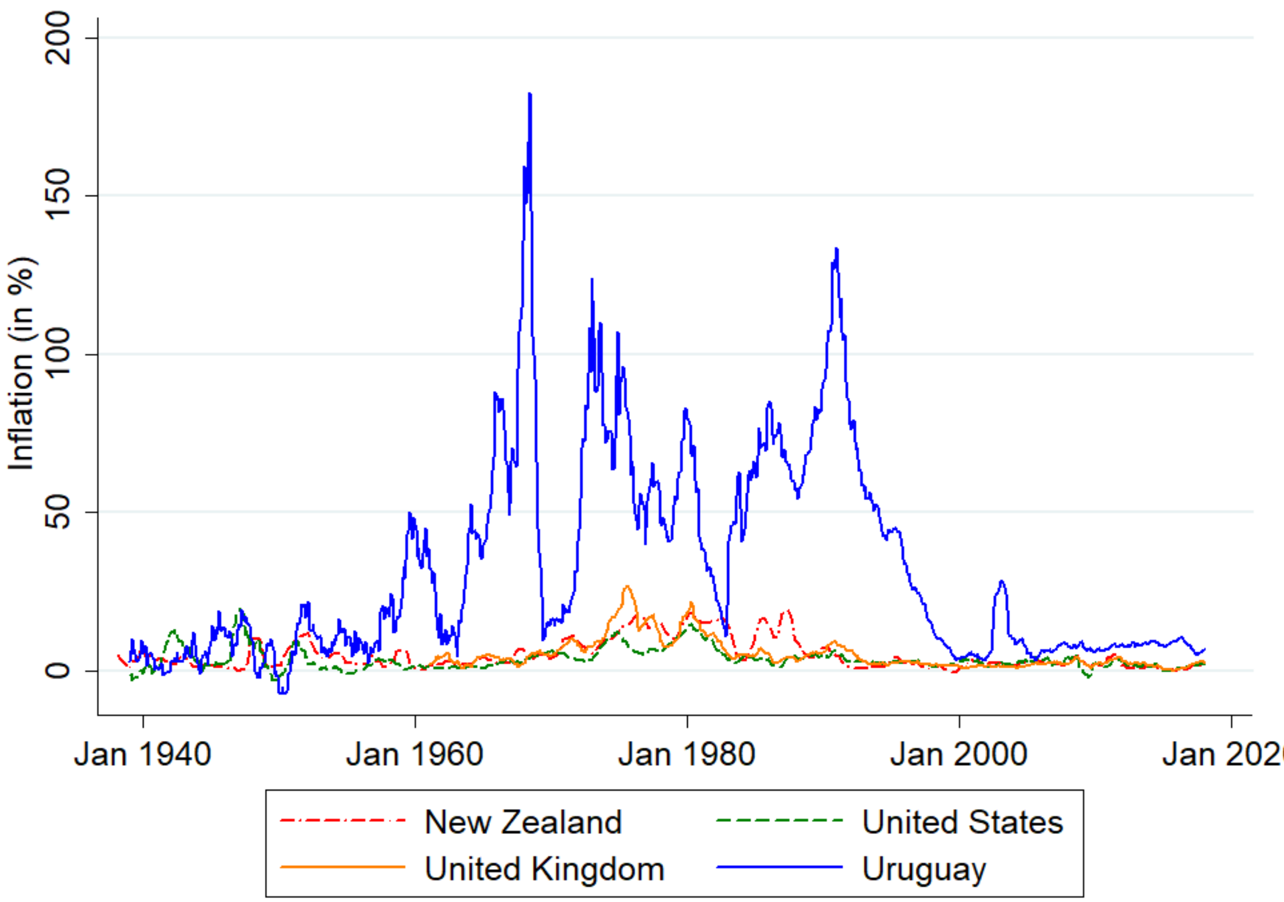
7 Appendix

7.1 Inflation in Uruguay

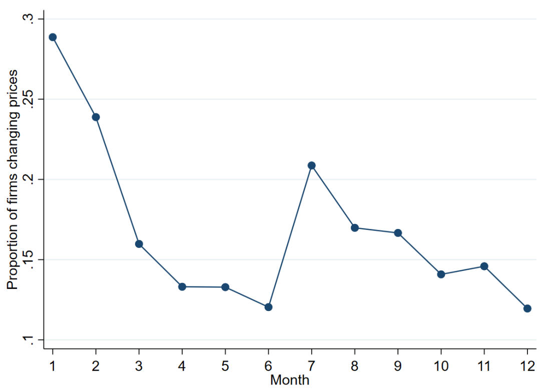
Figure 7.1: *Inflation in Uruguay and Other Selected Countries*



