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# PRICE RIGIDITIES, INPUT COSTS, AND INFLATION EXPECTATIONS: UNDERSTANDING FIRMS' PRICING DECISIONS FROM MICRO DATA

by Marianna Riggi* and Alex Tagliabracci*

**Abstract**

Using a rich survey panel dataset of Italian businesses, this paper provides new empirical evidence on the drivers of firms' pricing decisions over the last six years. We document a set of interesting results. First, the share of firms adjusting their prices in each period co-moves with current inflation. Moreover, firms' choices are consistent with a hybrid framework that lies between time- and state-dependent models of price setting. Second, firms' pricing decisions respond to past pricing choices, changes in input costs and beliefs about future developments of their own prices, rather than on expectations for aggregate inflation. Third, firms' price changes are also connected to their observable characteristics: size class, sector of activity and exposure to foreign markets. Fourth, the heterogeneity in price changes depends strongly on the dispersion of beliefs concerning future price variations, while input prices only explain a limited part. Our results shed light on the presence of different channels for the formation of firms' prices, pointing toward the need to consider the channels together so as to understand firms' pricing decisions and inflation developments.

**JEL Classification**: D22, D24, E31.
**Keywords**: firms' pricing decisions, price rigidities, input costs pass-through, expectations, survey data.
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**Contents**



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# 1 Introduction[1]

The comprehension of the origin and of the cyclical properties of inflation hinges upon the understanding of price setters' behaviours: what leads firms to adjust their prices and what determines the size of the price changes? The answer to these questions is a watershed in the theories of the business cycles as it shapes the real effects of monetary policy and, more in general, the propagation of macroeconomic shocks. Going beyond aggregate data is necessary: models matching the same average frequency and size of price changes can have very different implications on the extent and on the persistence of shocks' pass-through, depending on the underlying micro-foundation of price stickiness (as in Golosov and Lucas, 2007), especially in the face of large shocks (see e.g. Alvarez et al., 2016), while individual stickiness may build up or instead disappear from aggregate price indexes, based on the way prices are set at the firm level. Constrained by the lack of reliable and detailed firm-level data, empirical evidence remains still relatively scarce.

This paper uses a rich survey panel of Italian firms, the Bank of Italy's Survey on Inflation and Growth Expectations (SIGE, hereafter), to provide a full characterization of firms' pricing strategies that digs inside the drivers of both the *extensive* – i.e. what induces firms to adjust their prices - and the *intensive* margin of inflation – i.e. what determines the size of price changes.[2] The SIGE embraces quantitative information on actual and expected changes occurred in firms' output and input prices, as well as their inflation expectations, resulting in a detailed dataset that allows to rationalize firms' pricing decisions along different dimensions.

The paper poses several research questions. The first question we ask is to what extent prices' adjustment is state rather than time dependent. A state-dependent setup is one where price variations depend from disturbances to the firm's desired price: firms change their prices in a state-dependent fashion when the state, given by current profits or markups, attains a critical level. Conversely, a time-dependent setup is one where the occurrence of a price change is only a function of calendar time, as the time elapsed since

[1] *The views expressed in this article are those of the authors alone and do not necessarily represent the positions of the Bank of Italy or of the Eurosystem.*
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[2] This survey has already been exploited in the literature for understanding the formation mechanism of firms' expectations. For instance, Bottone and Rosolia (2019) and Bottone et al. (2022) look at the effects of monetary policy on the mechanism formation of firms' inflation expectations; Coibion et al. (2020) show the effect of inflation expectations on firms' economic decisions while Conflitti and Zizza (2021) find that labour contract renewals play a direct role in shaping the view of entrepreneurs on expected inflation. Bottone et al. (2021) examine how firms perceived the Covid-19 shock and its effect on inflation expectations. Ropele and Tagliabracci (2022) focus on the effects of the outbreak of the Russian invasion of Ukraine on firms' expectations.

the last price change completely determines the hazard of price variation.[3] Discerning between state- and time-dependent pricing behaviours is at the heart of the debate about the role of nominal rigidities in the transmission mechanism of monetary policy.[4] Indeed, state-dependent pricing models typically lead to smaller real effects of monetary shocks as the endogenous shift in the identity of adjusting firms – with firms that do adjust in a particular period being exactly those that need the largest price changes – imparts a greater degree of flexibility to the aggregate price level.

Our results point to the *coexistence* of time- and state-dependent pricing strategies. State dependency emerges from the highly significant effect exerted on the probability of a price variation by the changes experienced in input prices and by firms' expectations on their own future output prices. Moreover, the probability of price changes does not exhibit a seasonal pattern, as it should in the case of a strong time dependency. Besides, the correlation between the share of firms adjusting prices and the level of inflation indicates a high relevance of the extensive margin of price dynamics, which is an intrinsic property of state dependency. Yet, the fact that the probability of a price change is also significantly related to previous choice suggests the presence of time-dependency as well. The coexistence of both two pricing behaviours is also confirmed by the measure proposed by Costain and Nakov (2011), based on the cross-sectional distribution of price adjustments, which evaluates the degree of state dependency in the data. In our panel the degree of state depedency turns out to be 0.5, at the exact mid-point of the [0-1] interval, whose extremes represent the limiting cases of fully time and fully state dependency, respectively. Loosely speaking, our data suggest that price adjustments appear consistent with a hybrid state-dependent model with a significant degree of time dependence.

The second piece of evidence concerns the drivers of the size of price changes that, in turn, determine the *intensive* margin of inflation. Our dataset allows to estimate a firm-level relationship that resembles the New Keynesian Phillips Curve, where we directly observe changes in firms' input prices and firms' expectations on aggregate inflation and on their own output and input prices. Our results are as follows. First, price changes display some inertia: a one per cent variation in prices at time $t-1$ leads to an average change in current prices of roughly 0.3 per cent. Thus, firm-level data support the hybrid version of the New Keynesian Phillips curve, which relates current inflation also to its lag. This implies that any change in the output gap, even if purely

[3]In this framework, provided that the exact dates at which prices are to be changed are predetermined, the calendar date might be either *exogenous*, as in the first generation of time-dependent models based on Taylor (1980) and Calvo (1983), or *endogenous*, as in Ball et al. (1988) and Bonomo and Carvalho (2004), where time-dependent pricing rules are optimal.

[4]Broadly speaking, this also relates to the literature on *price rigidities*. Among others, Boivin et al. (2009) and Maćkowiak et al. (2009) have documented a tendency of a slow and persistent response of sectoral prices to aggregate shocks while a fast and non-persistent response to sector-specific shocks, and their implications for aggregate inflation dynamics. More generally, Midrigan (2011) show that price-adjustment decisions are mostly driven by idiosyncratic rather than aggregate shocks.

transitory, will have some long-lasting effects on inflation, as there is a certain degree of persistence in price setting beyond that inherited from the output gap.[5] Second, price setting decisions are forward looking. Yet, what matters for current pricing choices are firms' beliefs about future developments in their own output prices, rather than expectations on aggregate inflation. This evidence speaks to the macroeconomic paradigm of "islands" models, where agents only use the subset of prices with which they transact to shape their beliefs and expectations about aggregate conditions (see e.g. Lucas, 1972 and Andrade et al., 2022). Third, the pass-through of *input* costs to output prices is significant but quantitatively limited, with a one per cent increase in the prices of input leading to roughly a 0.2 per cent rise in firm's selling prices (see e.g. Nakamura and Zerom, 2010).[6] Putting it differently, firms typically absorb some of the cost increases by lowering their profit margins (see e.g. Schnabel, 2020).

Third, a natural question is whether observable firm characteristics matter for our results.[7] We explore four dimensions: the class size, the sector of activity, the geographical area and the exposure to foreign markets. We find that price setting decisions of large firms are more inertial and less forward-looking than those of small firms, while the pass-through of input costs to output prices is similar across size classes. Similarly, price changes of exporting companies are more persistent and less forward looking than those of firms operating only in their domestic market. Yet, the exposure to foreign markets is associated to a stronger transmission of input price changes to firms' prices. As for sector heterogeneity, the input–output price pass-through in industry is stronger than in construction and services (with the exception of retail-trading); pricing policies are much more forward looking in construction than in the other sectors. There is no evidence of geographical heterogeneity.

Fourth, we consider whether the price change *dispersion* reflects differences in firms' beliefs or in their input prices, and how it varies with the level of inflation rate (see e.g. Nakamura et al., 2018).[8] It appears that the heterogeneity in the changes of firms' selling prices is largely explained by the dispersion in expectations about their own future prices and by the differences in input price variations when comparing firms operating

[5]On a theoretical ground, the literature offers several explanations for the lagged inflation term in the Phillips curve; among them real wage rigidities (Blanchard and Galí, 2007), sticky information (Mankiw and Reis, 2002) and automatic indexation of prices to past inflation by the firms that are not re-optimizing prices (Christiano et al., 2005).

[6]Existing evidence show that the pass-through can be largely incomplete (i.e. the elasticity of firm prices to input costs is less than one) also as a consequence of living in a low-inflation environment as explained by Taylor (2000).

[7]For instance, Amiti et al. (2019) show that the cost pass-through is affected by the firm class size, with small firms exhibiting no strategic complementarities in prices setting and a larger cost pass-through, while large firms display strong strategic complementaries and they respond to both competitor price changes and their own cost shocks with roughly equal elasticities of around 0.5.

[8]In this respect, Lach and Tsiddon (1992), Choi (2010) and Sheremirov (2020) are example of studies that analyse the relationship between price dispersion and inflation using different metrics and/or approaches.

in different sectors. Again, aggregate inflation expectations do not result in being a significant driver: firms set their prices based on their "own island" experiences. On the top of that, there is strong evidence of a positive relationship between the dispersion in output price changes and the dynamics of actual inflation.

Overall, a common thread characterizes our results. Firms' pricing, both in terms of price hazard function as well as of the magnitude of price changes, responds to *past* pricing choices, *current* dynamics in input costs and beliefs about *future* developments of their own prices, rather than expectations on aggregate inflation.

