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Beyond Costs: The Dominant Role of Strategic Complementarities in Pricing

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ABSTRACT: This paper documents five empirical facts about the role of strategic complementarities in firms' price-setting behavior, using administrative data from Chilean firms. (1) Strategic complementarities play a dominant role in price setting, exerting a stronger influence than changes in marginal costs. (2) While the strength of strategic complementarities varies across sectors, they consistently outweigh the role of cost changes. (3) In high-inflation environments, firms become more responsive to changes in the prices of their competitors. (4) Firms respond more strongly to competitor price increases than to decreases, mirroring the `rockets and feathers' phenomenon of costs. (5) Strategic complementarities are stronger among firms with fewer competitors, larger market shares, and broader customer bases. These findings suggest that strategic complementarities---a source of real rigidities---are sizable, state-dependent, asymmetric, and shaped by market structure.

JEL Classification Numbers:	D22, E31
Keywords:	Pass-through; price setting; strategic complementarities; state dependency; market structure

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Beyond Costs: The Dominant Role of Strategic Complementarities in Pricing*

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Abstract

This paper documents five empirical facts about the role of strategic complementarities in firms' price-setting behavior, using administrative data from Chilean firms. (1) Strategic complementarities play a dominant role in price setting, exerting a stronger influence than changes in marginal costs. (2) While the strength of strategic complementarities varies across sectors, they consistently outweigh the role of cost changes. (3) In high-inflation environments, firms become more responsive to changes in the prices of their competitors. (4) Firms respond more strongly to competitor price increases than to decreases, mirroring the 'rockets and feathers' phenomenon of costs. (5) Strategic complementarities are stronger among firms with fewer competitors, larger market shares, and broader customer bases. These findings suggest that strategic complementarities—a source of real rigidities—are sizable, state-dependent, asymmetric, and shaped by market structure.

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1 Introduction

A central tenet of New-Keynesian macroeconomic models is that prices adjust sluggishly in response to changes in marginal costs. This nominal rigidity gives rise to monetary non-neutrality and is reflected in a flatter Phillips curve. If instead prices are flexible, the sacrifice ratio is lower and monetary policy effectiveness is diminished and can become even neutral (Golosov and Lucas, 2007). However, price rigidity is not only determined by the pass-through of marginal costs. A firm's pricing decisions are also shaped by the pricing behavior of its competitors (Cooper and John, 1988), and these interdependencies—referred to as strategic complementarities—have a direct effect on the slope of the Phillips curve (Gopinath and Itskhoki, 2011; Gagliardone et al., 2023). In this respect, some studies argue that monetary non-neutrality arises only when real rigidities are coupled with nominal rigidities (Klenow and Willis, 2016).

But how do strategic complementarities originate? When a firm considers raising its price in response to an increase in marginal costs, it also takes into account how competitors would react. If strategic complementarities are strong, the pass-through of marginal cost increases is reduced, as firms fear losing market share if they raise prices unilaterally. Thus, strategic complementarities can lead to a coordination problem, where firms are reluctant to be the first to change prices, contributing to price stickiness. From a theoretical standpoint, strategic complementarities arise in oligopolistic settings in which the elasticity of demand and markups are a function of the firms' market shares (Atkeson and Burstein, 2008; Wang and Werning, 2022). In these frameworks an increase in competitors' prices lowers a firm's relative prices, boosting its demand and resulting in a market share beyond the optimal level. Thus, the firm reacts by increasing its prices, bringing the market share back to its optimal level. The (slim) empirical evidence on the importance of strategic pricing suggests that these interdependences are important determinants of firms' prices, albeit less than changes in firms' marginal costs (Amiti, Itskhoki and Konings, 2019; Gagliardone et al., 2023).

In this paper, we use unique confidential administrative data on input and sales prices of firms in Chile to document some key facts about strategic complementarities in price setting. We employ an accounting framework in which prices can be expressed as a weighted average of firms' marginal costs and the prices of their competitors, with the weight on the latter providing a measure of the strength of strategic complementarities (Gopinath and Itskhoki, 2011). Using this framework, we examine the dynamic responses of firms' prices to changes in their competitors' prices and compare them to the responses to changes in their marginal costs, along both the extensive margin of price adjustments (the frequency of price changes) and intensive one (the magnitude of price changes).

Examining strategic complementarities requires a careful identification of each firm's competitors. The literature usually assumes that firms in the same sector are competitors. However, firms do not typically compete with all other firms in the same industry, and may in fact compete only on a subset of their products, and only in certain locations. Leveraging the granularity of our data, we construct a significantly narrower measure of competitors' prices that accounts for the industry in which firms operate, the products they sell, and the geographical area where they compete. With respect to marginal costs, we directly measure the prices of intermediate inputs using data from electronic invoices. Our sample period—from January 2014 to December 2023—is characterized by large inflation fluctuations in Chile, which further allows exploring whether firms' strategic pricing is state dependent and asymmetric. At the same time, the large cross-sectional dimension of the data—covering the universe of firms in the manufacturing, wholesale, and retail sectors (henceforth referred to as retailers)—lets us explore the sectoral heterogeneity and examine how the intensity of competition, firms' market shares, and their customer bases shape strategic behavior in pricing.

The first fact we document is that strategic complementarities are overwhelmingly important for firms' price setting, relatively more than changes in marginal costs. We estimate that firms pass-through 66 percent of the changes in competitors' prices to their own sales prices over the one-year horizon. In comparison, the response of sales prices to changes in marginal costs is considerably smaller and slower, with the degree of pass-through estimated at 18 percent one year after the shock. That is, the pass-through of changes in competitors' prices is about 3.7 times larger than the pass-through of changes in their own costs. Compared to recent studies estimating these elasticities for manufacturing firms, we find a much more prominent role of strategic complementarities relative to changes in marginal costs for firms' pricing.[1] We attribute these differences to a smaller measurement error, as we benefit from the rich administrative dataset that allows a more precise computation of competitors´ prices and firms' marginal costs, and a different sample composition.

We also find that firms adjust their prices in response to competitors' prices along both the extensive and the intensive margins. One year after a one percentage point increase in competitors' prices, the frequency of price changes rises by 2.2 percentage points—– 1.5 times the response to an equivalent increase in marginal costs. This implies that a 27

[1] Using data on Belgian manufacturing firms, Amiti et al. (2022) and Gagliardone et al. (2023) find an elasticity of about 0.4 in response to its competitors' price changes and an elasticity of about 0.6 in response to its own cost shocks.

percent increase in competitors' prices is sufficient to prompt the average firm to adjust the prices of all its products, whereas marginal costs would need to surge by 60 percent to achieve the same result. At the intensive margin, firms react swiftly, incorporating a large share of competitor price changes into their sales prices. By the end of the year, firms have passed through nearly 70 percent of the competitor price increase. In contrast, the adjustment to changes in marginal costs is more gradual and only 24 percent of the initial increase is reflected in sales prices.

The second fact is that the strength of strategic complementarities varies across sectors, but usually remains of first-order importance. We show that manufacturing firms pass through about 40 percent of the changes in competitors' prices. This is considerably less than for retail firms, whose pass-through is about 70 percent. These estimates, however, are still substantially larger than the cost pass-through rates: 26 percent for manufacturing firms and 13 percent for retail firms. That is, strategic complementarities remain dominant even when focusing on the manufacturing sector, the usual focus of the literature. Further analysis of cross-industry heterogeneity further corroborates that strategic complementarities are of first-order importance. Turning to the magnitude of price adjustments, we find that retailers pass on a much larger share of the changes in competitors' prices within the first couple of months since the shock, while it takes the entire year for manufacturers to pass on the same share. The frequency of price adjustments in response to changes in competitors' prices is also significantly higher for retailers than manufacturers at the one-year horizon. These results align with the evidence of higher repricing costs for manufacturers, which face longer production cycles and less frequent sales (Goldberg and Hellerstein, 2007).

The third fact is that strategic complementarities are state dependent. State dependent models predict that, in an environment of heightened nominal volatility firms are more likely to experience large cost shocks, which diminish their profits, triggering more frequent price adjustments compared to periods of greater stability (Klenow and Kryvtsov, 2008). If firms' optimal prices depend on competitors' prices, the increased frequency of price adjustments may also affect the extent to which firms engage in strategic pricing. Thus, we examine whether firms react more strongly to changes in their input prices and competitors' prices when aggregate inflation is high. We indeed find that, in high inflation environments, firms disproportionately respond to changes in marginal costs and competitors' prices. Mapping the pass-through estimates to the structural markup elasticities reveals that this pattern is related to firms' tendency to stabilize markups relative to their prices, which leads them to respond more aggressively to variations in both input and competitors' prices. In addition, we show that while firms are more likely to respond to changes in costs only by adjusting prices more frequently, changes in competitors' prices trigger both more frequent and larger price adjustments. From a policy perspective, this means that monetary policy has less traction on real outcomes, while it would lead to a faster adjustment in prices.

The fourth fact is that firms' prices react more strongly when competitors' raise prices than when they cut them. The literature has shown that firms are more sensitive to cost increases than cost decreases, like 'rockets and feathers' (Bacon, 1991; Peltzman, 2000). However, asymmetries in strategic pricing remain unexplored. We provide evidence that the pass-through from competitors' price changes is greater when these increase than when they decrease, extending the 'rockets and feathers' phenomenon of marginal cost changes to strategic complementarities. In the latter case, increases in competitors' prices result in lower relative prices, prompting a more aggressive upward price adjustment than the downward adjustment following declines in competitors' prices. This larger pass-through of competitors' price increases reflects a larger increase in the frequency of price adjustments, while there are no statistically significant differences in the magnitude of price changes.

The fifth fact is that firms exhibit stronger strategic complementarities when they have fewer competitors, hold larger market shares, and serve broader customer bases. Firms are more willing to engage in strategic pricing when they operate in concentrated markets (Atkeson and Burstein, 2008). In such settings, firms with market power can influence prices more effectively to maximize their profits. Also, concentrated markets often have high barriers to entry, enabling existing firms to engage in strategic pricing without the immediate risk of losing market share to new competitors. And with fewer competitors, firms can more easily coordinate their pricing strategies. Slicing the data of firms in the manufacturing sector along different dimensions of market concentration—the number of competing firms, the firms' market shares, or the size of their customer bases—we find support for the prediction that firms in more concentrated markets engage more aggressively in strategic pricing.

We conduct a range of robustness checks to validate the empirical facts documented in the paper. First, our results remain virtually unchanged when including sector-time fixed effects to account for sector-specific demand shocks and coordinated wage adjustments. Second, leveraging the granularity of our data, we construct instrumental variables (IVs) to address two sources of endogeneity. First, to mitigate the potential reverse causality of changes in marginal costs due to the monopsonic power of some firms, we exclude purchases of firms from suppliers that have only a few buyers. Second, to tackle the simultaneity in price setting between firms and their competitors, we instrument competitors' prices using input cost changes faced by their suppliers, excluding inputs sold to both the firm and its competitors. The IV results corroborate our finding that strategic complementarities play a dominant role in price setting—if anything, our OLS estimates appear to be conservative. Additional robustness checks—including extended response horizons and alternative estimation methods—further confirm the strength and consistency of our results.

These results underscore the importance of incorporating strategic complementarities, a source of real rigidities, in macroeconomic models. Our findings imply that monetary policy can have relatively larger effects on real variables than standard models predict. However, the magnitude of these effects depends on broader macroeconomic conditions, the direction of cost and competitor price changes, and the structural characteristics of the markets in which firms operate. By precisely estimating the elasticity of firms' prices with respect to both their own costs and competitors' prices, documenting how these elasticities vary across different environments, our findings open new avenues for future research aimed at assessing the effectiveness of monetary policy when nominal rigidities are paired with real ones.

Related literature. Our paper is primarily related to the studies quantifying the strength of strategic complementarities. Two key studies in this area are Amiti, Itskhoki and Konings (2019) and Gagliardone et al. (2023), who use Belgian micro data for manufacturing firms showing that the prices of the competitors matter when firms decide how to adjust their own prices. We complement the evidence in these papers by shifting the focus to an emerging market with larger inflation swings, broadening the sample of firms to those in the retail and wholesale sectors, narrowing the identification of competitors based on geographical and product information, exploring firms' price adjustments along the extensive and the intensive margins, and examining pass-through dynamics.[2]

The paper is also more generally related to the literature on cost pass-through. Data limitations forced much of the work in this area using micro data to focus on a few small sectors, such as cars, beer, and coffee (Feenstra, Gagnon and Knetter, 1996; Nakamura and Zerom, 2010; Goldberg and Hellerstein, 2013). Moreover, as it is challenging to obtain reliable information about the cost of firms' intermediate inputs, many studies solely consider selected products like energy (Fontagné, Martin and Orefice, 2018; Ganapati, Shapiro and Walker, 2020; Lafrogne-Joussier, Martin and Mejean, 2023) or rely on movements in the exchange rate or import prices (Gopinath and Itskhoki, 2010; Auer and

[2]Pass-through dynamics to changes in competitors' prices received little attention in the literature. An exception is Gagliardone et al. (2023), who characterize the dynamic pass-through via an error-correction equation.

Schoenle, 2016; Pennings, 2017; Amiti, Itskhoki and Konings, 2019) to identify exogenous variation in costs. By leveraging the richness of administrative price information from firm-to-firm invoices, we extend this evidence to a broader set of products and markets across different industries. Also, we depart from admittedly noisy accounting measures of firms' average variable costs and measuring directly the price changes of intermediate inputs.

Our analysis of state dependency in strategic pricing is related to the growing evidence on firms' optimizing behavior. Earlier contributions showed that pricing is indeed state dependent, both in advanced economies (Klenow and Kryvtsov, 2008; Nakamura and Steinsson, 2008; Eichenbaum, Jaimovich and Rebelo, 2011; Campbell and Eden, 2014; Lafrogne-Joussier, Martin and Mejean, 2023) and emerging markets (Gagnon, 2009; Alvarez et al., 2019). We extend these findings that largely focus on firms' own costs by examining whether the scope to engage in strategic pricing is also state dependent. Similarly, we contribute to the literature on asymmetric pricing (Bacon, 1991; Peltzman, 2000), extending it to strategic complementarities. Studies in this area are typically limited to firms' own costs and specific markets, such as fuel, food, and retail goods (Karrenbrock et al., 1991; Neumark and Sharpe, 1992). We broaden the focus to the universe of firms in the manufacturing and retail sectors, and examine both the asymmetric price response of firms to changes in marginal costs and competitors' prices.

Finally, our study contributes to the literature on how market concentration shapes firms' pricing behavior. In the model of Atkeson and Burstein (2008), strategic complementarities are stronger among firms facing lower competition and holding higher market shares. Amiti, Itskhoki and Konings (2019) document that strategic complementarities differ between large and small firms, as well as between firms with high and low market shares. Consistent with these findings, we show that firms with higher market shares exhibit stronger strategic complementarities—particularly when they face less competition and maintain a larger customer base. Our results can inform quantitative models, such as Wang and Werning (2022), that rely on estimates of strategic complementarities to gauge the effects of monetary policy under varying degrees of market concentration.

The rest of the paper is organized as follows. In Section 2, we describe the sources of our data and the cleaning procedure, and provide a descriptive analysis of price adjustments along the extensive and the intensive margins. We then discuss the empirical framework in Section 3. Section 4 establishes five key facts about firms' price setting in relation to their competitors' prices. We present the results of a series of robustness tests in Section 5. Section 6 concludes.

2 Data

Our empirical analysis focuses on Chile over the period January 2014 to December 2023. Unlike advanced economies, where inflation remained low and stable until the pandemic, Chile experienced substantial inflation fluctuations throughout the sample. On a year-on-year basis, CPI inflation declined to 1.4 percent in late 2017 after peaking at 5.9 percent at the end of 2014, remaining above the central bank's 3 percent target during the so-called 'commodity supercycle'. After a period of relative stability around the central bank's target, inflation began rising in mid-2020 and reached a peak of 14 percent in August 2022, before gradually declining to 3.8 percent by the end of 2023. PPI inflation followed a similar trajectory but with markedly higher volatility. It turned negative in 2016, 2019, and 2023, reaching a trough of –8.7 percent in July 2023. In 2014 it approached 10 percent, and surged to 27.9 percent in July 2022. These pronounced fluctuations in both consumer and producer prices provide a rich environment for studying firms' price-setting behavior.

To construct our dataset, we draw from the detailed price information of the administrative firm-to-firm invoice records maintained by Chile's Internal Revenue Service. Since 2014, Chilean firms have been required to issue electronic invoices, which report prices and quantities for each product variety sold. From these records, we extract information about the buyer, the seller, their economic sectors, the product varieties sold (identified by text descriptors), and the prices at which transactions were settled for the universe of domestic transactions.[3]

We aggregate the transaction-level data at the selling firm–product variety–month level by computing the median price at which each product variety is sold in a given month. Then, we apply a series of cleaning criteria to exclude erroneous or invalid records. If the month-to-month price change is smaller than 10 Chilean pesos (less than 2 U.S. cents), we treat the observation as a non-change and carry forward the previous month's price. If a price change in one month is fully reversed in the following month, we also replace it with the prior month's price. Also, we drop records for which the price change lies outside the bottom and top 5th percentile interval of the distribution, corresponding to instances in which prices decline by more than half or increase by more than double. Finally, to ensure that we are analyzing genuine firms—as opposed to entities

[3] Eichenbaum et al. (2014) shows that unit value based pricing induces a leftward shift in the distribution of price changes, overstating the frequency of small price adjustments and understating the frequency of large ones. It also leads to infer that the median size of price changes is smaller than in reality. Because we directly observe actual transaction prices rather than inferred unit values, our data are not subject to these distortions.

created for tax purposes—we further restrict the sample based on firm characteristics. First, we exclude firms with fewer than five employees on average over the year.[4] Second, we retain only firms that are listed in the Chilean National Accounts registry. Third, we drop within-firm transactions, which may not reflect market pricing. Fourth, we exclude transactions that were subject to invoice corrections via credit notes. [5]

2.1 Firms' prices

We compute a measure of firm-level inflation for all firms in the manufacturing and retail sectors. To do so, we first calculate the median (or, alternatively, the average) price of each product sold by a firm in each month. Then, for each firm i selling product variety v at time t, we construct its inflation rate as the sales-weighted average of product-level price changes

$$\Delta p_{i,t} = \sum_{v \in i} \omega_{i,v,t} \Delta p_{i,v,t}, \tag{1}$$

where $\omega_{i,v,t}$ denotes the one-year rolling average of the the sales share of product variety v in firm i's total sales at time t.[6] Our sample consists of 21,722 firms.