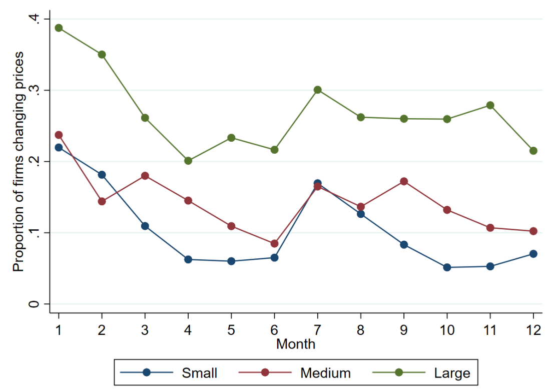
7.2 Seasonality by Firm Size

The average proportion of firms changing prices over the sample period masks large heterogeneity in seasonality in pricing decisions. As shown in Figure 7.2a, firms are more likely to change their prices in January, February, and July. About 30% of the firms change their prices in January, 25% in February, and just below 20% in July. Meanwhile, just above 10% of the firms change their prices between April and June and in December each year. Seasonality patterns in price adjustment decisions are not new and have been studied by previous literature, Nakamura and Steinsson (2008). The heterogeneity in pricing decisions across firm sizes is also present when we look at the seasonality of price changes, Figure 7.2b. These results confirm that there is high seasonality in price adjustment in Uruguay.

Figure 7.2: *Proportion of Firms Changing Prices (by Month)*



(a) All firms



(b) Sizes

7.3 Validity of Cost Proxy

A potential concern is the validity of our measure of costs, introduced in section 3.2, to resemble unobserved costs at the firm level. The underlying survey data used to compute the cost structure in 2012 for each firm was carried out by the National Statistical Institute of Uruguay. Moreover, it is used as the basis to update the base year for the National Accounts. If the measure of actual costs is not accurate, this could raise concerns that the effect captured by cost expectations on price changes is actually reflecting the effect of an increase in total costs.

To check the validity of our measure of costs, we show that: (1) it is positively and significantly correlated with expected costs, (2) the measure is also positively correlated with observed inflation, and (3) that there is a positive correlation between the forecast errors of inflation and costs. The results of these analyses are summarized in Table 7.1 below.

Table 7.1: *Correlation of costs*

	Dependent variable				
	(1)	(2)	(3)	(4)	(5)
	$C_{i,t+12}$	$C_{i,t+12}$	$C_{i,t+12}$	$FE^{C}_{i,t}$	π_{t+12}
$E_{i,t}(C_{i,t+12})$	0.0929**		0.0657**		
	(0.026)		(0.023)		
π_{t+12}		0.975**	0.969**		
		(0.087)	(0.086)		
$FE^{\pi}_{i,t}$				0.931**	
				(0.052)	
$E_{i,t}(\pi_{t+12})$					0.200**
					(0.030)
No. Obs	9,267	9,267	9,267	8,502	9,267
Firm FE	✓	✓	✓	✓	✓

Notes: This table reports panel fixed effects OLS estimates. The table reports, in parentheses, robust and clustered (by firm) standard errors. **, and * indicate statistical significance at the 5% and 10% level, respectively.