Our paper is related to the recent studies that use firm-level data to investigate the importance of different channels in shaping firms' pricing decisions. The closer to our analysis is Frache et al. (2021) who explores the role of input costs and expectations for price setting decisions for firms in Uruguay, finding that firms' beliefs about their overall costs matter for the extensive margin of price-changes, while inflation expectations play a role only for the intensive margin. Another example is Boneva et al. (2020) for UK firms, whose analysis is less close to ours, as they explore the formation of firms' inflation expectations rather than their pricing choices. Our results speak also to Andrade et al. (2022) who use a survey of French manufacturing firms and document that industry-specific shocks, with no aggregate impact, affect firms' expectations over their own future price changes.

The rest of the paper is structured as follows. Section 2 describes the data underlying the empirical analysis. Section 3 presents the main results on what makes firms more likely to change their prices and Section 4 quantifies the determinants of firm's pricing decisions and the role of observable firm characteristics. Section 5 looks at the heterogeneity in the price changes and its determinants. Section 6 summarizes the main results and briefly concludes.

# 2 Survey Data

## 2.1 The questionnaire

The Survey on Inflation and Growth Expectations (SIGE) has been run quarterly by the Bank of Italy since 1999, on a sample of about 1,000 manufacturing, service and construction firms with at least 50 employees. The sample is stratified along three characteristics: the sector of activity, the size class in terms of the number of employees and the geographical area, based on firm's administrative headquarters. Firms are interviewed in March, June, September and December, with the data collection process lasting approximately three weeks. The survey collects several information on firms' consumer inflation expectations over different horizons, on actual and expected change in their own selling prices, as well as firms' sentiment on aggregate cyclical developments and on their own real and financial conditions.[9]

Since 2016Q3 the questionnaire has included some specific queries gathering quantitative information on firms' *input* and *output* price changes, both in terms of those applied over the last twelve months and of those expected over the next twelve months.[10] Specifically, firms are asked the following questions:

> "*In the last twelve months, what has been the average change in your firm's prices?*"
> "*In the last twelve months, what has been the average change in your firm's prices of goods and services bought in Italy and abroad?*"

These questions on the recent price developments are accompanied by those related to firms' *expectations* on the same variables over the next twelve months, namely:

> "*For the next twelve months, what do you expect will be the average change in your firm's prices?*"
> "*In the next twelve months, what do you expect will be the average change in your firm's prices of goods and services bought in Italy and abroad?*"

The questionnaire also includes questions on aggregate inflation expectations, notably at the twelve-month horizon.[11] The information gathered on *firm-specific* input and output price changes, together with firms' view on nominal macroeconomic variables allow to fully characterize firms' pricing strategies, in terms of the factors considered when they change prices, the magnitude of the input price pass-through to output prices and the relevant underlying channels.

The panel structure is one of the main advantages of this survey. Our empirical analyses rely on a cross-section composed by more than one thousand firms observed over almost six years of quarterly data. That said, there are also two minor limits: first, we only observe the *average* price change at the firm level, therefore we do not have any detailed information on the number of products sold by each firm and on their corresponding price variations.[12] Moreover, the availability of information on the price change rather than the *level* of prices partially restricts our analysis.[13] Last, our analysis does not consider the role of expectations on future wages or more in general on labour

[9]Full details on the information contained in the questionnaire and on its structure are reported in the Appendix.

[10]While the questions on output prices were included from earlier waves, the ones on the variations to input costs were added only in 2016Q3. This restricts the sample period of our analysis.

[11]Firms are asked to provide their inflation expectations at different horizons, i.e. from six-month to four-year ahead. However, we consider only those at twelve-month to have an horizon comparable with the one for input and output price expectations.

[12]On this respect, Yang (2022) uses firm-level survey data from New Zealand to show that firms producing a large varieties of goods have both better information about inflation and more frequent but smaller prices changes.

[13]In particular, we cannot investigate the possibility of *price selection*, i.e. whether adjusted prices can differ systematically from the overall population of prices as in Carvalho and Kryvtsov (2021).

costs as in Boneva et al. (2020). However, the dynamics of wages in Italy has been remarkably stable at low levels in the period under consideration, therefore it should not play a major role in the determination of firms' price changes.

Overall, these minor caveats apply to most of the studies previously cited. The strength of our dataset lies in the richness of our survey, which encompasses the different channels relevant for firms' pricing decisions. In particular, to the best of our knowledge, the availability of a quantitative measure of input price changes, together with the corresponding change in selling prices, provides the key ingredients for an unprecedented exercise.

## 2.2 Data

We start our analysis by looking at the heterogeneity in firms' price variations. Figure 1 shows the distribution of input and of output price changes over the entire sample period. The overlap of these two distributions provides some immediate indications on the differences in the variations of input and output prices and on the corresponding pass-through along the pricing chain. It turns out that there is a large share of responses that are equal to zero (i.e. indicating no price change between two consecutive periods) or very close to it: this fraction is slightly above 30 per cent in the case of input prices, while it is almost 50 per cent for output prices.

[FIGURE 1 ABOUT HERE]

The prevalence of small price changes leans towards time-dependency in firms' pricing or to more complex pricing pattern than the one embedded in the classic menu-cost models (see e.g. Costain and Nakov, 2011 and Midrigan, 2011).[14] This would also suggest that the *selection* effect is weak. Note that we also observe some large price changes indicating a high variance in idiosyncratic shocks.

[TABLE 1 ABOUT HERE]

In terms of higher moments of the distribution, Table 1 offers some insights on some important features characterizing our dataset. First, the variance of changes in output prices is smaller than the one of input prices, signalling the incompleteness of the pass-through to output prices. Looking at the price change skewness, which is considered a crucial dimension for the effectiveness of monetary policy (see e.g. Luo and Villar, 2021), the distribution of output price changes is positively skewed, suggesting that high positive variations are more likely than low negative ones. This outcome on the asymmetry

[14]There are variants of menu-cost models able to generate small price changes, see Midrigan, 2011 among others.

also characterizes the variables related to firms' expectations, although with higher values. Last, the distribution appears quite dispersed and leptokurtic, consistent with the evidence presented in Midrigan (2011).

# 3 What makes firms change their prices?

This section presents new micro evidence on the determinants of price changes. We first characterize the main forces that induce firms to adjust their prices and we then provide some evidence of the pricing scheme that better characterizes firms' decisions.

First, we investigate how price change decisions are related to the dynamics of actual inflation in the spirit of Nakamura and Steinsson (2008). We compute the share of firms that in each period $t$ change their output prices, i.e. $\sum_i^{N_t} \mathbb{1}\{\Delta p_{i,t} \neq 0\}/N_t$ where $N_t$ represents the total number of firms participating to the survey at time $t$.

[FIGURE 2 ABOUT HERE]

Figure 2 shows the evolution of the share of firms adjusting their prices over time together with the dynamics of actual inflation in Italy. There is a clear positive correlation between these two series. This would characterize the aggregate inflation dynamics as being largely driven by the *extensive* margin rather than the *intensive* one (as in the case of Klenow and Kryvtsov, 2008).[15]

A standard probit model that allows to identify the factors affecting the probability of observing a price change. Specifically, we estimate the following probit model:

$$\begin{aligned} P(Adjp_{i,t}) = \Phi\big(&\beta_0 Adjp_{i,t-1} + \beta D(\Delta p_{i,t}^{input}) + \beta \pi_{t-1} + \beta D(\Delta p_{i,t}^{e,o}) + \beta D(\Delta p_{i,t}^{e,i}) \\ &+ \beta D(\pi_{i,t}^{e,t+12}) + \sum_{j=1}^{4} \gamma_j D(Q_j) + \omega \mathbf{X_i}\big) \end{aligned} \quad (1)$$

where $Adjp_{i,t}$ is a dummy variable which takes value 1 if the firms $i$ changed its prices at time $t$ and zero otherwise.[16] The specification includes the lag of the dependent variable $Adjp_{i,t-1}$ to capture the possible persistence in price adjustments; in addition, we consider some regressors related to the state-dependent approach, such as the change in input prices, expectations about firms' own input and output prices and aggregate inflation over the next twelve months. All these variables are considered as dummies

[15] Most of the previous studies were based on prices from the U.S. retail sector and this could limit the external validity of this relation.

[16] Frache et al. (2021) propose a similar analysis on the drivers of price adjustments using a *linear probability* model. In our case we prefer to adopt a probit model which is more suited for this analysis, overcoming the common issues associated to the use of linear probability models, such as heteroscedasticity and negative probabilities etc. Table A1 in the Appendix shows the robustness of our main results to the use of a linear probability model.

taking values $\{0, 1\}$ depending on whether they stay the same, or they changed (both decrease or increase) at time $t$, respectively. The specification also includes the matrix $X_i$ to consider standard fixed-effects for firm characteristics and the level of inflation rate $\pi_{t-1}$ to control for the role of aggregate price dynamics. We also consider a dummy indicator for each quarter $Q_j$ to capture the possible seasonality of price adjustments within the year, in the spirit of Nakamura and Steinsson (2008).