Following Klenow and Kryvtsov (2008), we decompose the firm's inflation rate into the product of the extensive margin—–the frequency of price changes, $f_{i,t}$—and the intensive margin—–the average size of non-zero price changes, $s_{i,t}$—as follows

$$\Delta p_{i,t} = f_{i,t} s_{i,t}, \tag{2}$$

and explore how firms set prices along these margins. The firm-level measure of the frequency of price changes is computed as the share of product varieties sold by the firm

[4]Chilean employers are required to report wage information to calculate social security contributions and withholding taxes. From these administrative records, we retrieve both the number of employees and the firms' wage bill.

[5]This study was developed within the scope of the research agenda conducted by the Central Bank of Chile (CBC) in economic and financial affairs of its competence. The CBC has access to anonymized information from various public and private entities, by virtue of collaboration agreements signed with these institutions. To secure the privacy of workers and firms, the CBC mandates that the development, extraction and publication of the results should not allow the identification, directly or indirectly, of natural or legal persons. Officials of the CBC processed the disaggregated data. All the analysis was implemented by the authors and did not involve nor compromise the Servicio de Impuestos Internos (Chilean IRS or SII). The information contained in the databases of the Chilean IRS is of a tax nature originating in self-declarations of taxpayers presented to the Service; therefore, the veracity of the data is not the responsibility of the Service.

[6]As alternative weighting schemes, we use simple averages and the contemporaneous sales shares.

that changed prices per unit of time

$$f_{i,t} = \sum_{v \in i} \omega_{i,v,t} \frac{\sum_{v \in i} D_{v,i,t}}{\sum_{v \in i} O_{v,i,t}}, \tag{3}$$

where $D_{v,i,t}$ is an indicator equal to one if the price of product variety v sold by firm i changes in month t, and $O_{v,i,t}$ indicates whether the price of product variety v is observed in that month. The firm-level measure of the average size of price changes, conditional on observing a non-zero price change, is

$$s_{i,t} = \sum_{v \in i} \omega^{\neq 0}_{i,v,t} \frac{\sum_{v \in i} \Delta p^{\neq 0}_{v,i,t}}{\sum_{v \in i} O^{\neq 0}_{v,i,t}}, \tag{4}$$

where $\Delta p^{\neq 0}_{v,i,t}$ denotes the price change for product variety v when the price differs from the previous month, and $\omega^{\neq 0}_{i,v,t}$ are the corresponding sales weights, normalized over the subset of varieties with non-zero price changes.

As we also want to examine whether price increases or decreases are more frequent and different in size, we repeat the frequency and size calculations separately for price increases and decreases such that

$$\Delta p_{i,t} = f_{i,t} s_{i,t} \approx f^{+}_{i,t} s^{+}_{i,t} + f^{-}_{i,t} s^{-}_{i,t}, \tag{5}$$

where superscripts + and – denote positive and negative price changes, respectively. To avoid the risk of large fluctuations affecting the results, we drop observations outside of the bottom and top 5 percentile interval of the distribution, which approximately corresponds to monthly price declines and increases of over 20 percent.

The literature pointed out that assessing price rigidity using observed prices can be problematic due to temporary sales and stockouts. Price variations associated with these events have little to do with the price changes analyzed in price-setting models and are unlikely to be related to macroeconomic conditions. The second issue is product substitution. A price change associated with the end of a product's life cycle and the introduction of a new one is motivated by factors unrelated to the firm's desire to change the product's price. To deal with temporary sales, we follow Nakamura and Steinsson (2008) and compute regular prices from observed prices.[7] As for product substitution, we get around the issue by working with data at the product variety level. In the Chilean system, whenever

[7]This methodology assumes that the regular price is usually the same after sales and stockouts as before, which indicates that the old regular price should be viewed as a latent state variable in the firm's pricing problem. Appendix A provides details about the implementation of this approach.

a firm introduces a new product substituting an old one, the new product gets assigned a different text descriptor corresponding to a unique variety. Thus, any product substitution gets classified as a new product variety.

Table 1 reports the frequency and size of price changes at the firm level, as defined in Equation 3 and Equation 4.[8] To aggregate across firms, we employ two alternative weighting schemes—based on sales and on employment—and report the corresponding time averages. Using sales-based weights, the weighted median frequency of observed price changes is 40.5 percent. With employment-based weights, the frequency is somewhat lower at 37.3 percent. Both estimates imply that, on average, firms adjust prices approximately every two months. When we focus on regular prices, the frequency declines: the weighted median falls to 31.6 percent using sales weights and to 27.7 percent using employment weights. This indicates that regular prices persist, on average, nearly three weeks longer than observed prices.

Price increases occur more frequently than price decreases. For observed prices, the difference in frequency is approximately 6 percentage points, while for regular prices the gap narrows to about 4 percentage points. Comparing observed and regular prices also reveals that the reduction in frequency is largely driven by fewer price increases, consistent with the notion that regular prices filter out temporary price declines, such as those associated with promotional sales. Moreover, weighted averages exceed weighted medians, indicating that a subset of products experiences price changes more frequently than the typical product.

We now turn to the intensive margin of firms' price adjustments. Over the sample period, the average magnitude of monthly price changes ranges between 0.7 and 0.8 percent, depending on whether we use median or average prices. Price increases range from 11.1 to 13.4 percent, depending on the weighting scheme and whether the median or average is used. Price decreases tend to be even larger, approximately 2.5 percentage points higher than price increases. This implies that while firms reduce prices less frequently, they do so by a larger magnitude. When comparing regular prices to observed prices, the overall size of price changes is similar. However, both regular price increases and decreases are somewhat smaller, suggesting that price adjustments associated with temporary sales tend to be larger.

[8] Most of the literature on price rigidity focuses on CPI or PPI products rather than firm-level measures. To relate our estimates to those in the literature, Appendix B presents analogous calculations of the frequency and size of price adjustments at the product level for varieties included in the CPI and PPI indexes. While direct comparisons across studies are challenging due to differences in methodology, sample periods, and data sources, the available evidence for emerging markets suggests that our firm-level estimates of price adjustment frequency fall broadly within the range reported for other countries.

Table 1: Frequency and size of price changes of firms
(Percent)

	Sales weights		Employment weights	
	Median prices	Average prices	Median prices	Average prices
Frequency				
Observed prices				
All changes	40.5	45.7	37.3	43.5
Duration (months)	2.0	1.6	2.2	1.8
Increases	20.2	25.9	17.0	24.4
Decreases	14.8	19.9	11.8	19.1
Regular prices				
All changes	31.6	34.8	27.7	33.3
Duration (months)	2.7	2.4	3.1	2.5
Increases	15.7	19.1	13.4	18.3
Decreases	11.5	15.6	8.9	15.0
Size				
Observed prices				
All changes	0.8	0.7	0.8	0.7
Increases	11.1	12.3	12.0	13.4
Decreases	-13.4	-14.6	-14.4	-15.9
Regular prices				
All changes	0.7	0.6	0.9	0.7
Increases	10.4	11.6	11.1	12.6
Decreases	-12.5	-13.8	-13.5	-15.0

Notes: The table reports the frequency and size of firms' price changes. Regular prices (i.e., excluding sales) are identified using the filter of Nakamura and Steinsson (2008), which removes asymmetric V-shaped sales, defined as temporary price reductions followed by a return to the regular price. The filter applies a return window of five months. Implied duration is expressed in months and calculated as the inverse of the frequency of price changes.

3 Empirical framework

Strategic complementarities arise in models where the elasticity of demand and markups are a function of the firms' market shares (Atkeson and Burstein, 2008). When a firm's market share depends inversely on its relative price, then its price should react positively to increasing competitors' prices. For instance, an increase in the competitors' price translates into a firm's lower relative price, increasing its demand and market share, which results in a market share and markup beyond its optimal level. Because of that, the firm reacts by increasing its prices and reducing its market share, bringing markups back to their optimal levels. Thus, the firm's optimal pricing strategy responds positively to changes in competitors' prices, generating strategic complementarities in price setting.

This strategic motive in pricing dampens the response of firms' prices to changes in their marginal costs. To illustrate, consider a firm facing a cost shock while competitors' prices remain unchanged. The firm can then aim at maintaining its markup by increasing its price and losing market share, or lower its markup by maintaining its price and market share. However, when a firm considers raising its price in response to an increase in marginal costs, it also considers how competitors would react. If strategic complementarities are strong, the pass-through of marginal cost changes is reduced because firms are concerned about losing market share. Hence, strategic complementarities can lead to a coordination problem where firms become hesitant to be the first to change prices, which in turn leads to price stickiness.

To examine the strength of strategic complementarities in relation to firms' own cost pass-through, we borrow the setup of Amiti, Itskhoki and Konings (2019), in which firms maximize profits by setting prices according to

$$p_{i,t} = mc_{i,t} + \mathcal{M}_i(p_{i,t}, \boldsymbol{p_{-i,t}}, \boldsymbol{\xi_t}), \tag{6}$$

where variables are in logs. $mc_{i,t}$ denotes the firm i's marginal cost at time t and $\mathcal{M}$ is the markup, which is a function of the firm's own prices, a vector of its competitors' prices $\boldsymbol{p_{-i,t}}$, and a vector of demand shifters $\boldsymbol{\xi_t}$.

The markup function is defined as

$$\mathcal{M}_i(p_{i,t}, \boldsymbol{p_{-i,t}}, \boldsymbol{\xi_t}) = \log\left(\frac{\epsilon\,(p_{i,t} - p_{-i,t}, \boldsymbol{\xi_t})}{\epsilon\,(p_{i,t} - p_{-i,t}, \boldsymbol{\xi_t}) - 1}\right), \tag{7}$$

where ϵ is the elasticity of demand. The intuition behind this formulation is that is that a change in any firm's prices affects the demand of other competing firms, which in turn alters their demand elasticities such that the optimal markups change for all firms. A key advantage of this framework lies in its generality. Specifically, the markup function holds for any invertible demand system and competition structure, and any vector $p_{-i,t}$, such that $p_{i,t}$ is the firm's optimal reaction function.

After some algebraic manipulations, the following estimating equation can be derived

$$\Delta p_{i,t} = \alpha_i + \tau_t + \sum_{r=0}^{R} \beta^r \Delta mc_{i,t-r} + \sum_{r=0}^{R} \gamma^r \Delta p_{-i,t-r} + \varepsilon_{i,t}. \tag{8}$$

which is the distributed lag version of the generalized accounting framework of price changes of Gopinath, Itskhoki and Rigobon (2010) and Burstein and Gopinath (2014).

The equation indicates that firms adjust prices according to the degree of pass-through of changes in their own marginal cost β^r and the strength of strategic complementarities γ^r, with the two coefficients being functions of the underlying own and competitor markup elasticities

$$\sum_{r=0}^{T} \beta_i^r \equiv \frac{1}{1+\Gamma_{i,T}}, \quad \sum_{r=0}^{T} \gamma_i^r \equiv \frac{\Gamma_{-i,T}}{1+\Gamma_{i,T}}, \tag{9}$$

where $\Gamma_{i,T} \equiv -\frac{\partial \mathcal{M}_i(p_T;\xi_T)}{\partial p_{i,T}}$ is the elasticity of the markup with respect to the firms' own prices and $\Gamma_{-i,T} \equiv \sum_{j \neq i} \frac{\partial \mathcal{M}_i(p_T;\xi_T)}{\partial p_{j,T}}$ is the elasticity with respect to competitors' prices.

These elasticities influence the reduced form coefficients differently. The own price markup elasticity affects both β_i^r and γ_i^r, since firms must adjust their prices in response to both cost and competitor shocks to stabilize their markups. In contrast, the competitor price markup elasticity influences only the response to competitor prices γ_i^r. Thus, the magnitude of strategic complementarities is directly embedded in the pass-through to competitors' prices. Then, the distributed lag specification allows us to capture the dynamics in response to changes in marginal costs and competitors' prices. In our baseline specification, $T = 12$ captures the long-term reduced form elasticities. To our understanding, this is the first paper to characterize the dynamics of these coefficients.[9]

We also examine how firms adjust prices along the extensive and intensive margins. Specifically, we re-estimate the specification in Equation 8, replacing the dependent variable with the frequency of price changes and the size of price changes, as defined in Equation 3 and Equation 4 respectively. The former is useful for gauging the extent to which nominal rigidities are state dependent, and the latter provides a measure of pass-through conditional on price changes.[10]

[9]One could alternatively obtain the dynamics by estimating local projections. However, there are two downsides to this approach. First, the first year of data would be lost because the independent variables have 12 lags, and this is particularly costly with already short series (moreover, specifications for farther horizons would be estimated on fewer observations because of the long difference in the dependent variable). Second, local projections are computationally more intensive as they require the estimation of one regression per horizon compared to a single regression in the distributed lag framework. In the robustness section of the paper, we present results using local projections.

[10]Appendix D illustrates the decomposition of the pass-through into the frequency and the magnitude of price adjustments.

3.1 Marginal costs

We assume that firms produce with constant returns to scale in material and labor, so that the log change in marginal costs is

$$\Delta mc_{i,t} = -\Delta a_{i,t} + (1-\rho_i)\Delta w_{i,t} + \rho_i \Delta ip_{i,t}, \tag{10}$$

where $\Delta a_{i,t}$ denotes productivity changes, $\Delta w_{i,t}$ represents wage growth, and $\Delta ip_{i,t}$ is the change in the firm's unit cost of intermediate inputs, aggregated via a Cobb-Douglas technology. The parameter ρ_i denotes the share of intermediate input costs in total costs.[11] In our baseline, we assume that wages are predetermined at the frequency of the firm's pricing decisions. We further assume that firm productivity evolves around a firm-specific trend plus an idiosyncratic white noise disturbance, yielding

$$\Delta mc_{i,t} = -\mu_i + \rho_i \Delta ip_{i,t} + \epsilon_{i,t}. \tag{11}$$

In the empirical specification, the firm-specific productivity trend, μ_i, is absorbed by firm fixed effects, while the idiosyncratic productivity shock, $\epsilon_{i,t}$, is part of the error term. Thus, the only component required to measure the firm's marginal costs is the intermediate input price change weighted by the intermediate input cost share.

We leverage the granularity and comprehensiveness of the price information in the electronic invoice data to construct firm level measures of changes in input prices. For each intermediate input k purchased by firm i in month t, we calculate the change in the within-month median price, $\Delta ip_{k,i,t}$, weighted by the firm's expenditure share $\omega_{i,k,t}$

$$\Delta mc_{i,t} = \rho_i \sum_k \omega_{k,i,t} \Delta ip_{k,i,t}, \tag{12}$$

where the expenditure shares are computed as one-year rolling averages.[12]

The left panel of Figure 1 displays the distribution of changes in marginal costs, which is skewed to the right, indicating that cost increases are more frequent and larger than cost decreases. The right panel plots the unconditional relationship between changes in marginal costs and changes in firms' sales prices. The slope of the regression line is 0.17, statistically significant at the 1 percent level, providing *prima facie* evidence of a positive

[11] We compute ρ_i as the firm's time series average of the intermediate input cost share in total costs, $\frac{1}{T_i}\sum_{t\in T_i} \frac{\text{inputs}_{it}}{(\text{inputs}_{it}+\text{wagebill}_{it})}$.

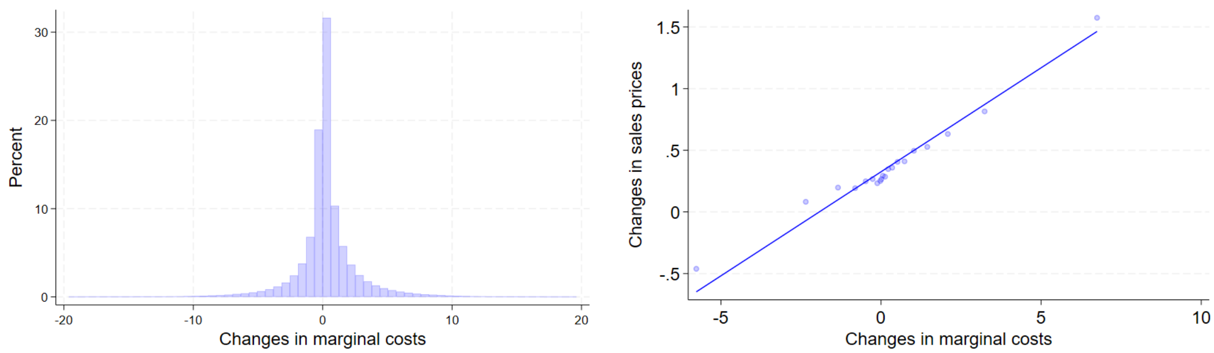
[12] To address concerns about potential recording mistakes, we restrict each firm's set of intermediate inputs to those it is expected to purchase based on the input-output matrix.

pass-through from input cost changes to output prices.

Figure 1: Changes in marginal costs
(Percent)

(a) Distribution

(b) Relationship with sales prices



Notes: The figure shows the distribution of changes in marginal costs and the relationship between changes in marginal costs and changes in sales prices.

Compared to Amiti, Itskhoki and Konings (2019) and Gagliardone et al. (2023), who proxy marginal costs using (admittedly noisy) accounting based measures of firms' average variable costs, we improve upon existing approaches by precisely tracking the price changes in the intermediate inputs purchased by each firm. One limitation of our measure is that it excludes price changes for imported intermediate inputs, which are not recorded in the domestic invoice data. However, in the Chilean context, this is less concerning, as approximately 70 percent of firms source all their intermediate inputs domestically. A second limitation is that we lack a precise measure of variable labor costs. From Social Security records, we observe workers' wages over the months they worked in the year, from which we can compute workers' average wages and then aggregate them at the firm level to obtain a measure of total labor costs. On average, total labor costs account for only 23 percent of the combined value of intermediate inputs and labor costs, suggesting that materials dominate firms' cost structure.

3.2 Competitors' prices

The literature typically assumes that a firm's competitors are all the other firms operating within the same sector.[13] However, Rossi-Hansberg, Sarte and Trachter (2021) note that

[13]See Amiti, Itskhoki and Konings (2019) and Gagliardone et al. (2023) for empirical examples and Wang and Werning (2022) for a theoretical model.

product markets are generally local because transportation of goods and people is expensive, so firms set up production plants, distribution centers, and stores close to buyers; and customers may locate in areas where they can obtain the goods they desire. Beyond geography, the product dimension also plays a critical role in identifying competitors. Firms may sell a variety of products and thus face different sets of competitors depending on the specific product, even if they are classified within the same sector and operate in the same geographical area. In sum, competition is also shaped by both spatial proximity and product specialization, challenging the conventional sector-based definitions.