First, if our cost proxy captures actual costs, it should be positive correlated with costs expectations. Column (1) in Table 7.1 shows the β coefficient after running the following regression:

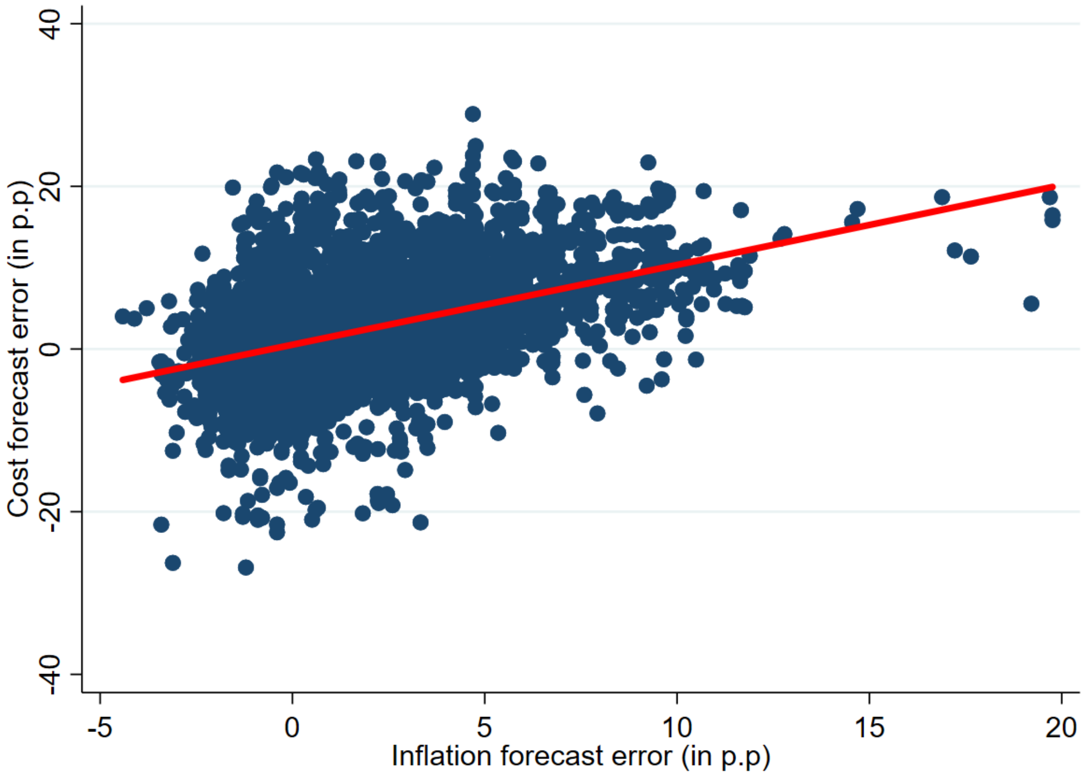
$$C_{i,t+12} = \alpha_i + \beta E_{i,t}(C_{i,t+12}) + \epsilon_{i,t}$$

Where α_i controls for firm fixed-effects and the rest of the variables are defined as in the main text. The coefficient on expected cost is positive and significantly different from zero, suggesting a positive correlation at the firm level between cost expectations and our measure. Similar results are found if we run that same regression but for inflation and expected inflation instead of costs. This is presented in Column (5).

Secondly, as shown in column (2) and column (3) of Table 7.1, our cost proxy is also positively correlated with observed inflation.

Finally, Figure 7.3 shows a scatter plot of $FE^{\pi}_{i,t} = \pi_{t+12} - E_{i,t}(\pi_{t+12})$ against $FE^{C}_{i,t} = C_{i,t+12} - E_{i,t}(C_{i,t+12})$ and the corresponding fitting line, where $C_{i,t+12}$ is our proxy measure of actual costs. The correlation between inflation and costs forecast errors is positive and significant. We arrive to the same conclusion after controlling for firms' fixed effects, column (4) Table 7.1).

Figure 7.3: *Inflation and costs forecast errors*



Thus, albeit imperfect, we can claim that our constructed proxy of costs using granular firm-level data can be interpreted as a valid proxy for actual costs.