[TABLE 2 ABOUT HERE]

Table 2 shows the main results. First, we document the presence of a sizeable persistence in firms' prices adjustments. Indeed, the probability of a price change at time $t$ is partially related to variations experienced in the previous period, with a marginal effect of roughly 25 per cent once we consider the full specification (column 4-5). Loosely speaking, this implies that one out of four firms that changed their prices at $t-1$ is also adjusting them at time $t$. This result also holds when we control for other factors, supporting the presence of a partial time-dependent pattern in firms' decisions. Second, some variables capturing state-dependency also have a crucial role: the choice of changing prices responds to the changes occurred in input prices and to firms expectations on their own future output prices. Indeed, the coefficient associated to the expected (firm-specific) price changes $D(\pi_{i,t}^{e,t+12})$ is quantitatively similar to the one on the lag of the dependent variable. In addition, there is also a significant contribution from the dummy $D(\Delta p_{i,t}^{input})$ representing the change occurred in input prices. In terms of the magnitude, the marginal effect is in the range of 17 per cent, therefore slightly below compared to the previously described factors. Loosely speaking, the statistical significance of these coefficients is indicative about the relevance of state-dependent patterns that operate in addition to the time-dependent ones. Third, the level of inflation does not seem to play *per se* a significant role, once we control for the other channels. In other words, the relationship between the share of firms adjusting their prices and the level of aggregate inflation shown in Figure 2 is not significant, as it appears to be captured by the other channels. Last, the probability of price changes does not exhibit a seasonal pattern: indeed, the coefficients associated to the quarterly dummies are not significant. In practice, this also suggests that the time-dependent pattern is entirely related to previous choices rather than to the seasonality of firms' pricing decisions.

To complement the previous evidence on the coexistence of time- and state-dependent patterns, we consider an additional analysis following the approach proposed by Costain and Nakov (2011) which allows to measure the degree of state dependency $S$ characterizing our SIGE data. Practically, we consider the following formula:

$$S \equiv \frac{\sigma_\lambda^2}{\mu_\lambda(1-\mu_\lambda)} \tag{2}$$

where $\mu_\lambda = E(\lambda_i)$ corresponds to the mean adjustment probability across firms over the sample and $\sigma^2_\lambda$ represents the corresponding variance. By construction this measure $S$ is included in the interval between 0 and 1, with the two extremes representing the Calvo and the fixed-cost menu models, respectively. Using our dataset, we obtain an estimate of $S$ equal to 0.50, as the mean adjustment probability $\mu_\lambda$ is estimated to be 0.61 and the corresponding variance $\sigma^2_\lambda$ is equal to 0.12. This confirms that price adjustments appear consistent with a hybrid state-dependent model, with a significant degree of time dependence.

# 4 How firms change their prices

This section studies the intensive margin of firms' pricing decisions from different perspectives. We first investigate the role of several channels and we then test to what extent these results are a function of observable firm characteristics.

## 4.1 Rationalizing firms' price variations

Equation (3) shows our pricing model for characterizing the changes in firms' output prices. We look at different channels that might be relevant for explaining firms' decisions, such as the persistence in price variations, the pass-through from input costs, the sensitivity to aggregate inflation and firms' expectations concerning future developments in their own output and input prices as well as future aggregate inflation. In practice, our regression models is specified as follows:

$$\Delta p_{i,t} = c+\alpha_i+\beta_1\Delta p_{i,t-1}+\beta_2\Delta p^{input}_{i,t}+\beta_3\pi_{t-1}+\beta_4\pi^{e,t+12}_{i,t}+\beta_5\Delta p^{e,i}_{i,t}+\beta_6\Delta p^{e,o}_{i,t}+\omega\mathbf{X_i}+u_{i,t} \quad (3)$$

where $\Delta p_{i,t}$ represents the change in firms' prices over the last twelve months, $\Delta p^{input}_{i,t}$ corresponds to the (firm-specific) variation in input costs, $\pi_{t-1}$ indicates the current level of inflation and $\pi^{e,t+12}_{i,t}$ stands for twelve-month ahead inflation expectations. The variables $\Delta p^{e,i}_{i,t}$ and $\Delta p^{e,o}_{i,t}$ correspond to firm-specific's beliefs about future input and output price variations in the next twelve months, respectively. The matrix $X_i$ includes standard fixed-effects to control for time-invariant firm characteristics.

[TABLE 3 ABOUT HERE]

Table 3 presents our main findings. First, we find a sizeable persistence in firms' price changes between consecutive periods. Indeed, the coefficient for the autoregressive component is estimated to be around 0.3, meaning that a one per cent variation in firms' output prices observed at time $t-1$ is followed by an average change of roughly 0.3 per cent at time $t$. This result strengthens the evidence reported in Section 3, suggesting that the persistence of firms' choices applies not only to the extensive margin of price setting but also to the intensive one.

Second, variations to input prices play an important role: the input cost pass-through, as measured by the coefficient attached to $\Delta p_{i,t}^{input}$, is estimated to be slightly above 0.2 (once we control for other regressors as in column 6). This suggests that the propagation of cost pressures is incomplete but the pass-through is quantitatively important for determining the changes in output prices. This also implies that firms typically absorb a large part of the cost increases by lowering their profit margins, especially in times of low inflation (see e.g. Taylor, 2000 and Schnabel, 2020).[17]

Third, it turns out that current pricing decisions are also *belief*-dependent. Interestingly, the expectations that matter for firms' prices are the ones about future *firm-specific* price variations and not those related to aggregate inflation or those concerning future (firm-specific) input price changes. This is similar to the evidence presented by Frache et al. (2021) on Uruguayan firms, where expectations on aggregate inflation do not play any role for firms' price setting, but firms' beliefs about their own future prices do.[18] On a conceptual ground, this result speaks to "island" models in the spirit of Andrade et al. (2022), where firms use the local prices they observe to make inferences about broader aggregate conditions. Related to this finding, we indeed obtain that the level of current inflation does not seem to play a crucial role. Finally, we consider a sort of robustness test on the importance of considering firm-specific fixed-effects to quantify the contribution of each factor (column 7).[19] In our case, removing the firm-specific fixed-effects has an impact on the persistence of firms' prices: the coefficient on past choices increases by almost 0.15 percentage points (as emerged from the comparison between column 6 and 7), whereas it has a very limited effect on the other coefficients, therefore confirming the robustness of our estimates.

Overall, our results point towards the presence of three main channels in the determination of firms' pricing decisions: beyond depending on previous choices, price changes are also influenced by current cost-pressures coming from input products and by firms' expectations about their own prices in the near term.

[17]For instance, Kouvavas et al. (2021) show that the dynamics of markups have had an important role in explaining the low inflation rate experienced in the euro area over the past two decades.

[18]However, differently from Frache et al. (2021), we find that input cost expectations do not play any role for current price adjustment.

[19]As shown by Coibion et al. (2018), firm-individual fixed-effects can be quite important for understanding firms' decisions: in their case they capture a significant part of the variability of the one-year ahead inflation expectations.

## 4.2 The role of firm characteristics

We now investigate to what extent the previous results are associated to firms' observable characteristics. One advantage of the panel structure of the SIGE survey is the possibility to analyze how the time-invariant firm characteristics affect their decisions. Indeed, different studies have shown that these dimensions might be important for explaining firms' choices. For instance, Amiti et al. (2019) show that the elasticity of firms' prices to changes in marginal costs and to competitors' prices vary considerably across different firms, in particular with respect to the size class.

To this aim, we adapt the regression model in (3) adding some interaction terms, namely:

$$\Delta p_{i,t} = c + \alpha_i + \beta_1 \Delta p_{i,t-1} * \mathbf{D_{fc}} + \beta_2 \Delta p_{i,t}^{input} * \mathbf{D_{fc}} + \beta_3 \Delta p_{i,t}^{e,o} * \mathbf{D_{fc}} + \omega \mathbf{X_i} + u_{i,t} \tag{4}$$

where the dummy $D_{fc}$ is interacted with each regressor, allowing us to provide some quantitative evidence on the role of firm characteristic on the various channels. We consider four dimensions that are most likely to generate some heterogeneity in firms' pricing decisions: the class size, the sector of activity, the geographical area and the exposure to foreign markets. The specification also includes the matrix $X_i$ to control for the systematic effect of firm characteristics. Differently from the specification previously used in (3), here we do not include as regressors some of the variables that do not have a significant role, such as firms' expectations about input price changes and aggregate inflation. For the sake of simplicity, we present the results obtained in (4) using an illustrative approach, as the one in Figure 3.[20]

[FIGURE 3 ABOUT HERE]

We highlight some interesting findings. First, Figure 3a shows that the degree of persistence in price adjustments is an increasing function of the size class, while the dependence on future prices is negatively associated to the firm dimension. In other words, larger firms tend to have more persistent price changes and less belief-dependent pricing decisions compared to smaller firms. Interestingly, the size of the pass-through of input costs to output prices is estimated to be almost invariant over the size class. This suggests that the size class does not change per se the way firms transfer their cost pressures to output prices. The pass-through might be more dependent on the macroeconomic framework, intended as the external environment in which the firm operates (see e.g. Taylor, 2000).[21] Second, the sector of activity is key feature for pricing decisions. Indeed,

[20]Full details on the estimated coefficients derived from equation (4) are presented in Table A2-A5 and not included here for the sake of brevity.

[21]Taylor (2000) show that the extent to which firms pass the changes in costs to their output prices in the US is determined by the overall level of inflation in the economy. This hints to the relevance of macroeconomic factors rather than firm-specific characteristics, consistently with our findings.

as shown by Figure 3b, firms in the service sector display less persistent price changes, which appear more dependent on expected future prices. In the industrial sector, instead, price adjustments are more persistent and more dependent on input price changes. Third, the geographical area of localization appears quite irrelevant for firms' pricing decisions. As illustrated by Figure 3c, the estimated coefficients are relatively similar when compared across different areas of Italy. This finding is indicative about the fact that the location has no systematic impact per se on the role of the factors we are considering. Lastly, firms that also operate in foreign markets tend to set their prices in a different way compared to the ones operating only in the domestic ones (see Figure 3d). Indeed, price changes of exporters are slightly more persistent and less dependent on future prices than those of firms operating in domestic markets. As for the pass-through of input prices, these two groups appear broadly similar.

All in all, we show that dimensions such as size class, sector of activity and exposition to foreign markets can generate quantitative heterogeneity in the role played by each channel. As such, they should be taken into account in order to get a more comprehensive understanding of firms' pricing decisions.