We depart from the existing literature by leveraging the granularity of our data to construct a significantly narrower measure of competitors' prices. Specifically, for each firm, we define competitors' price changes as the sales-weighted average of price changes for the same products, sold by other firms operating in the same sector and municipality. Formally, competitors' price changes are computed as

$$\Delta p_{-i,t} = \sum_{r \in R_i} \omega_{i,r,t} \sum_{d \in D_{i,r}} \sum_{j \in J_{s(i),d,r}} \omega_{j,s,d,r,t} \Delta p_{j,s,d,r,t}, \tag{13}$$

where R_i denotes the set of municipalities where firm i sells, D_i the set of products sold by firm i, and $J_{s,d,r}$ is the set of firms, excluding firm i, that sell product d in municipality r and operate in the same sector s as firm i.[14] And the firm-municipality-product price change rate is defined as

$$\Delta p_{j,s,d,r,t} = \sum_{v \in V_{j,s,d,r,t}} \omega_{j,v,t} \Delta p_{j,v,t}, \tag{14}$$

where $V_{j,s,d,r,t}$ is the set of varieties of product d that firm j sells in municipality r at time t.

This measure exploits the granularity of the electronic invoice data. In particular, the municipality is defined based on the location of the buyer, consistent with the notion that product markets are geographically localized. For the product dimension, we follow Acevedo et al. (2025), who apply natural language processing techniques to classify product varieties—identified through text descriptors—into 290 standardized product categories of the *Clasificador Único de Productos* (CUP), consistent with the Central Product Classification (CPC) and an adapted version of the Classification of Individual Consumption by Purpose (COICOP).[15]

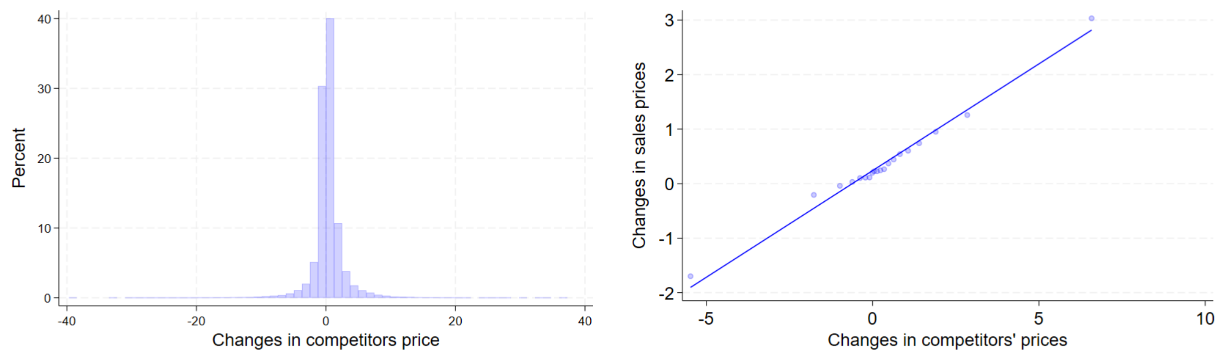
[14] According to the 3-digit ISIC rev. 4 classification, firms are sorted into 54 manufacturing sectors, 5 wholesale sectors, and 11 retail sectors. As for the other dimensions, there are 345 municipalities and about 1,700 products.

[15] See Appendix C for a detailed description of the mapping algorithm.

The distribution of changes in competitors' prices in Figure 2 appears leptokurtic, with a larger mass on the positive side of the distribution. For nearly half of the firm-time observations, competitors' prices remain unchanged; when changes occur, they are more likely to be price increases.[16] The unconditional correlation between changes in competitors' prices and changes in firms' own sales prices is about 0.38, which is suggestive of sizable strategic complementarities. Importantly, the correlation between the two variables is low at 0.15, easing the identification of the β^r and γ^r coefficients in Equation 8.

Figure 2: Competitors' price inflation
(Percent)

(a) Distribution (b) Relationship with sales prices



Notes: The figure shows the distribution of changes in competitors' prices and the relationship between changes in competitors' prices and changes in sales prices.

3.3 Identification challenges

Estimating Equation 8 poses three key identification challenges. First, sectoral demand shocks or coordinated wage adjustments may correlate with changes in firms' sales prices and marginal costs or competitors' prices, leading to omitted variable bias. To address this concern, we re-estimate Equation 8, replacing time fixed effects with sector-time fixed effects. This purges our baseline estimates of factors potentially correlated with both marginal costs and competitors' prices.

The second challenge is that firms with monopsony power may influence or even set prices charged by their suppliers. For these firms, reverse causality may introduce a

[16] Competitors' price changes range from -40 to 40 percent, reflecting that individual product variety price changes are bounded between –50 and 200 percent. Trimming the distribution of competitors' prices between -20 and 20 percent produces virtually identical results.

positive bias in the OLS estimates. To mitigate this concern, we leverage the granularity of our data to construct an instrument for the changes in marginal costs that excludes purchases of firms whose suppliers with a limited number of buyers

$$\Delta mc^*_{i,t} = \rho^*_i \sum_k \omega_{k,i,t} \Delta ip^{90}_{k,i,t}, \tag{15}$$

where $\Delta ip^{90}_{k,i,t}$ denotes changes in the prices of intermediate inputs sold by suppliers whose number of buyers exceeds the 90th percentile of the distribution, and ρ^*_i is the intermediate input cost share constructed using exclusively those inputs. The idea is that, by excluding transactions with suppliers that have a small number of buyers, we mitigate the risk that firms' monopsonic position may determine their purchase prices.

The third identification challenge is the potential simultaneity in price setting between firms and their competitors. In this case, the bias could go in either direction: competitors may adjust their prices in response to the firm's pricing decisions, or firms may strategically lower prices to undercut competitors and gain market share.

To address this concern, we construct an instrument for competitors' price changes by exploiting the geographical and product-level granularity used to define competitors' prices in Equation 13. Specifically, for each firm i we first identify the subset of suppliers $\mathcal{S}$ that sell both to firm i and its competitors. Then, we compute the sales-weighted changes in the costs of inputs K that competitors J operating in sector s use to produce product d sold in municipality r in month t.[17] Crucially, we exclude from the set K any inputs purchased from suppliers $\mathcal{S}$ that sell to both firm i and its competitors, thus isolating variation in competitors' input costs that is unlikely to be influenced by firm i's pricing decisions and breaking the possible simultaneity in price setting. Formally, the instrument is calculated as

$$\Delta p^*_{-i,t} = \sum_{r \in R_i} \omega_{i,r,t} \sum_{d \in D_{i,r}} \sum_{j \in J_{s(i),d,r}} \omega_{j,s,d,r,t} \rho_j \sum_{k \notin K_{\mathcal{S}}} \omega_{k,j,t} \Delta ip_{k,j,t}. \tag{16}$$

4 Five facts about strategic complementarities

In this section we document five key facts about firms' pricing behavior with respect to their competitors' prices.

[17] Input k is defined at the same level of product variety v.

4.1 Fact 1: strategic complementarities are overwhelmingly important

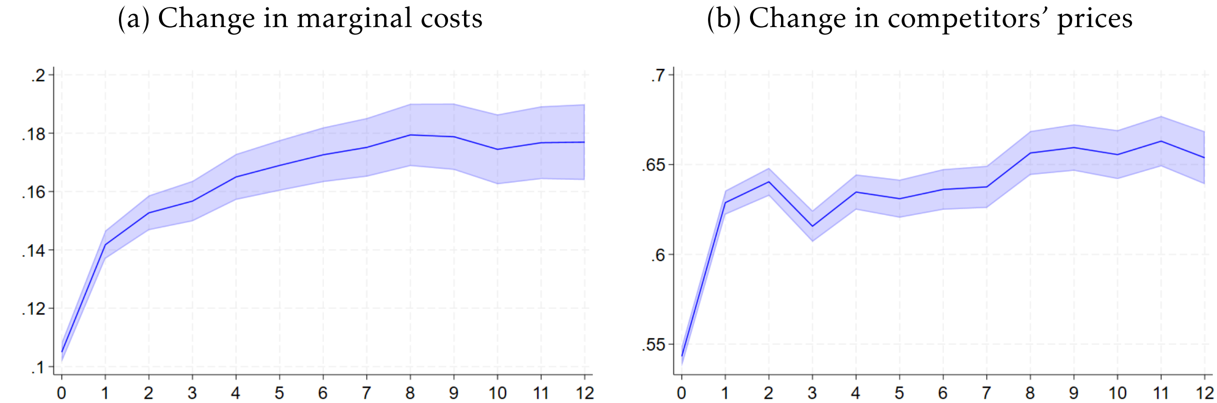
Our first key result is that strategic complementarities are overwhelmingly important for firms' price setting, relatively more than changes in marginal costs. Figure 3 presents the results from estimating Equation 8, with standard errors clustered at the firm and month level. We find that firms react quickly and strongly to changes in competitors' prices. Firms pass through 55 percent of the changes in competitors' prices to their own sales prices within the same month and 66 percent over the one-year horizon. By contrast, about 10 percent of the increase in marginal costs is passed through to sales prices on impact, reaching only 18 percent after one year. In other words, firms' pricing decisions are heavily influenced by competitors' prices, with the pass-through of competitors' prices changes being 3.7 times larger than the pass-through of changes in input prices.

The cross-competitor interdependence in firms' pricing behavior points to substantial real rigidities. Considering the mapping between the reduced form coefficient and the structural markup elasticities in Equation 9, our results indicate that firms exhibit a stronger tendency to stabilize their markups relative to competitors' prices—with an implied elasticity of 3.7—than to their own input prices—where the implied elasticity is 4.7. These findings stand in contrast to the predictions of complete pass-through and no strategic complementarities of canonical models with constant markups, constant elasticity of substitution demand functions, and monopolistic competition. Instead, they lend support to models allowing for strategic complementarities, such as Atkeson and Burstein (2008) and Amiti et al. (2022).

Compared to the results of Amiti et al. (2022) and Gagliardone et al. (2023) for manufacturing firms in Belgium, we find lower pass-through of firms' own marginal costs and higher pass-through of competitors' prices, which imply stronger strategic complementarities. This finding is important because, as emphasized by Ball and Romer (1990) and Klenow and Willis (2016), monetary non-neutrality arises when nominal rigidities are coupled with real rigidities. Moreover, relative to studies that do not account for strategic complementarities, our estimates of marginal cost pass-through are lower. If changes in marginal costs and competitors' prices are positively correlated, omitting competitors' prices from the regression would bias the coefficient on marginal costs upward. As a benchmark, estimating Equation 8 without controlling for competitors' prices yields a higher marginal cost pass-through of 37 percent, closer to the estimates reported in the existing literature.

As noted in Section 2, accounting for the geographical and product dimensions is critical to accurately identifying firms' competitors. We now provide evidence of how neglecting these dimensions affects the estimates of the coefficients of interest. Specifically,

Figure 3: Cost pass-through and strategic complementarities
(Percent)



Notes: The figure shows the percent change in firms' sales prices in response to a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

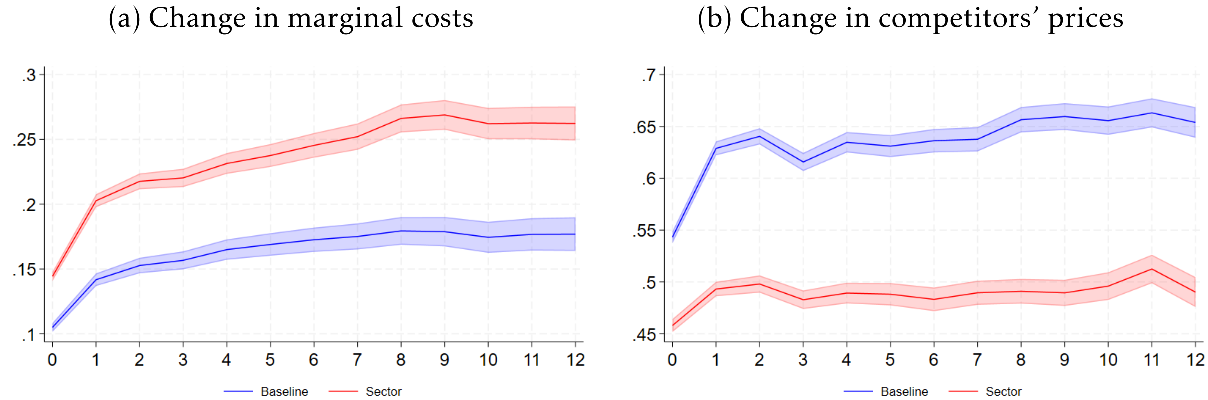
we replace the definition of competitors' prices in Equation 13 with the measure typically used in the literature, which identifies competitors based solely on their industry. The results in Figure 4 show that excluding the geographical and product dimensions leads to substantial biases in the estimated elasticities. In particular, the estimated marginal cost pass-through would be 44 percent higher, while the pass-through to competitors' prices would be 37 percent lower compared to our baseline estimates.

4.1.1 Extensive and intensive margins of price adjustments

We first examine the response of prices along the extensive margin——that is, the share of a firm's product varieties that change prices in a given month in response to changes in marginal costs or competitors' prices. The top-left panel of Figure 5 shows that a one percentage point increase in a firm's marginal costs is associated with a one percentage point increase in the share of products changing prices over a 12-month horizon. Based on the sales-weighted median frequency of price changes reported in Table 1, this implies that for the average firm it takes a 10 percentage point increase in marginal costs to raise the share of products changing prices to nearly 50 percent.

Consistent with our earlier findings, the top-right panel indicates that the frequency of price changes responds more strongly to changes in competitors' prices. In response to a one percentage point increase in competitors' prices, the share of products adjusting prices rises by 2.2 percentage points after one year. These estimates suggest that for the

Figure 4: Pass-through estimates with alternative measures of competitors' prices (Percent)



Notes: The figure shows the percent change in firms' sales prices in response to a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It compares the pass-through estimates based on two definitions of competitors: (i) the baseline definition (i.e., firms operating in the same sector, selling the same product, and located in the same municipality); and (ii) a broader definition based solely on the sector of operation. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

average firm to adjust prices across all product varieties, marginal costs would need to increase by approximately 60 percent, whereas only a 24 percent increase in competitors' prices would achieve the same effect.

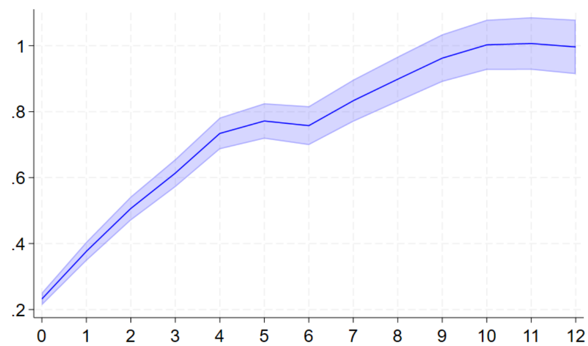
We complete the characterization of firms' price adjustments by examining the response of the intensive margin—that is, the magnitude by which firms adjust their prices, conditional on changing them (i.e., excluding zero price changes). The results show that, on impact, approximately 16 percent of a marginal cost increase is passed through to firms' sales prices. Firms continue to adjust over time, and after one year about 24 percent of the initial cost increase is reflected in sales prices.

Changes in competitors' prices generate different estimates and dynamics compared to changes in marginal costs. When competitors raise prices, firms respond by passing through a much larger share of the increase to their own prices. On impact, 64 percent of the increase in competitors' prices is reflected in firms' sales prices. This pass-through rises to 75 percent within the first quarter, before gradually declining to around 67 percent over the subsequent months.

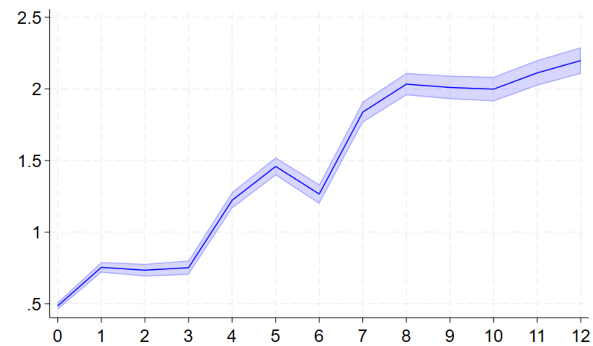
All in all, the substantial pass-through of competitors' prices reflects strong adjustments on both the extensive and the intensive margins. The initial increase in pass-through is driven by a short-run rise in the size of price adjustments, while the longer-run decline reflects a reduction in the size of adjustments, offset by a steady increase in the frequency of price changes. This pattern is consistent with models featuring state-dependent pricing and strategic complementarities, where firms adjust both the timing and the size of price changes in response to competitors' actions.

Figure 5: Frequency and size of price adjustments
(Percent)

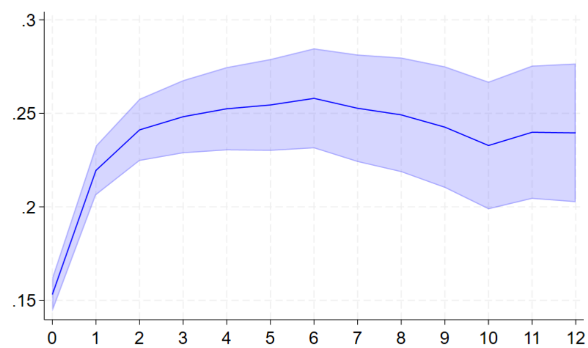
(a) Frequency, change in marginal costs



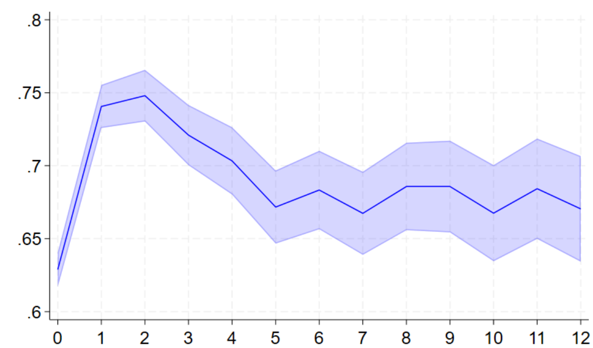
(b) Frequency, change in competitors' prices



(c) Size, change in marginal costs



(d) Size, change in competitors' prices



Notes: The figure shows the percent change in the frequency of firms' sales price adjustments and the percent change in size of non-zero sales price adjustments in response to a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

4.2 Fact 2: strategic complementarities are of first order importance across sectors

The second fact is that the strength of strategic complementarities varies across sectors, but remains of first-order importance relative to changes in marginal costs. As noted in Section 2, our sample covers the universe of both manufacturing and retail firms, with retail firms account for about two-thirds of the total. Hence, the results presented in subsection 4.1 reflect a sample composition skewed towards the retail sector. To examine sectoral heterogeneity in the strength of strategic complementarities, we estimate a variant of Equation 8 that allows the coefficients to vary between the manufacturing and the retail sectors

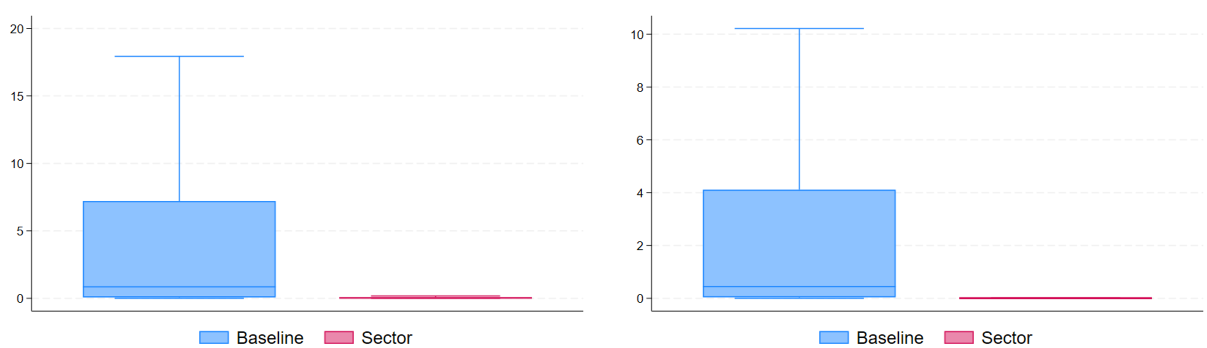
$$\Delta p_{i,t} = \alpha_i + \tau_t + \sum_{r=0}^{R} \Delta mc_{i,t-r}(\beta^r + \delta^r M_i) + \sum_{r=0}^{R} \Delta p_{-i,t-r}(\gamma^r + \xi^r M_i) + \varepsilon_{i,t}, \quad (17)$$

where M_i is a variable equal to one if firm i is in the manufacturing sector, and zero otherwise.