7.4 Probability of Price Adjustments: Full Table

Table 7.2: ***Probability of Price Adjustments: All Effects***

	(1)	(2)	(3)	(4)
$E_{it}(\pi_{12m})$	-0.0008	0.0009	0.0019	-0.0008
	(0.0049)	(0.0054)	(0.0067)	(0.0055)
$E_{it-1}(\pi_{12m})$		0.0020	0.0041	0.0004
		(0.0050)	(0.0062)	(0.0051)
$E_{it-2}(\pi_{12m})$		-0.0039	-0.0030	-0.0047
		(0.0044)	(0.0050)	(0.0043)
$E_{it-3}(\pi_{12m})$		-0.0012	-0.0033	-0.0021
		(0.0054)	(0.0057)	(0.0055)
$E_{it-4}(\pi_{12m})$		-0.0012	-0.0017	-0.0025
		(0.0058)	(0.0056)	(0.0058)
$E_{it}(C_{12m})$	0.0014	-0.0036	-0.0020	-0.0043
	(0.0029)	(0.0040)	(0.0048)	(0.0041)
$E_{it-1}(C_{12m})$		0.0028	0.0029	0.0028
		(0.0024)	(0.0031)	(0.0025)
$E_{it-2}(C_{12m})$		0.0014	0.0028	0.0019
		(0.0024)	(0.0025)	(0.0024)
$E_{it-3}(C_{12m})$		0.0059**	0.0047*	0.0060**
		(0.0024)	(0.0027)	(0.0025)
$E_{it-4}(C_{12m})$		0.0029	0.0015	0.0030
		(0.0028)	(0.0029)	(0.0030)
$CostsProxy_{it}$	0.0020	0.0028	0.0050*	0.0030
	(0.0019)	(0.0026)	(0.0026)	(0.0025)
$CostsProxy_{it-1}$		0.0021	-0.0005	0.0010
		(0.0032)	(0.0034)	(0.0031)
$CostsProxy_{it-2}$		-0.0057*	-0.0054*	-0.0077**
		(0.0030)	(0.0032)	(0.0030)
$CostsProxy_{it-3}$		0.0006	0.0001	0.0041
		(0.0033)	(0.0036)	(0.0035)
$CostsProxy_{it-4}$		0.0017	0.0033	0.0012
		(0.0032)	(0.0032)	(0.0031)
$Inflation_t$	0.0098	0.0090	-0.0010	0.0028
	(0.0103)	(0.0108)	(0.0112)	(0.0091)
$Inflation_{t-1}$	-0.0209**	-0.0127	-0.0094	0.0182*
	(0.0091)	(0.0100)	(0.0101)	(0.0096)
$Taylor_{1,it}$	-0.2215***	-0.2313***		-0.2268***
	(0.0203)	(0.0223)		(0.0222)
$Taylor_{2,it}$	-0.2402***	-0.2393***		-0.2435***
	(0.0148)	(0.0156)		(0.0158)
$Taylor_{3,it}$	-0.2148***	-0.2133***		-0.2211***
	(0.0133)	(0.0140)		(0.0143)
$Taylor_{4,it}$	-0.2075***	-0.2037***		-0.2095***
	(0.0129)	(0.0137)		(0.0140)
$Taylor_{5,it}$	-0.1935***	-0.1892***		-0.1954***
	(0.0127)	(0.0135)		(0.0139)
$Taylor_{6,it}$	-0.1358***	-0.1297***		-0.1244***
	(0.0150)	(0.0164)		(0.0166)
$Taylor_{7,it}$	-0.1177***	-0.1170***		-0.1167***
	(0.0242)	(0.0244)		(0.0242)