## 5 The heterogeneity in price changes

The availability of firm-level data provides the main ingredients to study the cross-sectional *heterogeneity* in the pricing decisions. Note that SIGE data allow us to examine the cross-sectional dispersion of price *changes*, and not that of price *levels*. Previous studies have focused on both approaches based on data availability, providing mixed evidence depending on the period and/or the country under scrutiny.[22]

In what follows we discuss some of the possible channels that can determine firms' price change dispersion. One plausible driver is the *level of inflation*. This has been frequently examined in the literature as high inflation could lead to inefficient price dispersion. An alternative channel regards the role played by *input costs*: different degrees of market power, differences in firm size and in the exposure to foreign markets might lead firms to pay different prices for their inputs and this might potentially explain the cross-sectional differences in output price changes (see e.g. Amiti et al., 2019). Lastly, differences in current pricing decisions could be explained by the *expectation channel*: indeed, the heterogeneity in expected future developments might also have an impact.[23]

[22]Lach and Tsiddon (1992) also studies the dispersion of price *changes* with respect to the inflation dynamics. Subsequently, Nakamura et al. (2018) argue that price change dispersion should fall as inflation increases because the price change distribution narrows to include mostly price increases, therefore reducing the cross-sectional variance of price variations. Using web-scraped data, Cavallo (2018) finds that the absolute size of price changes, which is also used as a measure of price dispersion, does not vary much across countries with very different levels of inflation.

[23]In the case of firms' inflation expectations, Coibion et al. (2018) show that inattention to economic

Our approach relies on the *interquartile range* as a measure of dispersion. Specifically, we calculate the interquartile range as follows:

$$IQR^{\Delta p_t}_{fc,t} = p75^{\Delta p_t}_{fc,t} - p25^{\Delta p_t}_{fc,t} \tag{5}$$

where $p75^{\Delta p_t}_{fc,t}$ and $p25^{\Delta p_t}_{c,t}$ are the $75^{th}$ and the $25^{th}$ percentiles of the distribution of variable $\Delta p_{i,t}$ observed at time $t$ by firm characteristic $fc$, respectively.

Figure 4 shows that the heterogeneity in price changes, measured by the interquartile range in each period, strongly co-varies with the dynamics of actual inflation. This finding is coherent with some evidence presented in the literature and in line with the prediction of realistic menu cost models used recently.[24]

[FIGURE 4 ABOUT HERE]

To evaluate the quantitative role of each channel, we adopt the following regression model:

$$IQR^{\Delta p_t}_{fc,t} = \alpha + \beta_1 IQR^{input}_{fc,t} + \beta_2 IQR^{e,input}_{fc,t} + \beta_3 IQR^{e,output}_{fc,t} + \beta_4 IQR^{e,\pi^{t+12}}_{fc,t} + \beta_5 \pi_{t-1} + u_{fc,t} \tag{6}$$

where the dispersion in firms' price changes, $IQR^{\Delta p_t}_{fc,t}$, is explained by the one in input prices ($IQR^{input}_{fc,t}$), in firms' expectations about input ($IQR^{e,input}_{fc,t}$) and output prices ($IQR^{e,output}_{fc,t}$) and about future aggregate inflation ($IQR^{e,\pi^{t+12}}_{fc,t}$). Following the evidence presented in Figure 4, we also examine for the role played by the level of actual inflation ($\pi_{t-1}$). Here we consider four different firm characteristics $fc$ as a clustering criterion for computing the metric as in (5), such as sector of activity, firm class size, geographical area and the export share, to provide a comprehensive view on the importance of these channels.

[TABLE 4 ABOUT HERE]

Table 4 presents our main results. First, the coefficient on input prices ($IQR^{input}_{fc,t}$) is always statistically different from zero except in the case that clusters on the sector of activity. In other words, the dispersion in input price changes explains a sizable part of heterogeneity in output price variations except in the case in which we cluster prices *within* sector. This result can be interpreted as an empirical evidence that firms operating

conditions is a primary source of differences in future beliefs. Consistently, Bottone et al. (2022) find that the provision of information on inflation dynamics or on monetary policy objectives can attenuate this dispersion in expectations.

[24]For instance, Sheremirov (2020) find a positive co-movement of price dispersion and inflation data once sales prices are excluded. Using the real price variability as a measure of dispersion, Choi (2010) shows that the relationship between dispersion and inflation varies over time, with a U-shape that best represents U.S. data from the Great Moderation. Therefore, this confirms that the heterogeneity in price variations might rise once inflation is increasing.

in the same sector of activity tend to face input price variations that are driven by the sector-specific shocks. Therefore the prices paid on their inputs do not affect the difference in those paid for their product prices.

Second, the role of the expectation channel turns out to be significant and quantitatively predominant compared to the other factors, but only for beliefs about future *firm-specific* price changes. In practice, the coefficient for $IQR^{e,output}_{fc,t}$ is statistically significant in all the specifications considered, with an estimate ranging between 0.40 and 0.65, suggesting that roughly half of the variation in the dispersion in expectations propagates to the heterogeneity in current price changes. Surprisingly, the result is different for expectations concerning future input price changes and aggregate inflation dynamics: the coefficients for $IQR^{e,input}_{fc,t}$ and for $IQR^{e,\pi^{t+12}}_{fc,t}$ turn out to be significant just in few cases, therefore suggesting that these factors do not play any systematic role in explaining the heterogeneity in firms' price variations.

Third, there is a clear evidence of a positive relationship between the dispersion in (output) price changes and the dynamics of actual inflation ($\pi_{t-1}$). Indeed, the corresponding coefficient is statistically significant over the different firm characteristics with estimates ranging between 0.15 and 0.33 depending on the specification considered. This finding reinforces the evidence presented in Figure 4: even when controlling for other channels, the heterogeneity in price changes remains an increasing function of the level of inflation.[25] This evidence speaks to the results presented by Choi (2010) and Sheremirov (2020) where the dispersion in price variations rises with higher values of inflation.

# 6 Conclusions

The ultimate goal of monetary policy is keeping inflation at its target in the medium term. The achievement of this goal hinges upon the pricing choices of a large number of heterogeneous firms operating in different sectors of the economy. Going beyond aggregate data is, therefore, clearly necessary to fully understand the origin of inflation and its dynamics, as well as to design the relevant micro-foundations of macroeconomic models. Yet, the understanding of how firms actually set prices is undoubtedly impaired by the lack of data on firms' pricing behaviours.

Our paper fits into this research field: we use a detailed survey panel on Italian firms, which embraces firm-level data on actual and expected changes in input and output prices, as well as on their inflation expectations, in order to explore all the different facets of firms' price setting policies.

[25] This finding is also robust to the approach used in Nakamura et al. (2018) that considers the *absolute size* of price changes as a measure of dispersion. Table A6 confirms that the heterogeneity in firms' price changes is an increasing function of actual inflation.

Firms' decisions, both in terms of the extensive and intensive margin, are inertial, as they depend on past choices, forward looking, as they respond to firms' beliefs in the future developments of their own prices rather than on their beliefs about aggregate inflation, are cost-based, as they entail a pass-through of the pressures that originate from variations in input costs.

Our results shed light on the presence of different channels in the formation of firms' prices, pointing toward the need of considering them together to understand their pricing decisions and the dynamics of inflation. Future research should be focused on providing evidence on the possible role of other channels/factors (such as monetary policy, productivity, etc) that might influence firms' pricing policies, offering a more comprehensive view on the mechanisms behind them. Future works could empirically test models' hypothesis, thus providing a bridge between theory and empirics that could enhance the ability of theoretical and empirical models to make forecasts and predict the consequences of, for example, alternative monetary policies.

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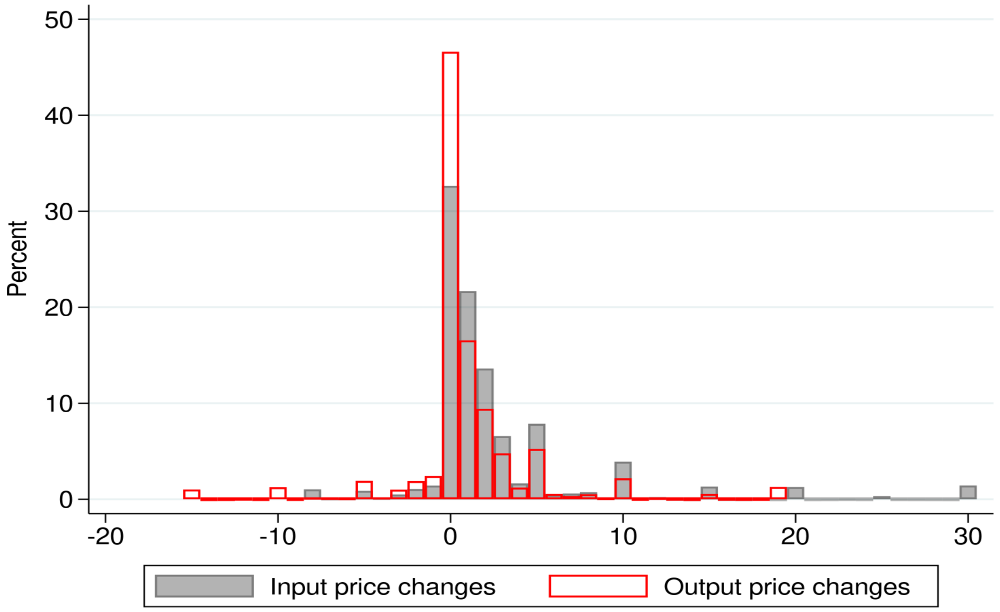
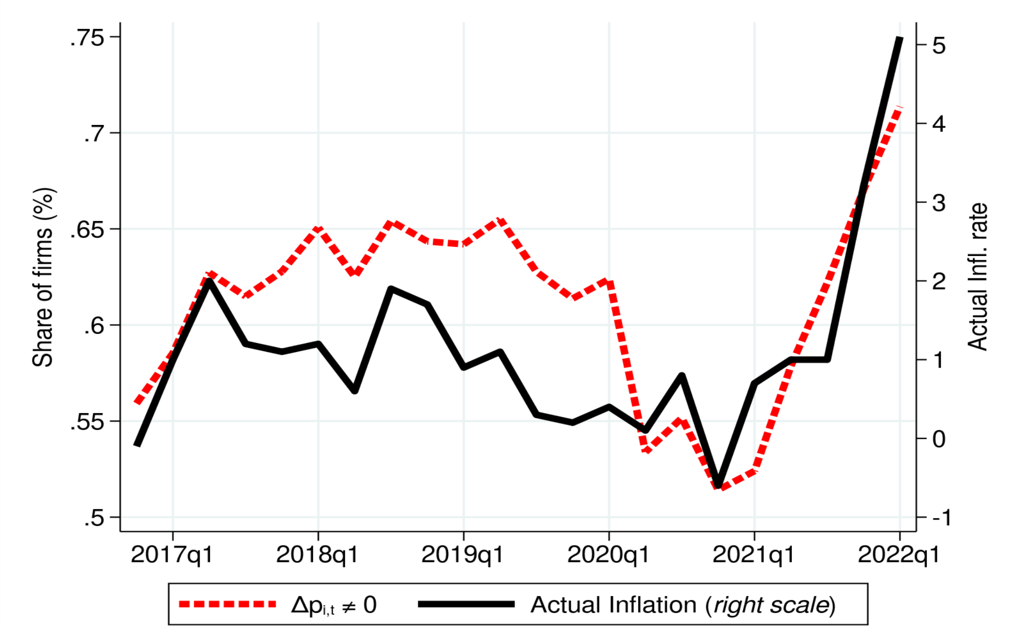
# Figures