Our empirical strategy assumes that firms internalize the effect of their pricing decisions on the market in which they compete (defined as the firms of the same sector selling the same product in the same municipality) and react strategically to their competitors. For strategic complementarities to happen, some firms need to have some degree of power to influence decisions in their markets. As shown in Figure 6, this appears to be the case: firms hold relatively large market shares within narrowly defined markets (i.e., 3-digit ISIC sector–municipality–product combinations), compared to much smaller shares when competition is measured at a broader level (i.e., 3-digit ISIC sector). As a reference, for the level of disaggregation we work with, the average market share is 6.1 percent for retail firms and 8.9 percent for manufacturing firms.

Figure 6: Market shares distributions
(Percent)

(a) Manufacturing sector (b) Retail sector



Notes: The figure shows the distribution of firms' market shares under two alternative market definitions: (i) the baseline definition (i.e., firms operating in the same sector, selling the same product, and located in the same municipality); and (ii) a broader definition based solely on the sector of operation.

Figure 7 shows that, on impact, the pass-through of changes in marginal costs is similar for manufacturing firms and retail firms, at about 10 percent. However, a wedge emerges over time: for manufacturing firms, the pass-through rises to 26 percent one year after the shock, nearly double that of retail firms. Sectoral heterogeneity is even more pronounced in the response to changes in competitors' prices. Among manufacturing firms, less than 20 percent of competitors' price changes are passed through to sales prices on impact. By contrast, retail firms immediately pass through 65 percent of competitors' price changes. Over time, both sectors continue to adjust prices, but the gap persists: by the end of the year, manufacturing firms have passed through approximately 40 percent of competitors' price changes, compared to about 75 percent for retail firms.[18] These sectoral differences are consistent with the notion that retail markets, characterized by lower menu costs and more flexible pricing strategies, exhibit stronger strategic complementarities. In contrast, manufacturing firms, facing higher adjustment costs and longer production cycles, respond more sluggishly to competitive pressures.[19]

These heterogeneous reduced-form coefficients reflect substantial structural differences in the determinants of pricing behavior between the manufacturing and retail sectors. In particular, markup elasticities are significantly larger in the retail sector compared to the full sample. For input prices, the estimated elasticity is 6.7 in retail versus 4.7 in the full sample; for competitors' prices, the elasticity is 5.3 compared to 3.7, respectively. In contrast, manufacturing firms display much lower elasticities: 3 with respect to competitors' prices and only 1.6 with respect to their own input prices. These differences in structural elasticities across sectors help explain the variation in estimated pass-through coefficients. Despite these differences, the evidence for both sectors supports our general conclusion that firms in both sectors tend to stabilize markups with respect to competitors prices to a larger extent than markups with respect to input prices.

We now turn to the sectoral differences in the extensive and intensive margins of price adjustments. Our results indicate that in response to a marginal cost increase, firms in the manufacturing sector adjust prices more frequently and by a larger magnitude than firms in the retail sector. A one percentage point increase in marginal costs leads manufacturing firms to increase the share of product varieties changing prices by 1.5 percentage points at the end of the year, compared to 0.7 percentage points for retail firms. Similarly, on the intensive margin, manufacturing firms pass through 42 percent of the increase in marginal costs to sales prices, compared to 15 percent for retail firms.

A one percentage point increase in competitors' prices is associated with a similar immediate increase in the share of product varieties changing prices for both manufacturing

[18] Appendix Table F.1 reports the cumulative coefficients on the interaction terms and their statistical significance for both marginal cost changes and competitors' price changes.

[19] Bils and Klenow (2004) show that durable good sectors, which include a lot of manufacturing industries, have stickier prices than non-durable goods.

and retail firms. However, by the end of the year manufacturing firms increase the share of products adjusting prices by 1.5 percentage points, while retail firms show a larger increase of 2.5 percentage points. Interestingly, the dynamics differ across sectors: the frequency of price adjustments among retail firms continues to rise steadily even 12 months after the shock, whereas for manufacturing firms the adjustment peaks at 1.8 percentage points after six months and then marginally declines. The intensive margin response also shows distinct dynamics. Among manufacturing firms, the size of price adjustments rises from 28 percent on impact to 66 percent after 12 months. In contrast, retail firms pass through approximately 75 percent of competitors' price changes immediately, peaking at 82 percent just two months after the shock. Retail firms thus respond more quickly and aggressively to changes in competitors' prices, likely reflecting the higher degree of competition in retail markets. However, their adjustment subsequently retrenches, and by 12 months after the shock, the size of the price change is not statistically different from that observed among manufacturing firms.

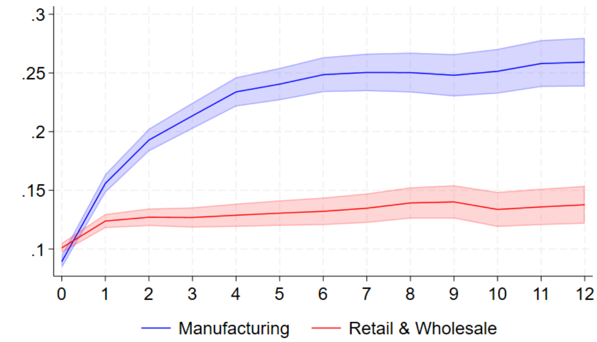
We now delve deeper into sector heterogeneity. We run the baseline specification in Equation 8 separately for each industry (at the 2- or 3-digit ISIC Rev. 4 level) within the manufacturing and retail sectors, for industries with at least 100 firms. For each industry, we compute the difference between the estimated one-year pass-through coefficient for competitors' prices and the corresponding one for marginal costs. Figure 8 shows that for most industries the positive difference between the two estimates is statistically significant. For the few industries where the difference is negative, such estimates are statistically indistinguishable from zero. We interpret these findings as further evidence of the dominant role of strategic complementarities relative to firms' own marginal costs in shaping pricing decisions.

4.3 Fact 3: state-dependent strategic pricing

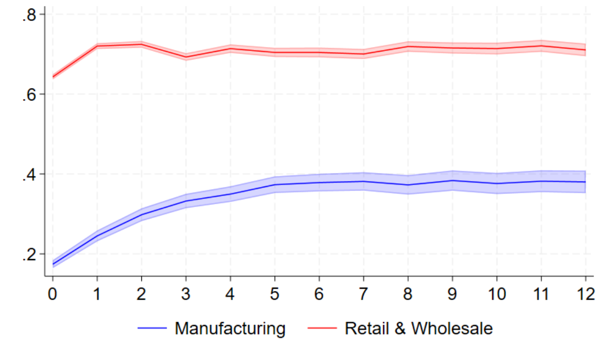
The third fact is that when inflation runs high, firms become more sensitive to the actions of their competitors. In a high inflation environment, firms are more likely to face large and persistent cost shocks, which squeeze their profit margins (Taylor, 2000). According to state dependent pricing theories, these shocks increase the likelihood to pass through changes in their own costs, thereby reducing nominal rigidities. This is central to policy debates, because when pricing is state-dependent, monetary policy becomes approximately neutral (Golosov and Lucas, 2007) and the Phillips curve is nonlinear, reducing the sacrifice ratio (Karadi et al., 2024). If firms' optimal prices depend on competitors' prices, when inflation runs high and the frequency of price adjustment increases, firms

Figure 7: Manufacturing versus retail firms
(Percent)

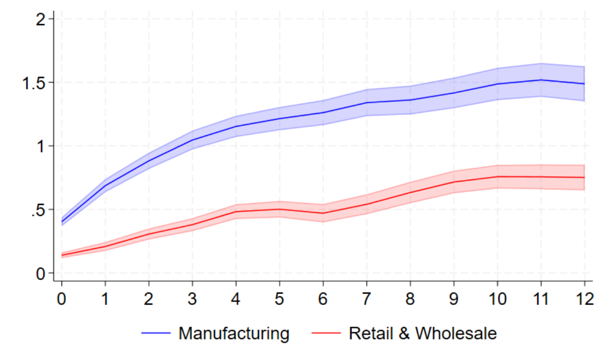
(a) Pass-through, change in marginal costs



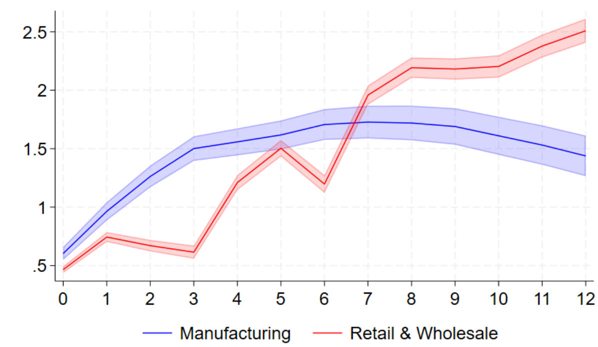
(b) Pass-through, change in competitors' prices



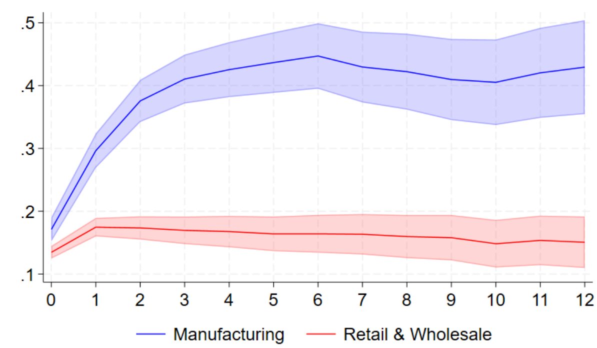
(c) Frequency, change in marginal costs



(d) Frequency, change in competitors' prices



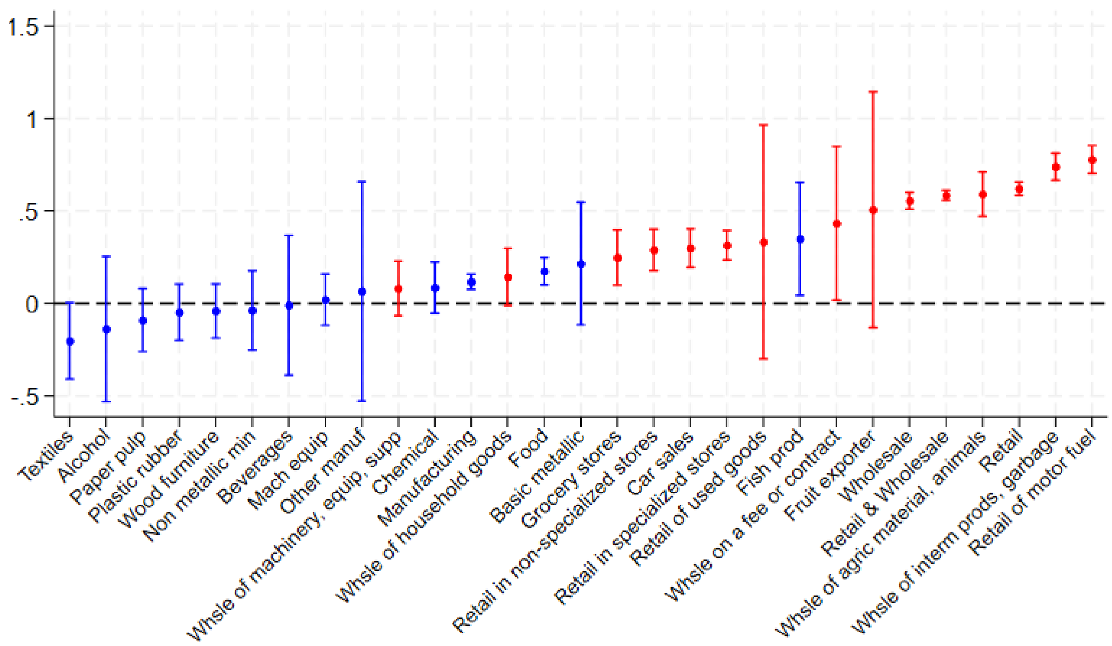
(e) Size, change in marginal costs



(f) Size, change in competitors' prices

Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It compares the responses of manufacturing and retail firms. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Figure 8: Elasticity differential
(Percent)



Notes: The figure shows the difference between the competitors' price pass-through estimate and the marginal cost pass-through estimates at the one-year horizon, along with the 90 percent confidence intervals. For manufacturing sectors, the 2-digit ISIC Rev. 4 classification is used, while for retail and wholesale sectors, the 3-digit ISIC Rev. 4 classification is used. The figure also reports the estimates for the 1-digit Rev. 1 classifications (i.e., manufacturing, wholesale, and retail).

may become more likely to seize opportunities to stabilize their prices with respect to their competitors.

We study whether firms' pricing behavior changes in a high inflation environment by conditioning their responses to changes in marginal costs and competitors' prices on being in a period of high inflation

$$\Delta p_{i,t} = \alpha_i + \tau_t + \sum_{r=0}^{R} \Delta mc_{i,t-r}(\beta^r + \delta^r \pi_{t-r}) + \sum_{r=0}^{R} \Delta p_{-i,t-r}(\gamma^r + \xi^r \pi_{t-r}) + \varepsilon_{i,t}, \tag{18}$$

where π_{t-r} equals one when (monthly) inflation is above the median plus one standard deviation, and zero otherwise.[20] This section focuses on manufacturing firms, for which nominal rigidities appear more important.[21] In this conditional specification, coefficients β^r and γ^r describe the responses to changes in marginal costs and competitors' prices, respectively, in a low inflation environment, while δ^r and ξ^r capture the differential effects in a high inflation environment.

Figure 9 compares the estimated pass-through of changes in marginal costs and competitors' prices between periods of low and high inflation. We find that in a high-inflation environment, firms become more responsive to their own cost shocks, passing through a larger share to sales prices. On impact, manufacturing firms pass through approximately 12 percent of marginal cost changes when inflation is high, compared to 7 percent when inflation is low. Over time, this gap widens considerably, with firms passing through almost 30 percent of their cost changes in a high inflation environment and only 17 percent in a low inflation environment.

The wedge in the cost pass-through between periods of low and high inflation is primarily driven by more frequent price adjustments when inflation is high. A one percentage point increase in marginal costs is associated with a two percentage point increase in the frequency of price adjustments during high-inflation periods, compared to a 0.6 percentage point increase when inflation is low. In contrast, the size of price adjustments remains broadly similar across inflation regimes. The finding that firms adjust a significantly larger share of their products per unit of time when aggregate inflation is high is consistent with previous evidence in the literature (Nakamura et al., 2018; Alvarez et al., 2019; Karadi and Reiff, 2019; Blanco et al., 2024).

We now turn to whether inflation alters the scope for strategic behavior in price

[20] The mean and standard deviation are computed within each calendar month to account for seasonal patterns. We obtain similar results when constructing the dummy based on monthly inflation without seasonality adjustment or using annual inflation, as shown in Appendix E.

[21] Appendix G reports the results for retail firms.

setting. We find that firms become more sensitive to competitors' pricing decisions in high inflation environments. Specifically, a one percentage point increase in competitors' prices is associated with a 0.5 percent increase in a firm's sales prices when inflation is high, compared to approximately half of that when inflation is low.

In contrast to the adjustment to changes in marginal costs, the differential effect of high inflation on firms' responses to competitors' prices occurs at both the extensive and intensive margins. A one percentage point increase in competitors' prices is associated with a two percentage point increase in the frequency of price adjustments one year after the shock when inflation is high. In contrast, when inflation is low, the increase in frequency is transitory and modest, peaking at one percentage point three months after the shock and declining to only 0.4 percentage points after one year. In addition, when inflation is high, firms fully reflect competitors' price changes in the prices they adjust, whereas the size effect is only 0.4 percent when inflation is low.[22] In sum, our results suggest that high inflation weakens nominal rigidities and increases firms' responsiveness to competitors' prices.

A striking pattern emerges when mapping the reduced-form coefficients to the underlying structural markup elasticities. The larger pass-through estimates observed during high-inflation periods, compared to low-inflation periods, can be largely attributed to a decline in the markup elasticity with respect to the firm's own prices. Specifically, this elasticity declines from 4.9 during low-inflation periods to 2.3 in high-inflation periods, reflecting firms' stronger tendency to stabilize markups in more volatile environments. According to the structural relationships in Equation 9, the reduction in the markup elasticity with respect to firms' own prices accounts for approximately 90 percent of the overall increase in the reduced-form pass-through coefficients, with the remaining 10 percent attributable to changes in the markup elasticity with respect to competitors' prices.

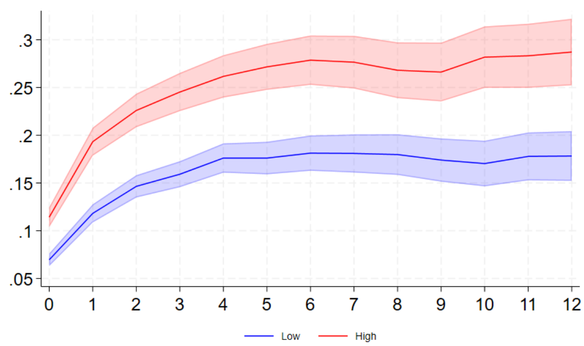
4.3.1 The 2021–2022 inflation surge

We established that when inflation runs high, firms respond to changes in their own marginal costs primarily by increasing the frequency of price adjustments, and to changes in competitors' prices by increasing both the frequency and the magnitude of price changes. An interesting question is what margin of price adjustments was the largest contributor to the 2021–2022 inflation surge.