Table 7.3: ***Probability of Price Adjustments: All Effects (continuation)***

	(1)	(2)	(3)	(4)
$Taylor_{8,it}$	-0.1381***	-0.1377***		-0.1380***
	(0.0219)	(0.0218)		(0.0219)
$Taylor_{9,it}$	-0.1196***	-0.1182***		-0.1259***
	(0.0241)	(0.0243)		(0.0240)
$Taylor_{10,it}$	-0.1388***	-0.1370***		-0.1418***
	(0.0246)	(0.0244)		(0.0243)
$Taylor_{11,it}$	-0.0857***	-0.0846***		-0.0834**
	(0.0312)	(0.0312)		(0.0316)
$Taylor_{12,it}$	0.0300	0.0329		0.0444
	(0.0426)	(0.0427)		(0.0428)
Month_1	0.1071***	0.1100***	0.1392***	
	(0.0198)	(0.0202)	(0.0238)	
Month_2	0.0676***	0.0735***	0.0852***	
	(0.0174)	(0.0181)	(0.0195)	
Month_3	0.0434***	0.0479***	0.0374**	
	(0.0143)	(0.0152)	(0.0165)	
Month_4	0.0143	0.0222	-0.0007	
	(0.0136)	(0.0151)	(0.0163)	
Month_5	0.0155	0.0231*	0.0033	
	(0.0123)	(0.0137)	(0.0142)	
Month_7	0.06980***	0.0700***	0.0861***	
	(0.0146)	(0.0157)	(0.0184)	
Month_8	0.0435***	0.0550***	0.0637***	
	(0.0131)	(0.0137)	(0.0149)	
Month_9	0.0532***	0.0600***	0.0559***	
	(0.0135)	(0.0145)	(0.0158)	
Month_{10}	0.0259*	0.0328**	0.0263*	
	(0.0132)	(0.0137)	(0.0151)	
Month_{11}	0.0337**	0.0391***	0.0287**	
	(0.0135)	(0.0141)	(0.0146)	
Month_{12}	0.0181	0.0201	0.0134	
	(0.0140)	(0.0149)	(0.0153)	
Sector FE	✓	✓	✓	✓
Taylor Dummies	✓	✓	×	✓
Month FE	✓	✓	✓	×
Years FE	✓	✓	✓	×
R^2	0.1511	0.1506	0.0276	0.1374
Observations	8,553	7,553	7,553	7,553

Notes: This table reports panel fixed-effects OLS estimates associating aggregate and idiosyncratic expectations with 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) only uses current inflation and cost expectations, and column (2) include 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 at time t and four lags of a cost index proxy at a firm level. The table reports, in parentheses, robust and clustered (by firm) standard errors. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

7.5 Baseline Especification Robustness

Table 7.4: *Baseline Especification Robustness*

	Probablity of Price Adjustments			
	(1)	(2)	(3)	(4)
$E_{i,t-3}(C_{i,t+12})$	0.0059	0.0059	0.0055	0.0055
Std. Dev.	(0.0024)	(0.0026)	(0.0030)	(0.0033)
p-value	0.015	0.024	0.066	0.093
Firm FE	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Month-Sector FE			✓	✓
Year-Sector FE			✓	✓
Clustered errors at firm level	✓		✓	
Clustered errors at firm-month level		✓		✓
No. Obs	7,553	7,553	7,443	7,443

Notes: This table reports panel fixed effects OLS estimates. The table exhibits, in parentheses, cluster-robust at different levels standard errors.

7.6 Probability of Price Adjustments: Sizes

Table 7.5: ***Marginal Effects: Sizes***

	Medium (1)	Large (2)	Medium (3)	Large (4)	Medium (5)	Large (6)
$E_{it}(Inf_{12m})$	0.0030	0.0132	-0.0038	0.0217	-0.0002	0.0137
	(0.0094)	(0.0153)	(0.0109)	(0.0183)	(0.0093)	(0.0155)
$E_{it-1}(Inf_{12m})$	-0.0066	-0.0031	-0.0086	-0.0020	-0.0080	-0.0072
	(0.0085)	(0.0119)	(0.0098)	(0.0144)	(0.0084)	(0.0121)
$E_{it-2}(Inf_{12m})$	-0.0033	0.0090	-0.0004	0.0073	-0.0034	0.0078
	(0.0090)	(0.0096)	(0.0107)	(0.0098)	(0.0088)	(0.0095)
$E_{it-3}(Inf_{12m})$	0.0016	-0.0155	0.0007	-0.0151	0.0023	-0.0178
	(.0084)	(0.0112)	(0.0092)	(0.0126)	(0.0089)	(0.0112)
$E_{it-4}(Inf_{12m})$	0.0084	0.0017	0.0077	0.0023	0.0060	0.0005
	(0.0105)	(0.0109)	(0.0097)	(0.0114)	(0.0109)	(0.0107)
$E_{it}(Costs_{12m})$	-0.0078	0.0020	-0.0008	0.0018	-0.0080	0.0013
	(0.0072)	(0.0072)	(0.0082)	(0.0081)	(0.0073)	(0.0075)
$E_{it-1}(Costs_{12m})$	0.0080	0.0006	0.0133*	-0.0023	0.0080	0.0013
	(0.0061)	(0.0039)	(0.0070)	(0.0043)	(0.0062)	(0.0041)
$E_{it-2}(Costs_{12m})$	-0.0051	-0.0016	-0.0062	0.0013	-0.0054	-0.0009
	(0.0080)	(0.0044)	(0.0081)	(0.0042)	(0.0082)	(0.0044)
$E_{it-3}(Costs_{12m})$	0.0007	0.0077**	-0.0020	0.0073**	0.0014	0.0073**
	(0.0074)	(0.0033)	(0.0083)	(0.0036)	(0.0079)	(0.0033)
$E_{it-4}(Costs_{12m})$	0.0096	0.0057	0.0035	0.0048	0.0099	0.0054
	(0.0061)	(0.0039)	(0.0065)	(0.0039)	(0.0065)	(0.0041)
Sector FE	✓		✓		✓	
Taylor Dummies	✓		×		✓	
Month FE	✓		✓		×	
Years FE	✓		✓		×	
R^2	**0.1344**		**0.0091**		**0.1415**	
Observations	7,553		7,553		7,553	