**Figure 1:** The distribution of firms' input and output price changes




*Source:* Authors' calculations on SIGE data on the sample period 2016Q3-2022Q1. The bars represent the distribution of firms' price changes for input (light grey) and output (white bars with red lines) prices.

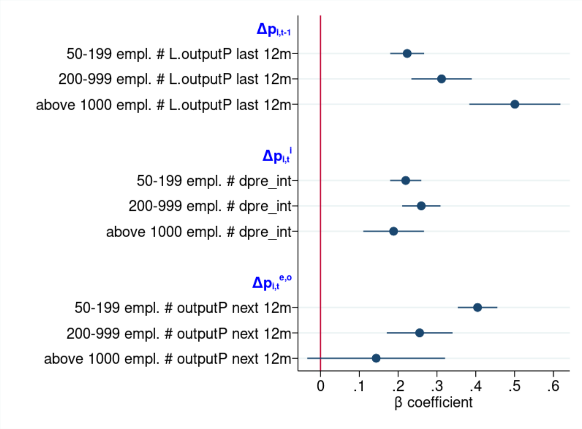
**Figure 2:** Share of firms adjusting their prices and the level of inflation



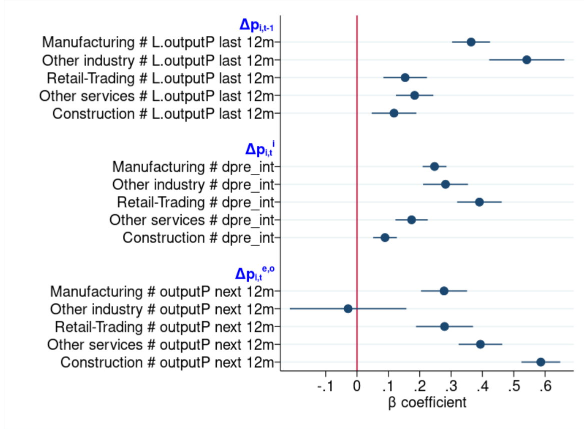

*Source:* Authors' calculations on SIGE data on the sample period 2016Q3-2022Q1. *Note*: the red dashed line represents the share of firms that in each period changed their prices, while the black solid line corresponds to the current actual inflation rate in Italy (expressed in y-o-y percentage change).

**Figure 3:** Firm characteristics as a determinant for pricing decisions

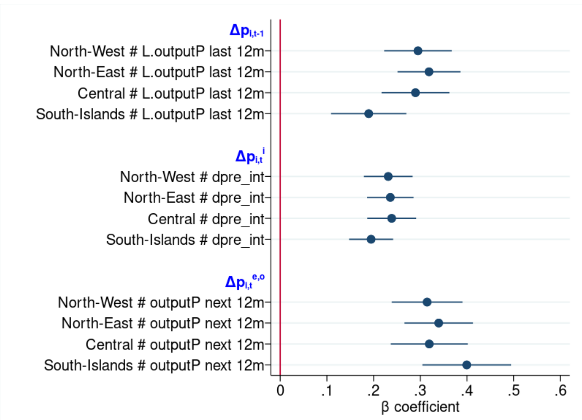
**(a)** by class size



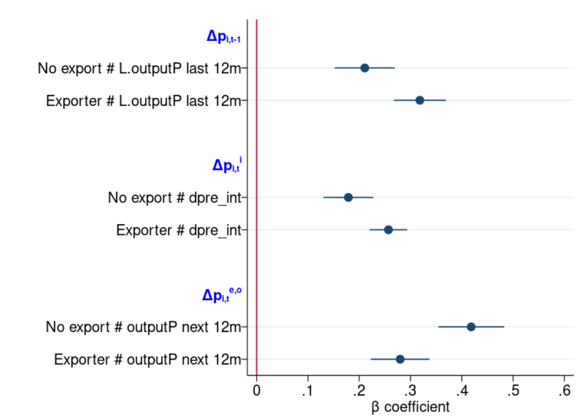

**(b)** by sector of activity




**(c)** by geographical area

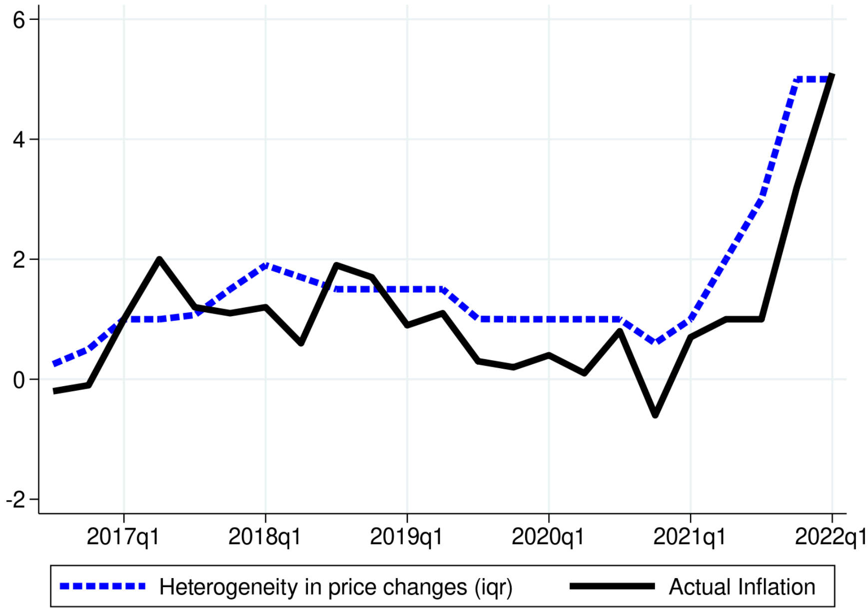



**(d)** by exposure to foreign markets




*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. The points and the corresponding lines represent the estimated coefficients and the confidence intervals for each specific regressor in equation (4), respectively.

**Figure 4:** The dispersion in price changes and the level of actual inflation




*Source*: Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. The blue dashed line corresponds to the interquartile range of the prices changes calculated in each period. The black solid line corresponds to the actual inflation rate.

# Tables

**Table 1:** Descriptive statistics

*Panel A*: Firms' price changes

| Variable | Mean | Std | p10 | p25 | p75 | p90 | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| $\Delta p_{i,t}$ | 0.96 | 3.96 | -0.80 | 0.00 | 1.50 | 5.00 | 0.87 | 11.40 |
| $\Delta p_{i,t}^{input}$ | 2.49 | 5.26 | 0.00 | 0.00 | 3.00 | 7.00 | 3.03 | 14.67 |

*Panel B*: Firms' expectations

| Variable | Mean | Std | p10 | p25 | p75 | p90 | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| $\Delta p_{i,t}^{e,input}$ | 2.71 | 4.81 | 0.00 | 0.00 | 3.00 | 7.00 | 3.19 | 15.80 |
| $\Delta p_{i,t}^{e,output}$ | 1.33 | 3.37 | 0.00 | 0.00 | 2.00 | 5.00 | 1.05 | 8.81 |
| $\pi_{i,t}^{e,t+12}$ | 1.31 | 1.39 | 0.10 | 0.50 | 1.70 | 2.50 | 1.94 | 14.61 |

*Source:* Authors' calculations on SIGE data. The statistics presented in the table are calculated over the sample period 2016Q3-2022Q1.