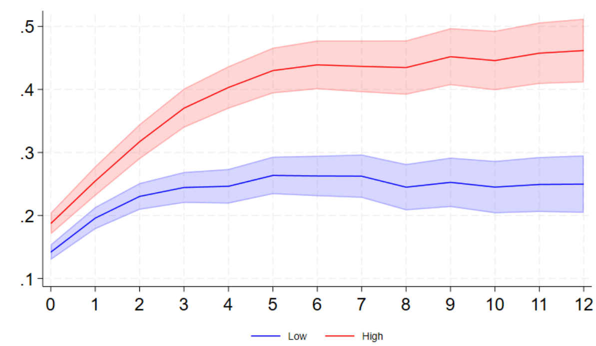
[22] Appendix Figure G.1 reports the corresponding pass-through estimates for retail firms. For retail firms, the pass-through of marginal costs is statistically indistinguishable between high- and low-inflation environments, but, similar to manufacturing firms, the pass-through of competitors' prices is higher when inflation runs high.

Figure 9: Firms' pricing during high vs low inflation
(Percent)

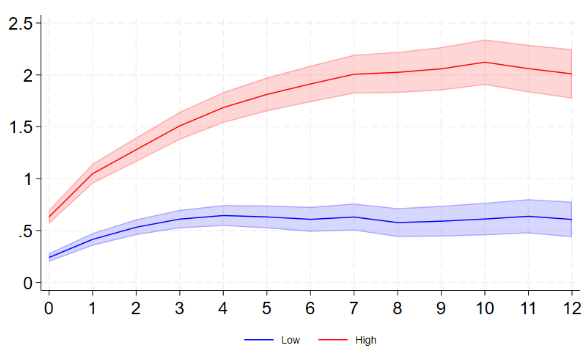
(a) Pass-through, change in marginal costs



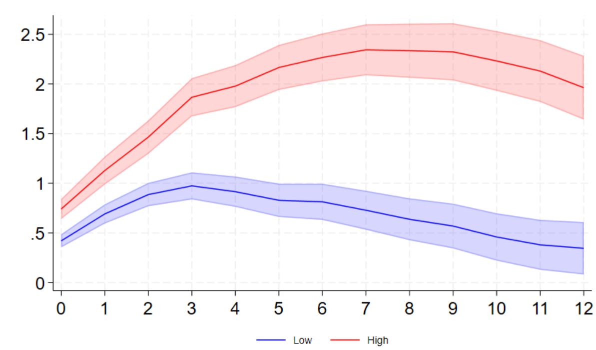
(b) Pass-through, change in competitors' prices



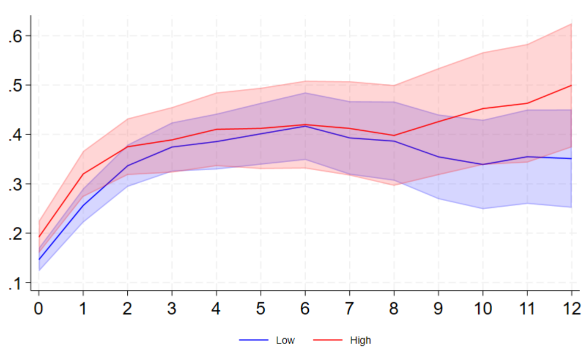
(c) Frequency, change in marginal costs



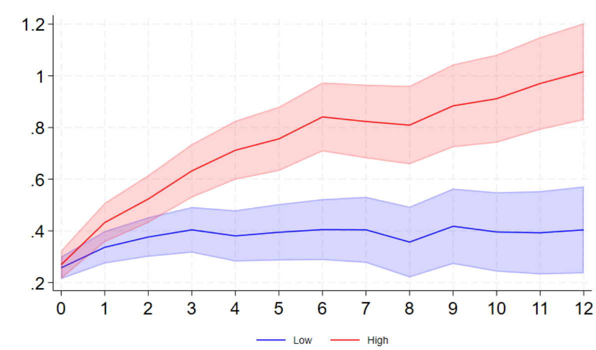
(d) Frequency, change in competitors' prices



(e) Size, change in marginal costs



(f) Size, change in competitors' prices



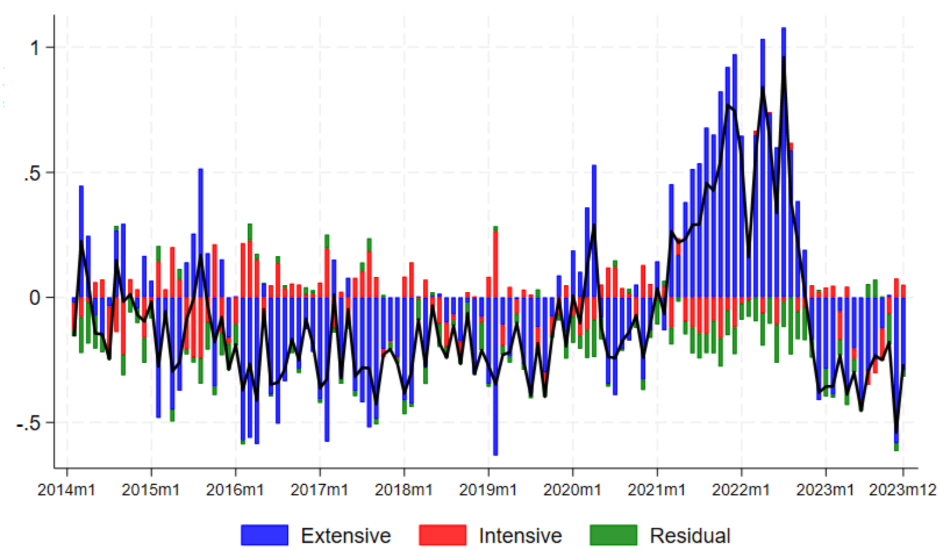
Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It compares the responses of manufacturing firms during high inflation periods to those during low inflation periods. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

To address this question, we define inflation as $\pi_t = \dot{\pi} + \tilde{\pi}_t$, where $\dot{\pi}$ denotes the time series average inflation rate and $\tilde{\pi}_t$ denotes deviations from the average. We then decompose $\tilde{\pi}_t$ into the contributions from changes in the frequency of price adjustments, changes in the size of price adjustments, and a residual term

$$\tilde{\pi}_t = \underbrace{\left(\tilde{f}_t^+ \dot{s}_t^+ + \tilde{f}_t^- \dot{s}_t^-\right)}_{\text{Frequency}} + \underbrace{\left(\dot{f}^+ \tilde{s}_t^+ + \dot{f}^- \tilde{s}_t^-\right)}_{\text{Size}} + \underbrace{\left(\tilde{f}_t^+ \tilde{s}_t^+ + \tilde{f}_t^- \tilde{s}_t^-\right)}_{\text{Residual}}. \tag{19}$$

Figure 10 plots the contributions of each margin to the deviation of aggregate CPI inflation from its long-run average. The results unambiguously indicate that the frequency of price adjustment was the primary driver of the inflation surge that began in 2021 and the subsequent normalization that started in 2023.[23]

Figure 10: Contributions of margins of price adjustments to aggregate inflation (Percentage points)



Notes: The figure shows the contributions of the extensive and intensive margins of price adjustments to firms' inflation deviations from their time-series average.

4.4 Fact 4: strategic complementarities as 'rockets and feathers'

The fourth fact is that firms' prices react more strongly when competitors raise prices (like 'rockets') than when they cut them (like 'feathers'). Earlier work on cost pass-through has shown that firms are more sensitive to cost increases than cost decreases

[23] Dedola et al. (2024) report similar findings for Euro area countries.

(Bacon, 1991; Peltzman, 2000). The underlying mechanism is that when costs rise, firms have an incentive to increase prices to maintain profit margins, leading to a high pass-through of cost increases. In contrast, when costs fall, firms facing favorable demand conditions may prefer to keep prices unchanged to avoid inducing buyers to re-optimize their purchasing decisions, resulting in a lower pass-through of cost decreases.

In the case of strategic complementarities, the mechanism operates through the elasticity of markups with respect to competitors' prices. An increase in competitors' prices lowers the firm's relative prices, leading to an expansion in the firms' demand. The firm's optimal response is to raise its prices to restore the desired markup. Conversely, a reduction in competitors' prices raises the firm's relative prices, reducing its demand and prompting a downward adjustment in its own prices. Downward nominal rigidities could generate an asymmetric response whereby the response to increases in competitors' prices is larger than the response to competitors' prices declines.

To examine the potential asymmetry in firms' pricing behavior in response to changes in competitors' prices (as well as changes in marginal costs), we estimate the following specification

$$\Delta p_{i,t} = \alpha_i + \tau_t + \sum_{r=0}^{R} \Delta mc_{i,t-r}(\beta^r + \delta^r I_{i,t-r}^{\Delta mc}) + \sum_{r=0}^{R} \Delta p_{-i,t-r}(\gamma^r + \xi^r I_{i,t-r}^{\Delta p_{-i}}) + \varepsilon_{i,t}, \tag{20}$$

where $I_{i,t-r}^{\Delta mc}$ and $I_{i,t-r}^{\Delta p_{-i}}$ are two indicators equal to one if changes in marginal costs and competitors' prices are positive, respectively, and zero otherwise. In this setup, β^r and γ^r capture the responses to negative changes, while δ^r and ξ^r measure the differential effect for positive changes. Thus, a statistically significant positive estimate of the latter two coefficients would indicate that firms respond more strongly to marginal cost or competitor price increases than to decreases, consistent with asymmetric price adjustment.

In Figure 11, we present the results for manufacturing firms. Consistent with earlier findings in the literature, we find that marginal cost pass-through is higher for cost increases than for cost decreases. This asymmetry is particularly pronounced immediately after the cost shock, with a gap as large as 7 percentage points. However, the gap narrows over time and becomes statistically insignificant by the end of the year. Examining the margins of price adjustment, we find that firms catch up with cost increases by adjusting sales prices more frequently compared to when marginal costs decline. One year after a one percentage point increase in marginal costs, the share of products changing prices rises by 1.7 percentage points, compared to 0.4 percentage points following a one percentage point decrease.[24] This is consistent with the notion that firms delay price reductions to avoid triggering buyer re-optimization and associated cognitive costs. We also find that the initial size of price changes is larger in response to cost increases than to decreases, although this difference quickly fades and becomes negligible within a quarter after the cost shock.

The evidence of asymmetric pricing points to a 'rockets and feathers' phenomenon for competitors' prices as well, though the dynamics differ. The pass-through is significantly larger for competitors' price increases than for decreases, and the gap is more persistent. On impact, the pass-through to a price increase is 10 percentage points higher than for a price cut (19 percent versus 9 percent). Over time, the gap widens slightly: by the end of the year, firms have passed through 34 percent of competitors' price increases, compared to 22 percent of price decreases.

These dynamics reflect a larger increase in both the frequency and the magnitude of price adjustments in response to competitors' price hikes. A one percentage point increase in competitors' prices leads to a gradual rise in the share of products changing prices, reaching 2.8 percentage points higher after one year. For competitors' price cuts, the frequency of price changes declines by about 1.5 percentage points. In contrast, the size of price changes in response to competitors' price increases and decreases is statistically indistinguishable. Overall, these results suggest the presence of strong downward nominal rigidities.[25]

4.5 Fact 5: market structure shapes firms' strategic pricing responses

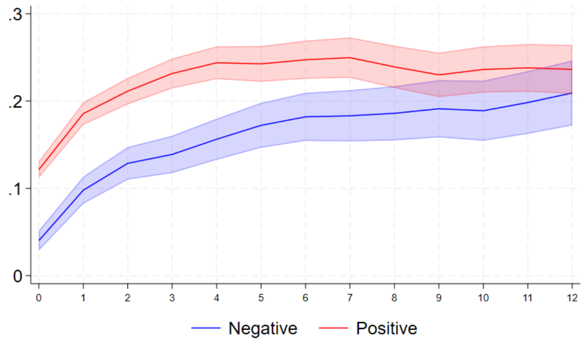
The fifth fact is that firms exhibit stronger strategic complementarities when they face less competition, enjoy higher market shares, and serve larger customer bases. In models of oligopolistic competition, firms operating in less competitive sectors exhibit stronger strategic complementarities relative to those in more competitive markets. For example, in the framework of Atkeson and Burstein (2008), a larger number of competing firms reduces the degree of strategic complementarities. As competition intensifies, firms' market shares shrink and demand elasticity increases, dampening strategic complementarities. Other studies focusing on firms' own costs, including Genesove and Mullin (1998),

[24] Note that, by construction, the regression estimates represent the response of the frequency of price adjustments to increases in marginal costs or competitors' prices. Thus, for declines in marginal costs or competitors' prices, negative estimates correspond to a positive change in the frequency of price adjustments.

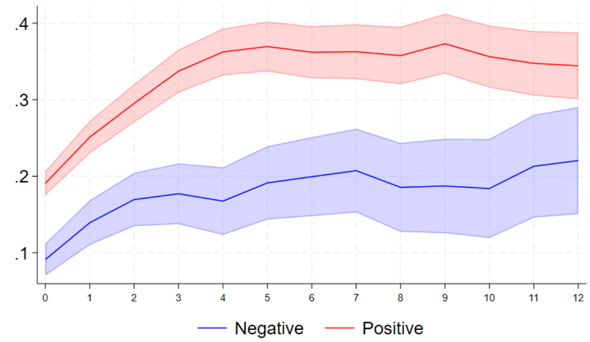
[25] Appendix Figure G.2 reports the corresponding estimates for retail firms. In contrast to manufacturing firms, the marginal cost pass-through for retail firms is generally statistically indistinguishable between cost increases and decreases. For changes in competitors' prices, the asymmetry is also limited; if anything, retail firms appear somewhat more sensitive to competitors' price declines.

Figure 11: Asymmetric pricing
(Percent)

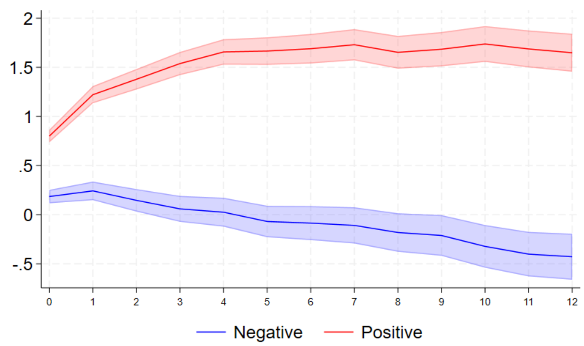
(a) Pass-through, change in marginal costs



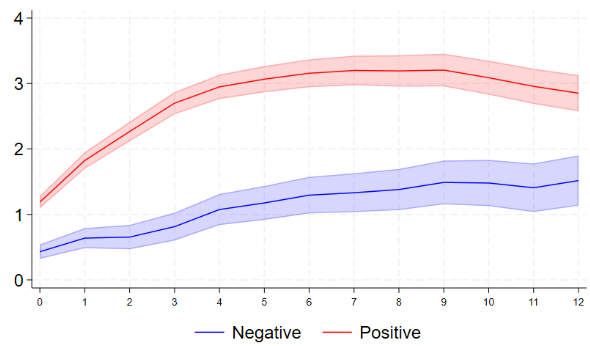
(b) Pass-through, change in competitors' prices



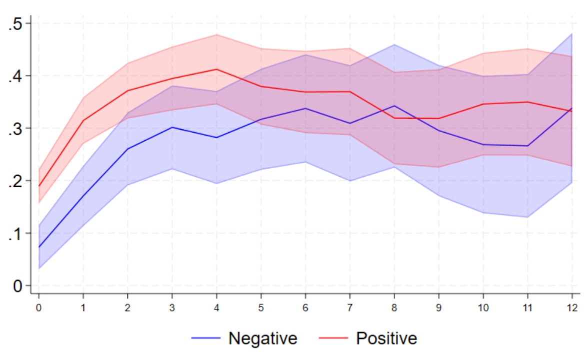
(c) Frequency, change in marginal costs



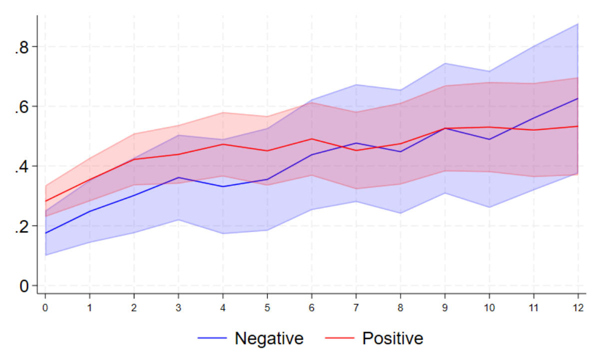
(d) Frequency, change in competitors' prices



(e) Size, change in marginal costs



(f) Size, change in competitors' prices



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It compares the responses of manufacturing firms to positive and negative changes in marginal costs and competitors' prices. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Campbell and Hopenhayn (2005), and Genakos and Pagliero (2022) lend support to this view, documenting that markups are inversely related to the number of competitors, which in turn raises the pass-through of firms' own cost changes into prices.

We empirically test these predictions. To do that, we first construct a proxy for the degree of competition as the sales-weighted sum of the number of firms operating in the same sector of firm i, selling the same products, and selling them in the municipalities where they operate. In particular, we measure

$$C_{i,t} = \sum_{r \in R_i} \sum_{d \in D_{i,r}} \omega_{i,r,d,t} F_{i,r,d,t}, \tag{21}$$

where $\omega_{i,r,d,t}$ is the share of firm i's sales in municipality-product r, d, and $F_{i,r,d,t}$ denotes the number of firms selling product d in municipality r. Then, we examine if firms respond differently to changes in their own costs and competitors' prices by estimating the following specification for manufacturing firms

$$\Delta p_{i,t} = \alpha_i + \tau_t + \sum_{r=0}^{12} \Delta mc_{i,t-r}(\beta^r + \beta_C^r I_{i,t-r}^C) + \sum_{r=0}^{12} \Delta p_{-i,t-r}(\gamma^r + \gamma_C^r I_{i,t-r}^C) + \sum_{r=0}^{12} \beta_C^r I_{i,t-r}^C + \varepsilon_{i,t}, \tag{22}$$

where $I_{i,t}^C$ takes value one if $C_{i,t}$ is above the median at any given point in time, and zero otherwise.