Notes: This table reports panel fixed-effects OLS estimates associating aggregate and idiosyncratic expectations on price-adjustment decisions according to firm size. Firms are categorized according to total production costs into small, medium and large, with small firms as the omitted category. The dependent variable in all columns is an indicator variable that takes the value of one if the firm i in month t decided to adjust its price. The reported coefficients correspond to the partial effect of size, resulting from the interaction of the size dummy with current and lagged expectations (inflation and costs). Column (1) and (2) report the partial effects for medium and large firms respectively and include firm, month and year fixed effects (constants not reported). Column (3) and (4) report the partial effects for medium and large firms when the time-dependent channel is removed, that is the Taylor group of variables. Finally, columns (5) and (6) remove the state-dependent channel, i.e., there are no time fixed effects. All specifications include 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% levels, respectively.

7.7 Probability of Price Adjustments: Competitors and Multi-Products

Table 7.6: ***Marginal Effects: Alternative specifications***

	Competitors Average (1)	Competitors Many (2)	Multi-Product (3)
$E_{it}(Inf_{12m})$	-0.0013	0.0101	0.0062
	(0.0073)	(0.0118)	(0.0071)
$E_{it-1}(Inf_{12m})$	0.0093	0.0019	-0.0014
	(0.0080)	(0.0074)	(0.0064)
$E_{it-2}(Inf_{12m})$	-0.00003	-0.0126*	0.0003
	(0.0080)	(0.0070)	(0.0047)
$E_{it-3}(Inf_{12m})$	-0.0056	-0.0037	-0.0071
	(0.0075)	(0.0103)	(0.0056)
$E_{it-4}(Inf_{12m})$	0.0039	-0.0137	0.0057
	(0.0079)	(0.0118)	(0.0059)
$E_{it}(Costs_{12m})$	-0.0043	0.0011	-0.0003
	(0.0058)	(0.0067)	(0.0050)
$E_{it-1}(Costs_{12m})$	0.0007	-0.0005	0.0016
	(0.0039)	(0.0037)	(0.0029)
$E_{it-2}(Costs_{12m})$	0.0035	0.0007	-0.0003
	(0.0041)	(0.0037)	(0.0032)
$E_{it-3}(Costs_{12m})$	0.0088**	0.0085**	0.0064**
	(0.0045)	(0.0035)	(0.0031)
$E_{it-4}(Costs_{12m})$	0.0007	0.0046	0.0049
	(0.0035)	(0.0066)	(0.0031)
Sector FE	✓		✓
Taylor Dummies	✓		✓
Month FE	✓		✓
Years FE	✓		✓
R^2	**0.1332**		**0.1336**
Observations	7,553		7,553

Notes: This table reports panel fixed effects OLS estimates associating aggregate and idiosyncratic expectations with price-adjustment decisions conditioning on the number of competitors or products produced. For columns (1) and (2), firms are categorized according to the number of competitors into a few, average, and many, leaving the first group as the omitted category. For column (3) we define an indicator variable which is one if the firm produces more than one good. The dependent variable in all columns is an indicator variable that takes the value of one if the firm i in month t decided to adjust its price. All specifications include current inflation and cost expectations and up to four lags of those variables, firm, month, and year fixed effects (constants not reported); a set of Taylor group variables (which controls for time-dependent price adjustments), and a time t and four lags of a cost index proxy at a 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.