**Table 2:** Determinants of the probability of a price change

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $Adjp_{i,t-1}$ | 0.437*** | 0.350*** | 0.350*** | 0.254*** | 0.254*** |
| | (0.003) | (0.004) | (0.004) | (0.005) | (0.005) |
| $D(\Delta p_{i,t}^{input})$ | | 0.248*** | 0.245*** | 0.167*** | 0.167*** |
| | | (0.007) | (0.007) | (0.008) | (0.008) |
| $\pi_{t-1}$ | | | 0.009*** | 0.003 | 0.003 |
| | | | (0.003) | (0.002) | (0.002) |
| $D(\Delta p_{i,t}^{e,output})$ | | | | 0.237*** | 0.237*** |
| | | | | (0.006) | (0.006) |
| $D(\Delta p_{i,t}^{e,input})$ | | | | -0.026*** | -0.026*** |
| | | | | (0.007) | (0.007) |
| $D(\pi_{i,t}^{e,t+12})$ | | | | -0.002 | -0.002 |
| | | | | (0.005) | (0.005) |
| $D(Q1)$ | | | | | 0.006 |
| | | | | | (0.007) |
| $D(Q2)$ | | | | | 0.002 |
| | | | | | (0.008) |
| $D(Q3)$ | | | | | 0.006 |
| | | | | | (0.006) |
| $N$ | 19892 | 19892 | 19892 | 19892 | 19892 |

*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. Each reported coefficient represents the marginal effect for the corresponding regressor on the probability of a price change on the basis of the probit model described in (1). All regressions include fixed-effects for sector of activity, geographical area, firm class size, and exposure to foreign markets. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

**Table 3:** Drivers of firms' price changes

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $\Delta p_{i,t-1}$ | 0.405*** | 0.299*** | 0.293*** | 0.316*** | 0.316*** | 0.295*** | 0.432*** |
| | (0.043) | (0.024) | (0.023) | (0.025) | (0.025) | (0.025) | (0.021) |
| $\Delta p_{i,t}^{input}$ | | 0.291*** | 0.278*** | 0.269*** | 0.270*** | 0.223*** | 0.179*** |
| | | (0.016) | (0.014) | (0.014) | (0.017) | (0.017) | (0.016) |
| $\pi_{t-1}$ | | | 0.144*** | 0.080 | 0.081 | 0.005 | -0.016 |
| | | | (0.042) | (0.052) | (0.051) | (0.038) | (0.037) |
| $\pi_{i,t}^{e,t+12}$ | | | | 0.101*** | 0.101*** | 0.022 | -0.012 |
| | | | | (0.034) | (0.035) | (0.028) | (0.026) |
| $\Delta p_{i,t}^{e,input}$ | | | | | -0.003 | | |
| | | | | | (0.014) | | |
| $\Delta p_{i,t}^{e,output}$ | | | | | | 0.350*** | 0.379*** |
| | | | | | | (0.029) | (0.025) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes | No |
| Size | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Area | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Quarter FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 19501 | 19501 | 19501 | 16930 | 16930 | 16930 | 17258 |
| R2 | 0.422 | 0.521 | 0.523 | 0.521 | 0.521 | 0.571 | 0.544 |

*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

**Table 4:** Determinants of the dispersion in price changes

| | **Sector of activity** | | **Size class** | | **Geographical area** | | **Export Share** | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (1) | (2) | (1) | (2) | (1) | (2) |
| $IQR^{input}_{fc,t}$ | 0.255 | 0.205 | 0.162** | 0.162** | 0.220*** | 0.197*** | 0.379*** | 0.327*** |
| | (0.178) | (0.171) | (0.062) | (0.062) | (0.067) | (0.061) | (0.115) | (0.117) |
| $IQR^{e,input}_{fc,t}$ | -0.142 | -0.115 | -0.062 | -0.049 | -0.090 | -0.061 | -0.266** | -0.255** |
| | (0.088) | (0.083) | (0.076) | (0.070) | (0.081) | (0.075) | (0.108) | (0.107) |
| $IQR^{e,output}_{fc,t}$ | 0.651*** | 0.632*** | 0.566*** | 0.474*** | 0.527** | 0.400* | 0.598*** | 0.596*** |
| | (0.173) | (0.162) | (0.095) | (0.103) | (0.159) | (0.160) | (0.119) | (0.101) |
| $IQR^{e,\pi^{t+12}}_{fc,t}$ | 0.196*** | -0.239 | 0.271** | 0.142 | 0.231 | 0.029 | 0.134 | -0.049 |
| | (0.361) | (0.310) | (0.134) | (0.128) | (0.185) | (0.165) | (0.330) | (0.296) |
| $\pi_{t-1}$ | | 0.330*** | | 0.148*** | | 0.238** | | 0.202*** |
| | | (0.087) | | (0.051) | | (0.065) | | (0.066) |
| Obs. | 115 | 115 | 69 | 69 | 92 | 92 | 69 | 69 |
| R2 | 0.684 | 0.713 | 0.919 | 0.927 | 0.840 | 0.859 | 0.866 | 0.876 |

*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. Inference is conducted using robust standard errors. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

# Appendix

# A1 Additional Figures

## A1.1 Example of the questionnaire

QUARTERLY SURVEY ON INFLATION AND GROWTH EXPECTATIONS
IL SOLE 24 ORE – BANCA D'ITALIA

**Company Name** ______________________________________________________________________

**A0.** Which is your firm's main sector? |__|

**(1) Manufacturing**

**(2) Other Industry**
- Mineral extraction from mines
- Elettrical. gas. vapour. air conditioning supply
- Water supply
- Sewerage, waste management, and redevelopment

**(3) Trading**

**(4) Other Servicies**

**(5) Construction**
- Buildings
- Engineering
- Special construction works
(demolition and preparation of building sites, plant installation, completion and finishing. etc.)

## INDUSTRY EXCLUDING CONSTRUCTION AND SERVICES

**Firm**
**Instructions**: For percentage changes, indicate the sign in the first box on the left (+ :for increases; —: for decreases).

### SECTION A – General Information

**A1.** Number of employees : |__|__|__|__|__|

**A2.** Share of sales revenues coming from exports: |__|
(1= more than 2/3; 2= Between 1/3 and 2/3; 3= Up to 1/3 and more than zero; 4=Zero)

### SECTION B – General economic situation of the country

| | …in 6 months 2? | ..in one year? | … in two years? | … on average between three and five years? |
|---|---|---|---|---|
| **B1** The last [month ] consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was equal to [IT] in Italy and to [EA] in the euro area. What do you think it will be in Italy... | \|__\| \|__\|__\|,\|__\|% | \|__\| \|__\|__\|,\|__\|% | \|__\| \|__\|__\|,\|__\|% | \|__\| \|__\|__\|,\|__\|% |

**B2.** Compared with 3 months ago, do you consider Italy's general economic situation is …? ☐ Better ☐ The same ☐ Worse

**B3.** What do you think is the probability of an improvement in Italy's general economic situation **in the next 3 months**?
☐ Zero ☐ 1-25 per cent ☐ 26-50 per cent ☐ 51-75 per cent ☐ 76-99 per cent ☐ 100 per cent

### SECTION C – Your firm's business conditions

How do you think business conditions for your company will be:

**C1.** in the **next 3 months**? ☐ Much better ☐ Better ☐ The same ☐ Worse ☐ Much worse

**C2.** in the **next 3 years**? ☐ Much better ☐ Better ☐ The same ☐ Worse ☐ Much worse

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

| | Better | | | The same | | | Worse | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C3.** in the next **3 months** | | | | | | | | | | **1** | **0** | **0** |
| **C4.** in the next **3 years** | | | | | | | | | | **1** | **0** | **0** |

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

| Factors affecting your firm's business In the **next 3 months** | ***Effect on business*** | | | ***Intensity*** *(if not nil)* | | |
|---|---|---|---|---|---|---|
| | *Negative* | *Nil* | *Positive* | *Low* | *Average* | *High* |
| **C5.** Changes in demand | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C6.** Changes in YOUR PRICES | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C7.** AVAILABILITY and the COST OF CREDIT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C7.1** UNCERTAINTY DUE TO ECONOMIC AND POLITICAL FACTORS | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C7.2** EXCHANGE RATE DYNAMICS | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C7. 3** OIL PRICE DYNAMICS | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **C7.4** TENSIONS ON LIBERALIZATION POLICIES OF INTERNATIONAL TRADE | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |

**C8.** Compared with 3 month ago, do you think conditions for investment are ... ? ☐ Better ☐ The same ☐ Worse

**C9.** What do you think your liquidity situation will be in the next 3 months. given the expected change in the conditions of access to credit?
☐ Insufficient ☐ Sufficient ☐ More than sufficient

**C10.** Compared with three months ago, is the total demand for your products ... ? ☐ Higher ☐ Unchanged ☐ Lower

**C11.** How will the total demand for your products vary in the next 3 months? ☐ Increase ☐ No change ☐ Decrease

**(Answer to questions C12-C13 only if the share of sales revenues coming from exports is positive. otherwise go to C14)**

**C12. Compared with three months ago**, is the foreign demand for your products ... ? ☐ Higher ☐ Unchanged ☐ Lower

**C13.** How will the foreign demand for your products vary **in the next 3 months**? ☐ Increase ☐ No change ☐ Decrease

**C14.** Compared with three months ago, are credit conditions for your company ...? ☐ Better ☐ Unchanged ☐ Worse

**C15.** Overall, do you think your firm passed the most difficult stage of the economic situation?
☐ No ☐ Yes

### SECTION D – Changes in your firm's selling prices

**D1.** In the last 12 months, what has been the average change in your firm's prices? |__| |__|__|__|.|__|%

**D2.** For the next 12 months, what do you expect will be the average change in your firm's prices? |__| |__|__|__|.|__|%

Please indicate direction and intensity of the following factors as they will affect your firm's selling prices **in the next 12 months**:

| Factors affecting your firm's prices in the next 12 months | ***Effect on firm's selling prices*** | | | ***Intensity*** *(if not nil)* | | |
|---|---|---|---|---|---|---|
| | *Downward* | *Neutral* | *Upward* | *Low* | *Average* | *High* |
| **D3.** TOTAL DEMAND | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D4.** RAW MATERIALS PRICES | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D5.** INTERMEDIATE INPUT | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D6.** LABOUR COSTS | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D7.** PRICING POLICIES of your firm's main competitors | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |
| **D8.** EXCHANGE RATE DYNAMICS | 1\|__\| | 2\|__\| | 3\|__\| | 1\|__\| | 2\|__\| | 3\|__\| |

**D9.** In the last 12 months, what has been the average change in your firm's prices of goods and services bought in Italy and abroad ?
|__| |__|__|.|__|%

**D10**. In the last 12 months, what has been the average change in your firm's prices of goods and services bought in Italy and abroad?
|__| |__|__|.|__|%