Figure 12 presents the pass-through estimates of changes in input costs and competitors' prices, comparing firms operating in high competition versus low competition environments. Since we are interested in differences in the long-run response, we focus on the impact after one year. We find that firms with a lower number of competitors respond more strongly to changes in their competitors' prices. Specifically, a one percentage point increase in competitors' prices is associated with a 0.4 percentage point increase in prices for firms operating in less competitive markets, compared to a 0.3 percentage point increase for firms in more competitive environments. In contrast, we find no statistically significant difference in the pass-through of firms' own input cost changes across competition levels.

We further explore the role of competition by replacing the variable $I_{i,t}^C$ in Equation 22 with a dummy variable that takes the value of one if firm i's market share is above the cross-sectional median. We compute each firm's market share at the sector-municipality-product level, and then aggregate these market shares to the firm level using the firm's sales weights across markets.

$$\text{market share}_{i,t} = \sum_{r \in R_i} \sum_{d \in D_{i,r}} \omega_{i,r,d,t} \frac{\text{sales}_{i,d,r,t}}{\sum_j \text{sales}_{j,d,r,t}}. \tag{23}$$

Our results indicate that firms with higher market shares respond more strongly to changes in competitors' prices than those with lower market shares. This finding aligns with the intuition that strategic complementarities become more pronounced as market shares increase, given that larger firms exhibit greater markup sensitivity to competitors' price changes (Atkeson and Burstein, 2008; Burstein and Gopinath, 2014). The magnitudes of these effects are similar to those obtained when using the number of competing firms as a proxy for competition. By contrast, the evidence is less conclusive for the pass-through of marginal costs, with no statistically significant differences between firms with high and low market shares one year after the shock.

Another approach to examining the role of market structure is to focus on firms' customer bases. Since a higher market share is associated with a larger residual demand, a relationship between the number of buyers and the strength of strategic complementarities should emerge. Firms with a large customer base are likely more concerned with maintaining their market share, leading them to pass through a smaller fraction of marginal cost increases to avoid losing customers. Conversely, when competitors raise prices, these firms can expand their market share by adjusting their own prices upward to restore optimal markups. As before, we test this prediction by constructing a dummy variable that equals one if a firm's number of buyers is above the cross-sectional median, and zero otherwise.

We find that firms with larger customer bases respond more strongly to competitors' price changes and less to marginal cost changes relative to firms with fewer buyers, although the differences in marginal cost pass-through are not statistically significant. Specifically, a one percentage point increase in competitors' prices is associated with a 0.4 percentage point increase in prices for firms with a large customer base, compared to 0.2 percentage points for firms with a smaller one.[26]

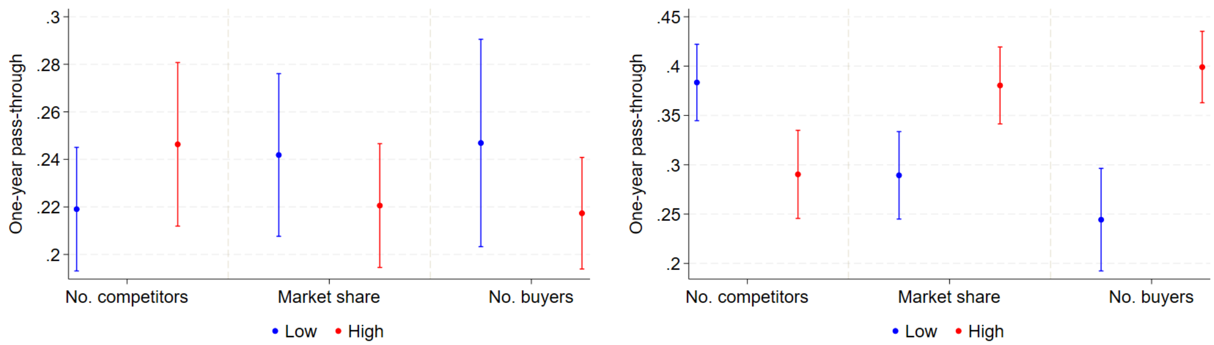
5 Robustness

In this section, we present the results of a series of robustness tests designed to address potential identification concerns outlined in Section 3. One such concern is the possibility

[26] Appendix Figure G.3 reports the evidence for retail firms. Except for the case of the number of competitors, the patterns are broadly consistent with those observed for manufacturing firms.

Figure 12: The role of market structure
(Percent)

(a) Pass-through, change in marginal costs (b) Pass-through, change in competitors' prices



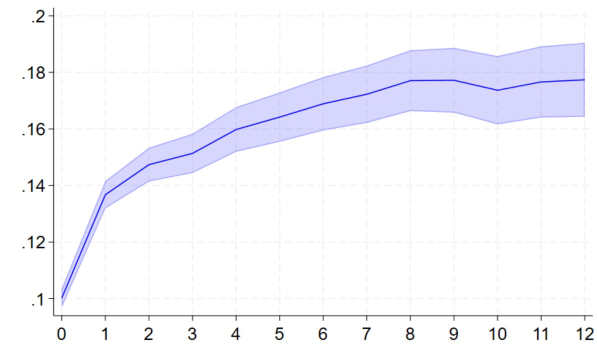
Notes: The figure shows the percent change in manufacturing firms' sales prices one year after a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, conditional on the firm's number of competitors, market share, and number of buyers, along with the 90 percent confidence interval. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

that common sectoral factors——such as sector-wide demand shocks or coordinated wage adjustments stemming from collective bargaining agreements——may simultaneously influence firms' pricing decisions, thereby biasing our estimates. To mitigate this issue, we augment our baseline specification (Equation 8) by incorporating sector-time fixed effects. These fixed effects control for unobserved, time-varying sectoral shocks that could affect all firms within a sector simultaneously. As illustrated in Figure 13, the inclusion of sector-time fixed effects yields results that are remarkably consistent with our baseline estimates, suggesting that our findings are robust to sector-level confounding factors.

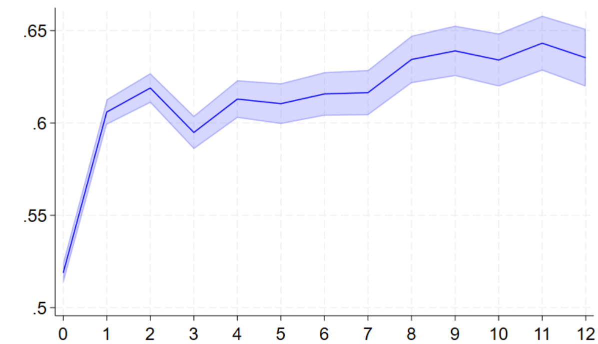
Another identification concern relates to the potential reverse causality of marginal costs and the simultaneity of competitors' price-setting decisions. Reverse causality in marginal costs arises when a firm, by purchasing a large share or all of a supplier's output, can influence the prices it pays for intermediate inputs. To address this, we instrument marginal costs using a measure that excludes purchases from suppliers with a limited number of buyers, as described in Equation 15. Competitors' prices may also be endogenous due to the simultaneity of price-setting between firms and their competitors. To mitigate this issue, we construct an instrument for competitors' price changes based on the costs of inputs used by competitors' suppliers, while excluding inputs from suppliers that transact with both the firm and its competitors, as detailed in Equation 16. Figure 14 reports the IV estimates where both marginal costs and competitors' prices are instrumented. The first-stage Kleibergen-Paap Wald F-statistic consistently exceeds

Figure 13: Sector-time fixed effects
(Percent)

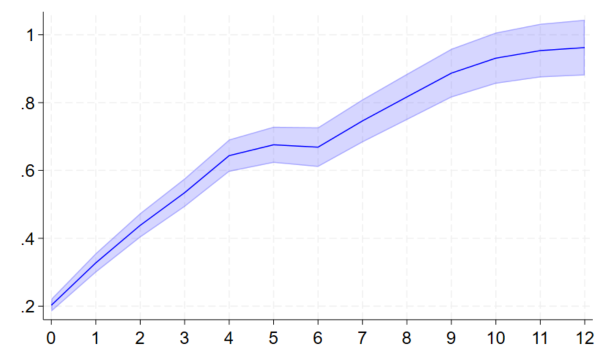
(a) Pass-through, change in marginal costs



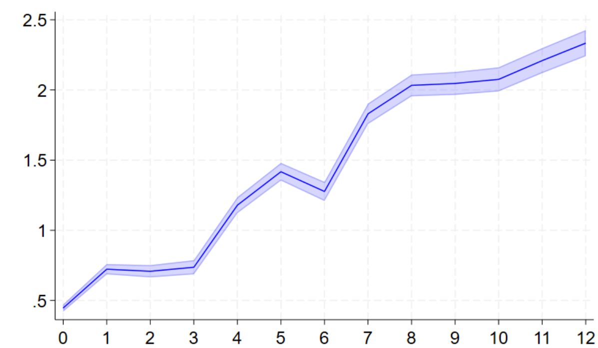
(b) Pass-through, change in competitors' prices



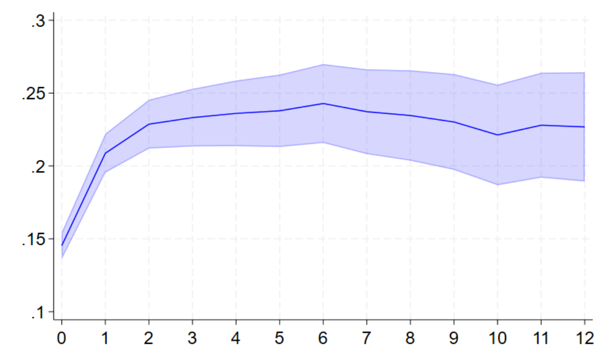
(c) Frequency, change in marginal costs



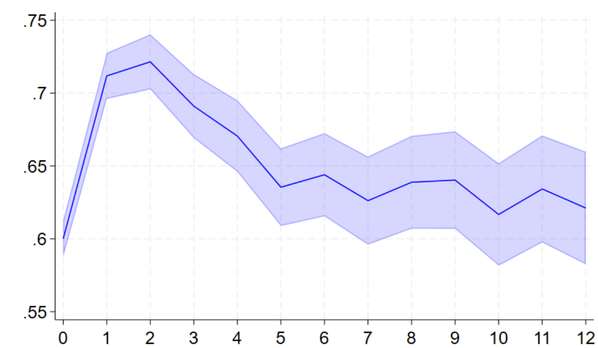
(d) Frequency, change in competitors' prices



(e) Size, change in marginal costs



(f) Size, change in competitors' prices



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The specification includes firm and sector-time fixed effects. Standard errors are clustered at the firm and time level.

200, addressing concerns about weak instruments. The IV estimates reveal an even larger pass-through of competitors' prices—approximately 85 percent over the one-year horizon—relative to the OLS results. In contrast, the pass-through of marginal costs declines to 12 percent, reinforcing the predominant role of strategic complementarities over cost factors in firms' pricing behavior. Notably, the sum of the two estimated elasticities is now statistically indistinguishable from one, consistent with the class of models from which our empirical specification is derived.[27]

The longitudinal dimension of our data is limited to the period from January 2014 to December 2023, constraining the horizon over which we can study the elasticities of interest. In the distributed lag framework, extending the horizon requires including additional lags of changes in marginal costs and competitors' prices, which reduces the available sample size for changes in sales prices. In our baseline specification, we assume that the adjustment dynamics are completed within 12 months. To test the validity of this assumption, we re-estimate the baseline model over a 24-month horizon.

Figure 15 reports the results. The responses to changes in marginal costs confirm that most of the adjustment is concentrated within the first 12 months after the shock. If anything, the magnitude of price adjustments declines during the second year, although the estimates become less precise. For changes in competitors' prices, we find that the pass-through elasticity after 24 months is approximately 55 percent, about 10 percentage points lower than in the baseline specification. Nevertheless, the pass-through remains considerably larger than that for changes in marginal costs. The decline is primarily explained by a continued reduction in the size of price adjustments during the second year, partially offset by a modest increase in the frequency of price adjustments.

Our preferred estimation approach is the distributed lag model, as it allows us to exploit the entire time series. However, to test the robustness of our results, we also estimate the elasticities of interest using local projections, which have the drawback of losing the first year of data due to the lags in the independent variables. Specifically, we estimate horizon-specific elasticities using the following specification:[28]

$$p_{i,t+h} - p_{i,t-1} = \alpha_i + \tau_t + \beta^h (mc_{i,t+h} - mc_{i,t-1}) + \gamma^h (p_{-i,t+h} - p_{-i,t-1}) + \varepsilon^h_{i,t}, \tag{24}$$

where changes in marginal costs and competitors' prices are cumulated over the same horizon h as the dependent variable.

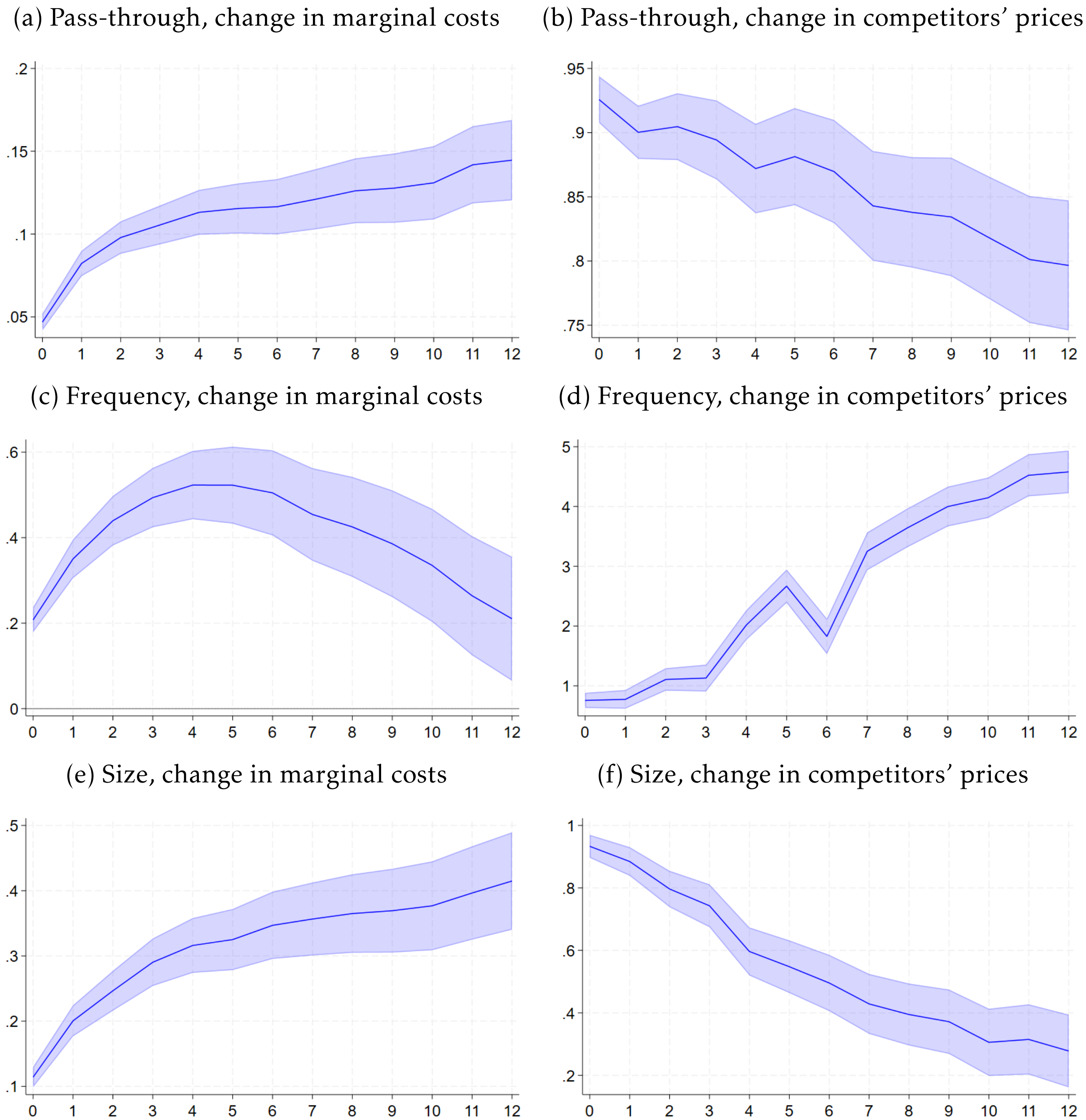
This approach accounts for the possibility that changes in marginal costs and competi-

[27] Appendix H reports results when instrumenting each variable separately.

[28] Amiti, Itskhoki and Konings (2022) and Boehm, Levchenko and Pandalai-Nayar (2023) use a similar approach to estimate exchange rate pass-through and trade elasticities, respectively.