## SECTION E – Workforce

| | *Lower* | *Unchanged* | *Higher* |
|---|---|---|---|
| **E1.** Your firm's total number of employees in the next 3 months will be: | 1\|__\| | 2\|__\| | 3\|__\| |

## SEZIONE F – Investment

**F1.** What do you expect will be the nominal expenditure on (tangible and intangible) fixed investment in the current year compared with the previous one?
☐ Much higher ☐ A little higher ☐ About the same ☐ A little lower ☐ Much lower

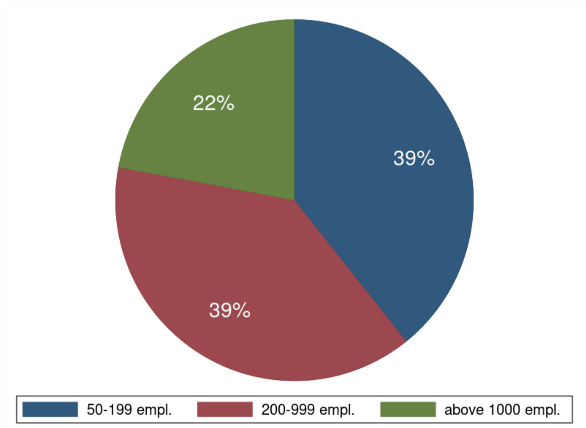
**F2.** And what do you expect will be the nominal expenditure in the first/second d half of the current year compared with that in the second /first half of current/previous year:
☐ Much higher ☐ A little higher ☐ About the same ☐ A little lower ☐ Much lower

NOTE: The responses "much higher" and "much lower" also apply when. in the two periods compared. investments are zero.

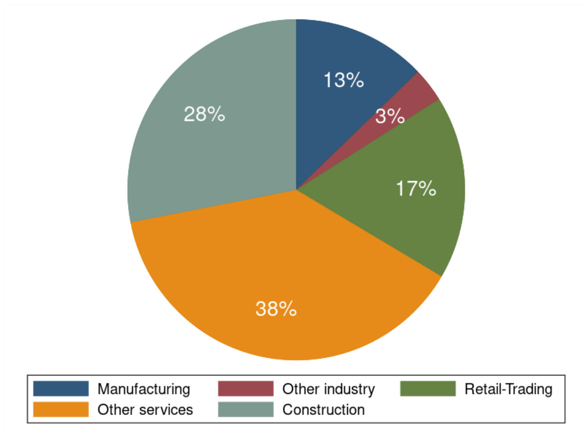
## A1.2 Survey composition

**Figure A1:** Composition of the sample by firm characteristic

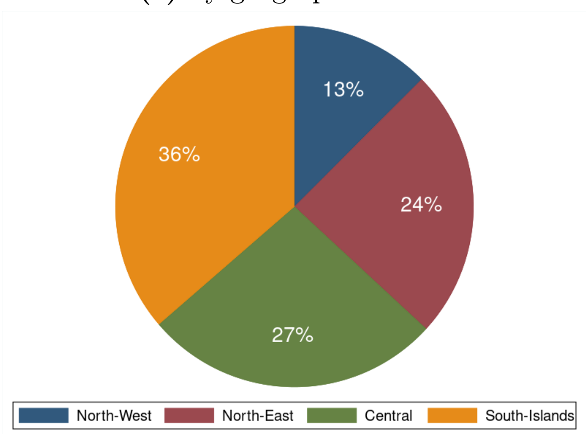
**(a)** by class size



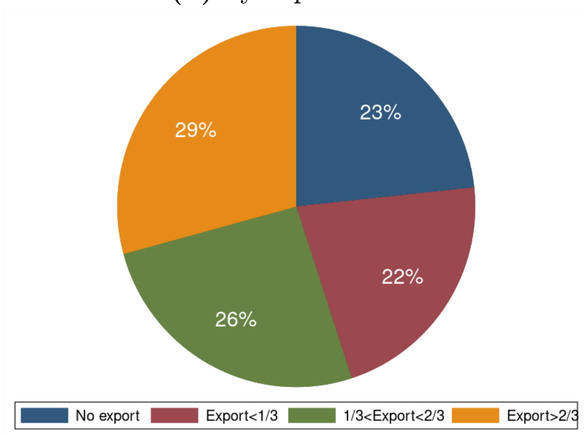

**(b)** by sector




**(c)** by geographical area




**(d)** by export share




*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1.

# A2 Additional Tables

## A2.1 Linear probability model

Table A1 shows the main results of a robustness in which we use a *linear probability model* (as in Frache et al., 2021) instead of a probit model as in Section 3. We adopt the following specification:

$$\begin{aligned} Adjp_{i,t} =& \beta_0 Adjp_{i,t-1} + \beta_1 D(\Delta p_{i,t}^{input}) + \beta_2 \pi_{t-1} + \beta_3 D(\Delta p_{i,t}^{e,o}) + \beta_4 D(\Delta p_{i,t}^{e,i}) \\ &+ \beta_5 D(\pi_{i,t}^{e,t+12}) + \beta_6\, slugghish_{i,t} + \sum_{j=1}^{4} \gamma_j D(Q_j) + \omega \mathbf{X_i} + u_{i,t} \end{aligned} \tag{7}$$

where we also add $slugghish_{i,t}$ in column (5) which is a variable that indicates the number of quarters from the last price adjustment. The evidence presented in Table 2 are also

**Table A1:** Probability of a price change and its drivers

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $Adjp_{i,t-1}$ | 0.601*** | 0.502*** | 0.501*** | 0.383*** | 0.471*** | 0.383*** |
| | (0.008) | (0.009) | (0.009) | (0.010) | (0.008) | (0.010) |
| $\Delta p_{i,t}^{input}$ | | 0.312*** | 0.310*** | 0.230*** | 0.141*** | 0.230*** |
| | | (0.010) | (0.010) | (0.011) | (0.008) | (0.011) |
| $\pi_{t-1}$ | | | 0.008*** | 0.002 | -0.000 | 0.002 |
| | | | (0.002) | (0.002) | (0.002) | (0.002) |
| $\Delta p_{i,t}^{e,o}$ | | | | 0.362*** | 0.232*** | 0.362*** |
| | | | | (0.011) | (0.009) | (0.011) |
| $\Delta p_{i,t}^{e,i}$ | | | | -0.055*** | -0.025*** | -0.055*** |
| | | | | (0.009) | (0.007) | (0.009) |
| $\pi_{i,t}^{e,t+12}$ | | | | -0.001 | -0.008** | -0.001 |
| | | | | (0.005) | (0.003) | (0.005) |
| $sluggish_{it}$ | | | | | 0.150*** | |
| | | | | | (0.007) | |
| $D(Q1)$ | | | | | | 0.006 |
| | | | | | | (0.008) |
| $D(Q2)$ | | | | | | 0.003 |
| | | | | | | (0.008) |
| $D(Q3)$ | | | | | | 0.007 |
| | | | | | | (0.006) |
| $N$ | 19892 | 19892 | 19892 | 19892 | 19892 | 19892 |
| adj. $R^2$ | 0.398 | 0.465 | 0.466 | 0.548 | 0.706 | 0.548 |

*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. All regressions include fixed-effects for sector of activity, geographical area, firm class size, and exposure to foreign markets. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

confirmed using this approach. Indeed, the probability of a price change at time $t$ remains a function of previous choices, variations to input costs and expected own prices. In addition, the statistical significance of the coefficient associated to $slugghish_{i,t}$ indicates that the probability of a price change is increasing with respect to the distance of the last variation.

## A2.2 Drivers of price changes and firm characteristics

To assess the role of different characteristics on firms' pricing decisions, we adapt the regression model in (3) with the addition of some interaction terms, namely:

$$\Delta p_{i,t} = c + \alpha_i + \beta_1 \Delta p_{i,t-1} * \mathbf{D_{fc}} + \beta_2 \Delta p_{i,t}^{input} * \mathbf{D_{fc}} + \beta_3 \Delta p_{i,t}^{e,o} * \mathbf{D_{fc}} + \omega \mathbf{X_i} + u_{i,t} \qquad (8)$$

where the dummy $D_{fc}$ is interacted with each regressor, allowing us to provide some quantitative evidence on the role of firm characteristic on the various channels. We consider four different firm characteristics for the interaction: the class size, the sector of activity, the geographical area and the exposure to foreign markets. These four dimensions are the most likely candidates that can generate some heterogeneity in firms' pricing decisions. The proposed specification includes also the matrix $X_i$ to control for the systematic effect of firm characteristics. Differently from the specification previously used in (3), here we do not include as regressors some of the variables that did not have a significant role, such as firms' expectations about input price changes and aggregate inflation.

**Table A2:** Firm class size as determinant

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $\Delta p_{i,t-1}$ | 0.406*** | | 0.299*** | | 0.275*** | |
| | (0.043) | | (0.024) | | (0.023) | |
| 50-199 empl. $\times$ $\Delta p_{i,t-1}$ | | 0.359*** | | 0.264*** | | 0.223*** |
| | | (0.038) | | (0.023) | | (0.022) |
| 200-999 empl. $\times$ $\Delta p_{i,t-1}$ | | 0.464*** | | 0.317*** | | 0.312*** |
| | | (0.067) | | (0.041) | | (0.039) |
| above 1000 empl. $\times$ $\Delta p_{i,t-1}$ | | 0.560*** | | 0.498*** | | 0.501*** |
| | | (0.065) | | (0.058) | | (0.059) |
| $\Delta p_{i,t}^{input}$ | | | 0.291*** | | 0.229*** | |
| | | | (0.016) | | (0.017) | |
| 50-199 empl. $\times$ $\Delta p_{i,t}^{input}$ | | | | 0.291*** | | 0.220*** |
| | | | | (0.019) | | (0.020) |
| 200-999 empl. $\times$ $\Delta p_{i,t}^{input}$ | | | | 0.309*** | | 0.260*** |
| | | | | (0.023) | | (0.025) |
| above 1000 empl. $\times$ $\Delta p_{i,t}^{input}$ | | | | 0.211*** | | 0.188*** |
| | | | | (0.037) | | (0.039) |
| $\Delta p_{i,t}^{e,o}$ | | | | | 0.345*** | |
| | | | | | (0.026) | |
| 50-199 empl. $\times$ $\Delta p_{i,t}^{e,o}$ | | | | | | 0.405*** |
| | | | | | | (0.026) |
| 200-999 empl. $\times$ $\Delta p_{i,t}^{e,o}$ | | | | | | 0.255*** |
| | | | | | | (0.043) |
| above 1000 empl. $\times$ $\Delta p_{i,t}^{e,o}$ | | | | | | 0.143 |
| | | | | | | (0.090) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Area | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Yes | Yes | Yes | Yes | Yes | Yes |
| Quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 19501 | 19501 | 19501 | 19501 | 19501 | 19501 |
| R2 | 0.422 | 0.425 | 0.521 | 0.524 | 0.570 | 0.577 |

*Source:* Authors' calculations on SIGE data. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

**Table A3:** Sector of activity as determinant

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $\Delta p_{i,t-1}$ | 0.406*** | | 0.300*** | | 0.275*** | |
| | (0.043) | | (0.024) | | (0.023) | |
| Manufacturing × $\Delta p_{i,t-1}$ | | 0.548*** | | 0.379*** | | 0.364*** |
| | | (0.069) | | (0.034) | | (0.031) |
| Other industry × $\Delta p_{i,t-1}$ | | 0.601*** | | 0.537*** | | 0.542*** |
| | | (0.082) | | (0.063) | | (0.061) |
| Retail-Trading × $\Delta p_{i,t-1}$ | | 0.337*** | | 0.187*** | | 0.154*** |
| | | (0.061) | | (0.038) | | (0.035) |
| Other services × $\Delta p_{i,t-1}$ | | 0.261*** | | 0.203*** | | 0.184*** |
| | | (0.040) | | (0.034) | | (0.030) |
| Construction × $\Delta p_{i,t-1}$ | | 0.244*** | | 0.216*** | | 0.118*** |
| | | (0.053) | | (0.049) | | (0.036) |
| $\Delta p_{i,t}^{input}$ | | | 0.291*** | | 0.229*** | |
| | | | (0.017) | | (0.018) | |
| Manufacturing × $\Delta p_{i,t}^{input}$ | | | | 0.297*** | | 0.247*** |
| | | | | (0.018) | | (0.019) |
| Other industry × $\Delta p_{i,t}^{input}$ | | | | 0.272*** | | 0.282*** |
| | | | | (0.035) | | (0.036) |
| Retail-Trading × $\Delta p_{i,t}^{input}$ | | | | 0.440*** | | 0.390*** |
| | | | | (0.029) | | (0.036) |
| Other services × $\Delta p_{i,t}^{input}$ | | | | 0.255*** | | 0.174*** |
| | | | | (0.032) | | (0.026) |
| Construction × $\Delta p_{i,t}^{input}$ | | | | 0.191*** | | 0.089*** |
| | | | | (0.014) | | (0.019) |
| $\Delta p_{i,t}^{e,o}$ | | | | | 0.345*** | |
| | | | | | (0.026) | |
| Manufacturing × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.278*** |
| | | | | | | (0.037) |
| Other industry × $\Delta p_{i,t}^{e,o}$ | | | | | | -0.028 |
| | | | | | | (0.094) |
| Retail-Trading × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.279*** |
| | | | | | | (0.046) |
| Other services × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.394*** |
| | | | | | | (0.035) |
| Construction × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.586*** |
| | | | | | | (0.031) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Size | Yes | Yes | Yes | Yes | Yes | Yes |
| Area | Yes | Yes | Yes | Yes | Yes | Yes |
| Quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 19501 | 19501 | 19501 | 19501 | 19501 | 19501 |
| R2 | 0.422 | 0.435 | 0.521 | 0.532 | 0.570 | 0.594 |

*Source:* Authors' calculations on SIGE data. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

**Table A4:** Geographical area as determinant

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $\Delta p_{i,t-1}$ | 0.406*** | | 0.299*** | | 0.275*** | |
| | (0.043) | | (0.024) | | (0.023) | |
| North-West × $\Delta p_{i,t-1}$ | | 0.442*** | | 0.316*** | | 0.295*** |
| | | (0.063) | | (0.039) | | (0.037) |
| North-East × $\Delta p_{i,t-1}$ | | 0.474*** | | 0.347*** | | 0.319*** |
| | | (0.047) | | (0.034) | | (0.034) |
| Central × $\Delta p_{i,t-1}$ | | 0.423*** | | 0.304*** | | 0.290*** |
| | | (0.053) | | (0.037) | | (0.037) |
| South-Islands × $\Delta p_{i,t-1}$ | | 0.269*** | | 0.220*** | | 0.190*** |
| | | (0.047) | | (0.042) | | (0.041) |
| $\Delta p_{i,t}^{input}$ | | | 0.291*** | | 0.229*** | |
| | | | (0.016) | | (0.017) | |
| North-West × $\Delta p_{i,t}^{input}$ | | | | 0.287*** | | 0.231*** |
| | | | | (0.022) | | (0.026) |
| North-East × $\Delta p_{i,t}^{input}$ | | | | 0.300*** | | 0.236*** |
| | | | | (0.026) | | (0.025) |
| Central × $\Delta p_{i,t}^{input}$ | | | | 0.291*** | | 0.239*** |
| | | | | (0.028) | | (0.026) |
| South-Islands × $\Delta p_{i,t}^{input}$ | | | | 0.269*** | | 0.195*** |
| | | | | (0.023) | | (0.024) |
| $\Delta p_{i,t}^{e,o}$ | | | | | 0.345*** | |
| | | | | | (0.026) | |
| North-West × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.315*** |
| | | | | | | (0.038) |
| North-East × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.339*** |
| | | | | | | (0.037) |
| Central × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.319*** |
| | | | | | | (0.042) |
| South-Islands × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.400*** |
| | | | | | | (0.048) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Size | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Yes | Yes | Yes | Yes | Yes | Yes |
| Quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 19501 | 19501 | 19501 | 19501 | 19501 | 19501 |
| R2 | 0.422 | 0.426 | 0.521 | 0.522 | 0.570 | 0.572 |

*Source:* Authors' calculations on SIGE data. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

**Table A5:** Export share as determinant

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $\Delta p_{i,t-1}$ | 0.405*** | | 0.299*** | | 0.275*** | |
| | (0.043) | | (0.024) | | (0.023) | |
| No export × $\Delta p_{i,t-1}$ | | 0.308*** | | 0.252*** | | 0.211*** |
| | | (0.036) | | (0.029) | | (0.030) |
| Exporter × $\Delta p_{i,t-1}$ | | 0.475*** | | 0.331*** | | 0.318*** |
| | | (0.052) | | (0.028) | | (0.025) |
| $\Delta p_{i,t}^{input}$ | | | 0.291*** | | 0.229*** | |
| | | | (0.016) | | (0.018) | |
| No export × $\Delta p_{i,t}^{input}$ | | | | 0.250*** | | 0.179*** |
| | | | | (0.024) | | (0.025) |
| Exporter × $\Delta p_{i,t}^{input}$ | | | | 0.309*** | | 0.257*** |
| | | | | (0.017) | | (0.018) |
| $\Delta p_{i,t}^{e,o}$ | | | | | 0.345*** | |
| | | | | | (0.026) | |
| No export × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.418*** |
| | | | | | | (0.032) |
| Exporter × $\Delta p_{i,t}^{e,o}$ | | | | | | 0.280*** |
| | | | | | | (0.029) |
| Firm FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Size | Yes | Yes | Yes | Yes | Yes | Yes |
| Area | Yes | Yes | Yes | Yes | Yes | Yes |
| Sector | Yes | Yes | Yes | Yes | Yes | Yes |
| Quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 19501 | 19501 | 19501 | 19501 | 19501 | 19501 |
| R2 | 0.422 | 0.427 | 0.521 | 0.523 | 0.570 | 0.574 |

*Source:* Authors' calculations on SIGE data. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.

## A2.3 The dispersion of price changes and the level of inflation

Following the approach by Nakamura et al. (2018), we use the *absolute size* of price changes as a measure of dispersion (instead of the *interquartile range* as in Section 5) and we analyse the relationship with actual inflation dynamics. In practice, we estimate the following model:

$$abs(\Delta p_{i,t}) = c + \beta\pi_{t-1} + \omega\mathbf{X_i} + u_{i,t} \tag{9}$$

where $abs(\Delta p_{i,t})$ corresponds to the absolute value of the price changes and $\pi_{t-1}$ to the level of actual inflation.

Table A6 confirms our main finding of a positive relation between the two series with respect to the inclusion on several type of fixed-effects. Overall, these results suggest that the average size of price changes increases with actual inflation dynamics.

**Table A6:** Absolute size of price changes and the level of inflation

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\pi_{t-1}$ | 0.470*** | 0.434*** | 0.435*** | 0.435*** |
| | (0.155) | (0.119) | (0.118) | (0.118) |
| Firm FE | No | Yes | Yes | Yes |
| Sector | No | No | Yes | Yes |
| Size | No | No | No | Yes |
| Area | No | No | No | Yes |
| Obs. | 27286 | 26677 | 26677 | 26677 |
| R2 | 0.029 | 0.420 | 0.420 | 0.420 |

*Source:* Authors' calculations on SIGE data over the sample period 2016Q3-2022Q1. Inference is conducted using a two-clustering approach on the time period and the sector of activity. Standard errors in parentheses. P-values: $*p < 0.1, **p < 0.05, ***p < 0.01$.