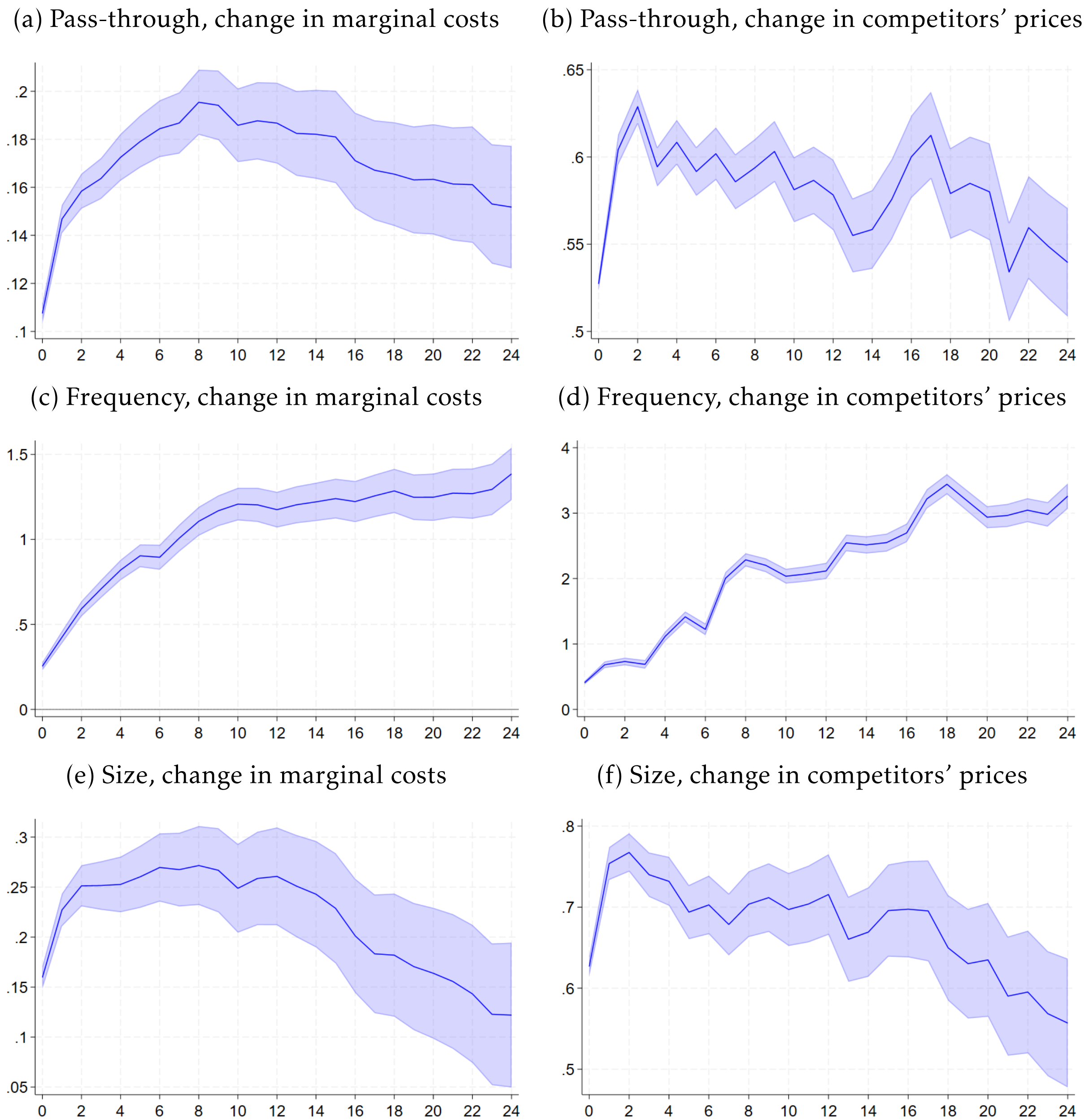
Figure 14: IV regressions

(Percent)



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It reports the results from IV regressions, in which both changes in marginal costs and competitors' prices are instrumented. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Figure 15: Longer horizon
(Percent)



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

tors' prices are autocorrelated, meaning that initial changes are often followed by further adjustments over subsequent periods. If autocorrelation is present, conventional local projections—based only on initial changes—could overestimate the coefficients for horizons $h > 0$, as they would omit subsequent cost or competitor price changes. Conversely, if these changes are mean-reverting, conventional local projections would underestimate the true parameters.

We report the results of horizon-specific local projections in Figure 16. The findings are broadly consistent with our baseline estimates, though the pass-through coefficients are marginally smaller. Specifically, the one-year-ahead marginal cost pass-through is estimated at 17 percent, compared to 18 percent in the baseline, while the pass-through of competitors' prices is 59 percent, down from 66 percent. These differences are primarily attributed to variations in the estimated responses of the frequency of price adjustments. In response to an increase in marginal costs, the frequency of price changes rises by 1.2 percentage points, slightly higher than the 1 percentage point increase observed in our baseline estimates. The magnitude of individual price adjustments remains similar at 0.2 percent. Similarly, following a change in competitors' prices, the frequency of price adjustments increases by 2.8 percentage points, compared to 2.2 percentage points in the baseline, with the size of adjustments remaining comparable at 0.7 percent.

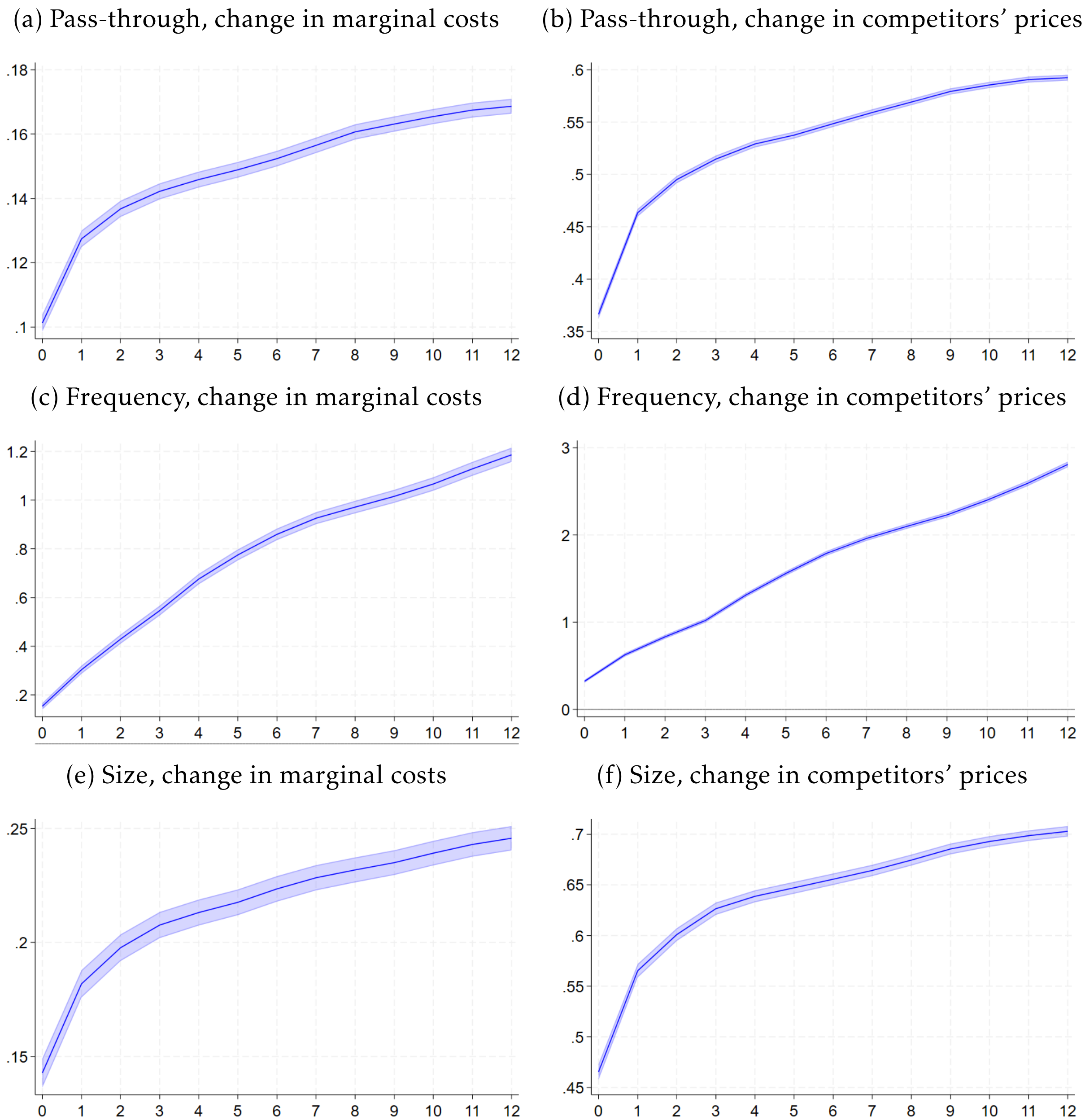
6 Conclusions

In this paper, we examine the role of strategic complementarities in firms' price setting. Using granular administrative data on Chilean firms, we make progress on measuring changes in marginal costs and competitors' prices, and use them to document five key facts about firm's strategic pricing behavior.

The first fact is that firms set prices strategically, with the pass-through from competitors' prices substantially exceeding that from their own costs. Specifically, firms pass through approximately two-thirds of changes in competitors' prices—about 3.7 times larger than the pass-through of marginal cost changes. The second fact is that the strength of strategic complementarities varies across sectors but remains of first-order importance throughout. For manufacturing firms, the pass-through of competitors' prices is estimated at 40 percent. This is considerably less than for retail firms, whose pass-through is above 70 percent. However, it is still significantly larger than the cost pass-through, confirming that strategic complementarities are a key factor for firms' pricing.

The willingness of firms to engage in strategic pricing, however, changes depending on a number of factors. The third fact is that strategic complementarities are state de-

Figure 16: Horizon-specific elasticities
(Percent)



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in their marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

pendent. Focusing on manufacturing firms, we find that during periods of high inflation, firms not only become more sensitive to changes in their own costs, but also twice as likely to adjust prices in response to competitors' price changes. High inflation thus weakens nominal rigidities while strengthening strategic complementarities. The fourth fact is that the pass-through is asymmetric: it is larger for competitors' price increases than for decreases. This 'rockets and feathers' phenomenon extends to strategic pricing. Finally, the fifth fact is that strategic complementarities are stronger when firms face lower competition, have larger customer bases, and enjoy higher market shares. These findings highlight the importance of market structure in shaping firms' strategic pricing behavior. Taken together, the evidence supports the view that strategic complementarities are a dominant source of real rigidities in pricing, leading firms to adjust their prices less than one-for-one with changes in marginal costs.

The pass-through of competitors' prices to firms' prices—along with the elasticity of markups to competitors' prices—provides valuable guidance for models that examine how rising market concentration affects general-equilibrium macroeconomic outcomes through firms' strategic behavior. Exploring the implications of these findings for quantitative models and optimal monetary policy design offers a promising direction for future research.

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Appendix

A Regular prices

For any product, we compute the regular prices r_t from observed prices p_t following the procedure of Nakamura and Steinsson (2008). This essentially filters out changes in observed prices due to sales and stockouts by assuming that the regular price of the product comes back to its level after sales and stockouts events. Specifically, the algorithm consists of the following steps

1. If $p_t = r_{t-1}$, then $r_t = r_{t-1}$
2. If $p_t > r_{t-1}$, then $r_t = p_t$
3. If $r_{t-1} \in \{p_{t+1}, \ldots, p_{t+J}\}$ and $p_t \leq r_{t-1}$ before returning to r_{t-1}, then $r_t = r_{t-1}$
4. If $\{p_t, p_{t+1}, \ldots, p_{t+L}\}$ has K or more different elements, then $r_t = p_t$
5. Define $p_{max} = \max\{p_{t+1}, \ldots, p_{t+L}\}$ and $t_{max} =$ first-time $\max\{p_{t+1}, \ldots, p_{t+L}\}$; if $p_{max} \in \{p_{t_{max}+1}, \ldots, p_{t_{max}+L}\}$, then $r_t = p_{max}$
6. $r_t = p_t$

In our calculations, we parametrize the filter with $L = 3$, $K = 3$, and $J = 5$.

B Price rigidity of CPI and PPI products

We provide descriptive evidence about price rigidity based on a sample product varieties that enter the CPI and PPI baskets, and compare it with that available for other countries.[29] The frequency of price changes is defined the number of price changes per unit of time. Thus, for each product variety v entering the CPI or PPI product category c sold in month t, $p_{v,c,t}$, we compute the frequency of price changes at the CPI or PPI product category level, $f_{c,t}$, and aggregate at the economy level using the expenditure weights

$$f_t = \sum_c \omega_c f_{c,t} = \sum_c \omega_c \frac{\sum_{v \in c} D_{v,c,t}}{\sum_{v \in c} O_{v,c,t}} \tag{25}$$

[29] For the period January 2018–December 2023, we can easily map product varieties to CPI and PPI categories using the CPC and COICOP classifiers as per the National Statistics Institute classification. Yet, for the period before January 2018, the mapping information is not available and we assume that the first available mapping holds backwards.

where ω_c denotes the CPI and the PPI weights from the National Statistics Institute, $D_{j,c,t}$ is a dummy variable that takes value one when the product variety changes price, and $O_{j,c,t}$ is a dummy variable that takes value one when the price of the product variety is observed; so that $D_{j,c,t} \leq O_{j,c,t}$. From the frequency of price changes, we infer the price price duration as $-1/\ln(1-f_t)$.

The size of price changes (i.e., the magnitude of price changes conditional on the prices changing from $t-1$ to t) is similarly computed by aggregating the magnitude of non-zero price changes at the CPI and PPI category level $s_{c,t}$ weighted by expenditure

$$s_t = \sum_c \omega_c s_{c,t} = \sum_c \omega_c \frac{\Delta p^{\neq 0}_{v,c,t}}{O^{\neq 0}_{v,c,t}} \tag{26}$$

where $\Delta p^{\neq 0}_{v,c,t} = p_{v,c,t} - p_{v,c,t-1} \neq 0$ and $O^{\neq 0}_{j,c,t}$ is a dummy variable that takes value one when the price differs from the one of the previous month.

To understand whether price increases or decreases are more frequent, we also compute the frequency of price changes separately for positive and negative price changes, f_t^+ and f_t^- respectively. Analogously, we repeat the size calculations for price increases and decreases, s_t^+ and s_t^-, such that

$$\Delta p_t = f_t^+ s_t^+ + f_t^- s_t^- \tag{27}$$

The upper panel of Table B.1 reports the time average of the frequency measure, as defined in Equation 25. The frequency based on the weighted changes of median prices is 30.3 and 30.9 percent for CPI and PPI products, respectively. This implies that after the price of a product changes, it takes almost three months to change again. The frequency computed out of median prices is significantly smaller than that obtained from average prices, suggesting that a few CPI and PPI product categories have relatively higher frequencies.

The analog calculations for regular prices indicate that, as expected, the frequency estimate is smaller than for observed prices. For regular prices of CPI and PPI products, we find frequency estimates of 25.6 and 25.2 percent respectively, indicating a longer duration of about 3 months and a half. These results suggest that temporary sales are a feature of the data, both for products sold to final consumers and intermediate inputs. Another finding is that price increases are considerably more frequent than decreases, which is consistent with a monetary policy regime aimed at a positive inflation target. The frequency of observed price increases is about 5 percentage points higher than for price declines. The same is true for regular prices.

It is difficult to compare estimates across studies as methodologies, sample periods, and data sources vary considerably. However, the evidence on emerging markets suggests that our estimates of the frequency of price adjustment are broadly in the range of those of other countries. For example, Gouvea (2007) and Barros et al. (2009) use prices of CPI products and find an average frequency of 37.2 and 37 percent, respectively. Julio, Zárate and Hernández (2009) estimate the average frequency at 21.1 percent using CPI data for Colombia, while the median frequency is 11.9 percent. Gagnon (2009) uses price information of Mexican CPI products and finds that the average frequency changes substantially when inflation is low and high, from 22.1 percent to 61.9 percent. Creamer and Rankin (2008) examine both CPI and PPI products in South Africa and find that the frequency is 16 percent for the former and 19.5 percent for the latter. Earlier evidence on Chile by Medina, Rappoport and Soto (2007) is limited to CPI products in the pre-2005 period and reports an average frequency of 44.7 percent and a median frequency of 28.9 percent.

The lower panel of Table B.1 reports the time average of the size of price changes of CPI and PPI products, as defined in Equation 26. Using median prices, the average size of price changes of CPI and PPI products over the full sample period is 1.3 percent. Also, differences are small when the size of price changes is computed starting from average prices instead of median prices.

We find that removing instances of temporary sales does not significantly alter the size of price adjustments. The size of regular price changes is in fact only 0.2 percentage points smaller than that of observed price changes. When we separate price increases and price decreases, however, we find that the size of regular price changes is smaller after excluding temporary sales. This suggests that price changes associated with temporary sales tend to be larger than other price adjustments.

Interestingly, while price decreases occur less frequently than price increases, they tend to be larger. For observed median prices, the size of price decreases is 15 percent for CPI products over the full sample, 2.3 percentage points larger than for price increases. In the case of PPI products, price decreases are 1.7 percentage points larger than price increases. These differentials are of similar magnitude for regular prices.[30]

Figure B.1 shows the distribution of the frequency and size of observed and regular price changes $f_{c,t}$ and $s_{c,t}$, separately for products entering the CPI and the PPI baskets. As shown in the top panels, regular prices have relatively fatter left tails than observed prices, indicating a lower frequency of adjustments as expected. The mode of the distri-

[30] The results for the post-January 2018 period—for which the mapping between product and CPI and PPI categories is available—are remarkably similar to those for the entire sample period.

Table B.1: Frequency and size of price changes of CPI and PPI products
(Percent)

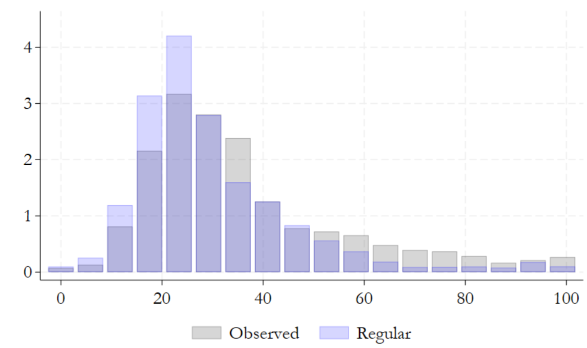
	CPI		PPI	
	Median prices	Average prices	Median prices	Average prices
Frequency				
Observed prices				
All changes	30.3	36.4	30.9	37.7
Duration (months)	2.8	2.2	2.7	2.1
Increases	17.3	21.2	16.6	22.0
Decreases	11.5	15.1	11.6	15.8
Regular prices				
All changes	25.6	30.0	25.2	28.9
Duration (months)	3.4	2.9	3.5	3.0
Increases	14.7	17.6	13.7	16.7
Decreases	9.5	12.1	9.1	12.2
Size				
Observed prices				
All changes	1.3	1.3	1.3	1.3
Increases	12.7	13.7	10.5	11.1
Decreases	-15.0	-15.8	-12.2	-12.6
Regular prices				
All changes	1.2	1.1	1.5	1.4
Increases	11.8	12.6	10.1	10.8
Decreases	-14.2	-15.0	-11.7	-12.3

Notes: The table reports the frequency and size of price changes for CPI and PPI product varieties. Beginning in January 2018, product varieties are mapped to CPI and PPI categories using the COICOP and CPC classifications; for earlier periods, the same mapping is assumed. Regular prices (i.e., excluding sales) are identified using the filter of Nakamura and Steinsson (2008), which removes asymmetric V-shaped sales—temporary price reductions followed by a return to the regular price—applying a five-month return window. Implied duration is expressed in months.

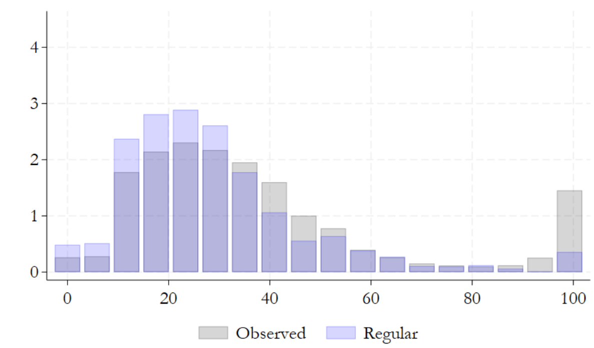
bution for regular prices is about 0.25, meaning that one-fourth of the products change prices in a typical CPI/PPI category and month. Also, the right tails of the distributions are long, indicating a few instances in which a significantly larger share of products changed prices. The bottom panels show that, after excluding instances in which prices did not change, regular prices display smaller price changes than observed prices, with the mode of the distribution at around 1.5 percent both in the case of CPI and PPI product categories. The distributions in the two panels display relatively fat right tails, indicating that price increases are more frequent than price declines.[31]

Figure B.1: Distribution of frequency and size of price changes

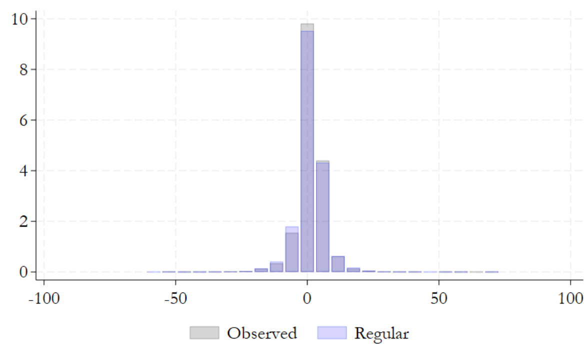
(a) Frequency, CPI products



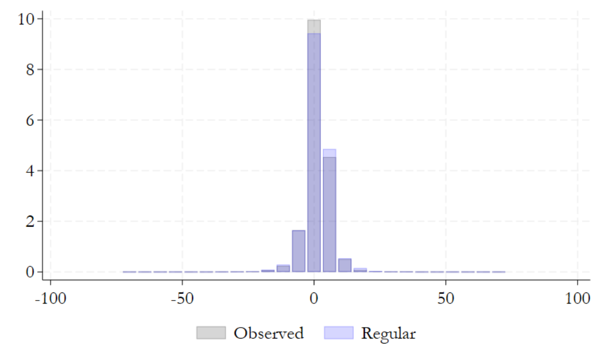
(b) Frequency, PPI products



(c) Size, CPI products



(d) Size, PPI products



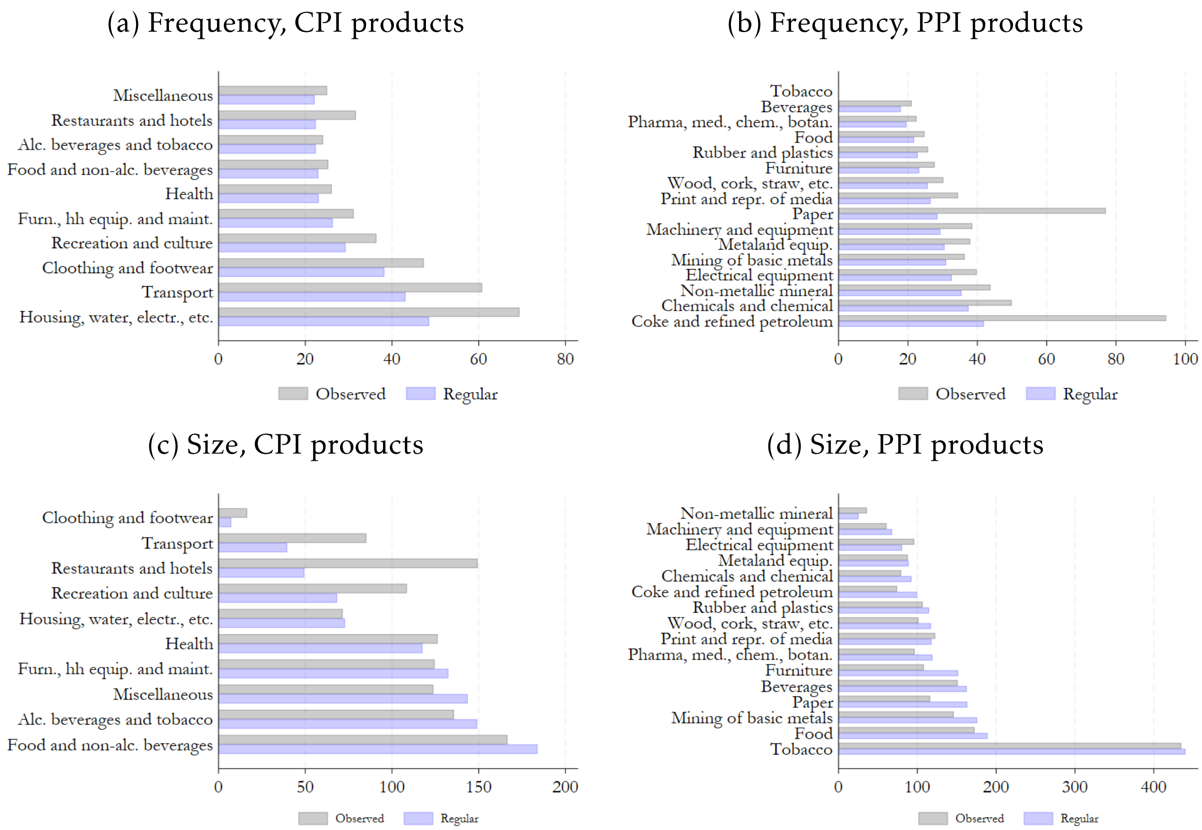
Notes: The figure shows the density distribution of the frequency and size of (median) price changes for CPI and PPI product categories. Regular prices (i.e., excluding sales) are identified using the filter of Nakamura and Steinsson (2008), which removes asymmetric V-shaped sales—temporary price reductions followed by a change in the regular price—applying a five-month return window.

The top panels of Figure B.2 illustrate the median frequency of price changes by CPI and PPI categories. Across categories, regular prices adjusted 5 to 15 percentage points less frequently than observed prices. However, there is substantial heterogeneity across categories. In the case of the CPI, 'restaurants and hotels' (along with 'miscellaneous') display the lowest frequency at 22 percent for regular prices, while 'housing, water, electricity, etc.' prices show the highest at 48 percent. For PPI, the category with the lowest frequency is 'tobacco', for which the median frequency is zero as most of the tobacco products did not change prices over the sample period, while about half of the products in the category 'coke and refined petroleum' changed prices. The bottom panels report the median size of price changes for CPI and PPI categories. Across CPI categories, the

[31] Appendix A reports the frequency and size of price changes across CPI and PPI product categories.

largest regular price adjustments take place in ‘food and non-alcoholic beverages’ with a median size of 1.7 percent, while the smallest price changes (about 0.2 percent) are in the ‘clothing and footwear’ category. With respect to PPI, the largest price changes happened in the ‘tobacco’ category (about 4.5 percent), while the smallest took place in the ‘non-metallic minerals’ group.

Figure B.2: Frequency and size of price changes by product category
(Percent)



Notes: The figure shows the frequency and size of (median) price changes for CPI and PPI product categories. Regular prices (i.e., excluding sales) are identified using the filter of Nakamura and Steinsson (2008), which removes asymmetric V-shaped sales—temporary price reductions followed by a return to the regular price—using a five-month return window.

C Classification of product varieties into product categories

We follow the work of Acevedo et al. (2025) to classify the product varieties into product categories consistent with the CPC and an adapted version of the COICOP, specifically the CUP with 290 categories. In a nutshell, the algorithm is as follows

1. It builds a sample of text descriptors associated with each product category.

2. It then computes a score for each text descriptor within each economic sector of the seller based on the sales amount.

3. For each product category, it selects up to 2,000 text descriptors with the highest score and manually classifies them into product categories.

4. It cleans the text descriptors following Gentzkow, Kelly and Taddy (2019), as free text descriptors are unstructured and might contain uninformative parts.

5. It employs the FastText classification algorithm proposed in Joulin et al. (2016) to predict the product category using the text of the training sample.[32]

6. It finally uses the trained model on the untrained sample and obtains the mapping between product varieties and product categories.

D Decomposing pass-through into frequency and magnitude of price adjustments

The pass-through is not simply the product of the change in frequency and the change in size of price changes. Rather, the cumulative change in prices over an R-period horizon can be expressed as

$$\Delta_R p_t = f_{t-R} \Delta_R s_t + s_{t-R} \Delta_R f_t + \Delta_R s_t \Delta_R f_t, \tag{28}$$

where Δ_R is the R-period difference operator and we omit the subscript i for notational simplicity. Let $\beta^{f,r}$ and $\beta^{s,r}$ denote the estimated coefficients on marginal cost changes when the dependent variable is the frequency and the size of price changes, respectively. Then, the cumulative effect of a marginal cost change on prices over horizon R is given by

$$\frac{\partial \Delta_R p_t}{\partial \Delta mc_t} = \sum_{r=0}^{R} \beta^r = f_{t-1} \sum_{r=0}^{R} \beta^{s,r} + s_{t-1} \sum_{r=0}^{R} \beta^{f,r} + \sum_{r=0}^{R} \beta^{s,r} \sum_{r=0}^{R} \beta^{f,r}, \tag{29}$$

where f_{t-1} and s_{t-1} are evaluated at their sample means. This decomposition highlights how price adjustments result not only from changes in how often firms change prices and

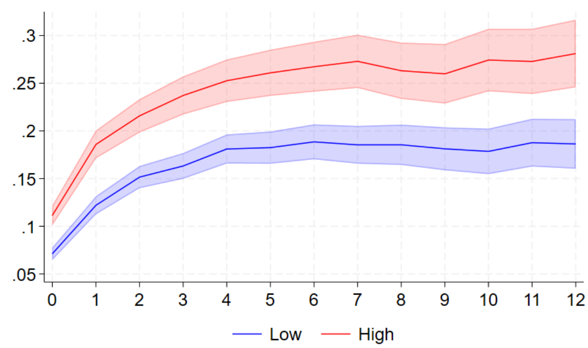
[32]The algorithm also uses information about the economic sector of the selling firm and the price range of the product to improve the fit of the model, which can help distinguish between product categories. For example, the sale of a computer and its repair/maintenance may be described very similarly. However, if the trained model knows the sector and price range associated with a text descriptor, it can better distinguish between them.

how much they change them, but also from the interaction between the two.

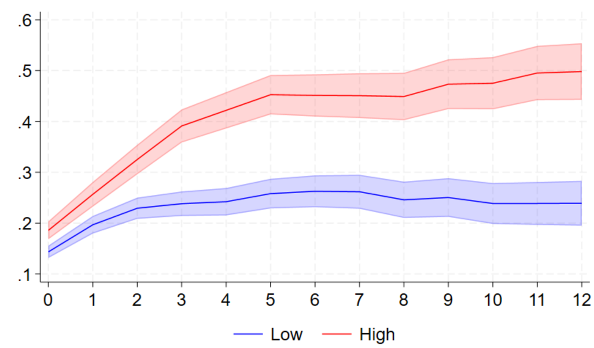
E Alternative measures of high and low inflation

Figure E.1: Pass-through estimates in high and low inflation periods
(Percent)

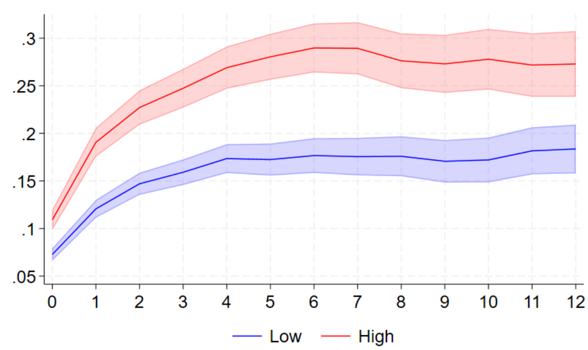
(a) Change in marginal costs,
monthly inflation



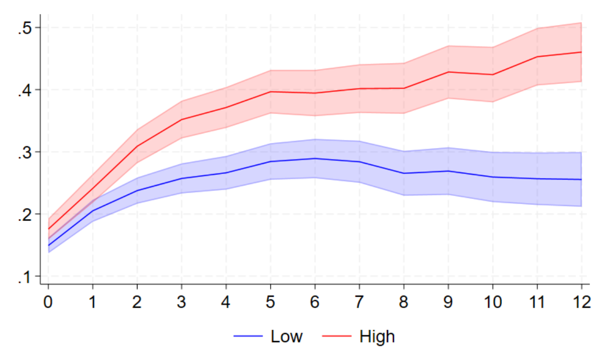
(b) Change in competitors' prices,
monthly inflation



(c) Change in marginal costs,
annual inflation



(d) Change in competitors' prices,
annual inflation



Notes: The figure shows the percent change in firms' sales prices in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices differentiating between periods of low and high inflation, along with the 90 percent confidence intervals. In panels (a) and (b), high inflation periods are identified using the mean and standard deviation of monthly inflation; while in panels (c) and (d) using the mean and standard deviation of annual inflation. The specifications include firm and time fixed effects. Standard errors are clustered at the firm and time level.

F Statistical differences

Table F.1: Differences in coefficients

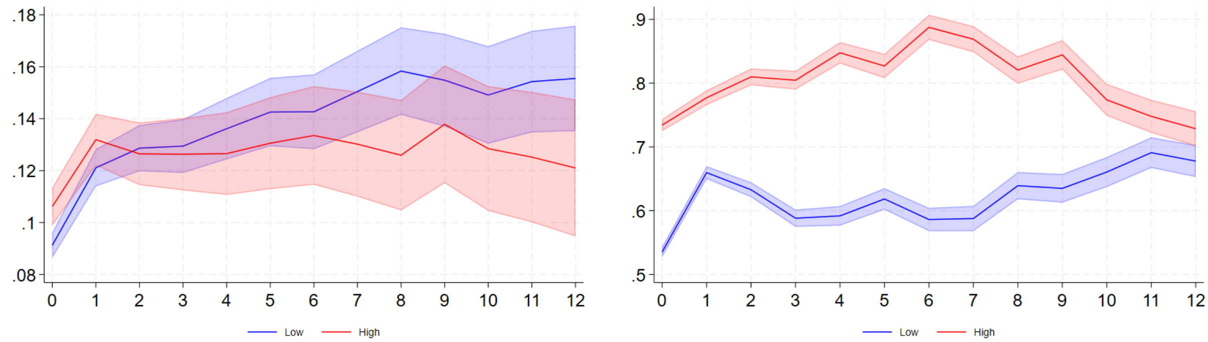
	Changes in marginal costs	Changes in competitors' prices
Manufacturing firms - retail firms		
Pass-through	0.121***	-0.331***
Frequency	0.737***	-1.071***
Size	0.279***	-0.014
High inflation - low inflation		
Pass-through	0.109***	0.212***
Frequency	1.403***	1.618***
Size	0.149	0.612***
Positive changes - negative changes		
Pass-through	0.027	0.124***
Frequency	2.077***	1.335***
Size	-0.006	-0.094
Many competitors - few competitors		
Pass-through	0.014	-0.076***
Large markets share - small market share		
Pass-through	-0.019	0.085***
Many buyers - few buyers		
Pass-through	-0.033	0.157***

Notes: The table reports the one-year cumulated coefficients on the interaction terms with changes in marginal costs (column 1) and changes in competitors' prices (column 2) from the regressions of pass-through, frequency of price adjustments, and size of price adjustments. All specifications include firm and time fixed effects. Standard errors are clustered at the firm and time level. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

G Evidence on retail firms

Figure G.1: Retail firms' pass-through during high vs low inflation
(Percent)

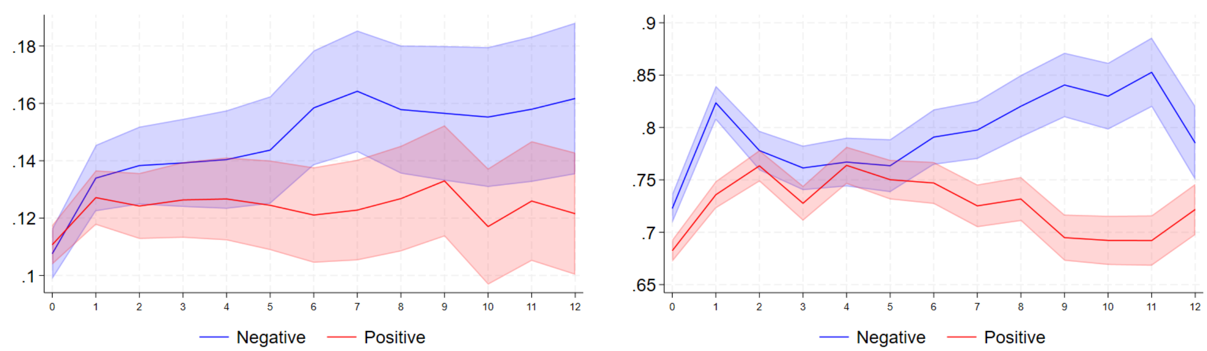
(a) Change in marginal costs (b) Change in competitors' prices



Notes: The figure shows the percent change in firms' sales prices in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. It compares the responses of retail firms during high inflation periods to those during low inflation periods. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Figure G.2: Asymmetric pass-through of retail firms
(Percent)

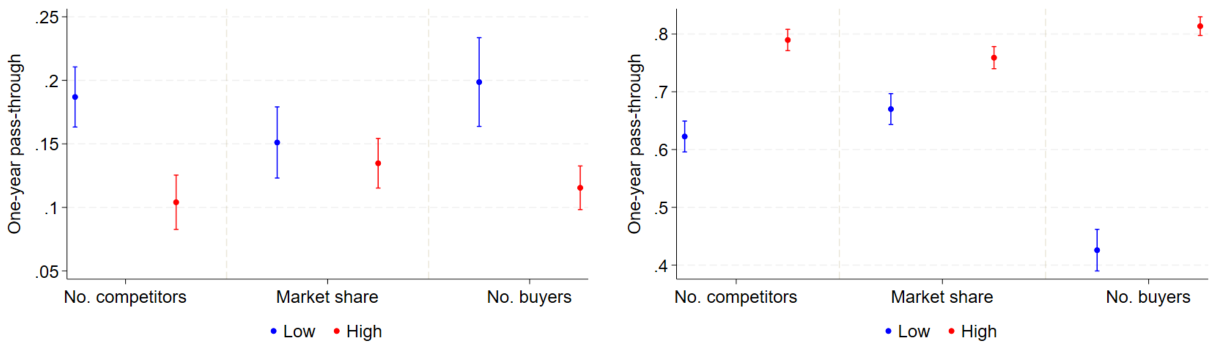
(a) Change in marginal costs (b) Change in competitors' prices



Notes: The figure shows the percent change in firms' sales prices in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The figures compares the responses of retail firms to positive and negative changes in marginal cost and competitors' prices. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Figure G.3: Market structure of retail firms
(Percent)

(a) Pass-through, change in marginal costs (b) Pass-through, change in competitors' prices

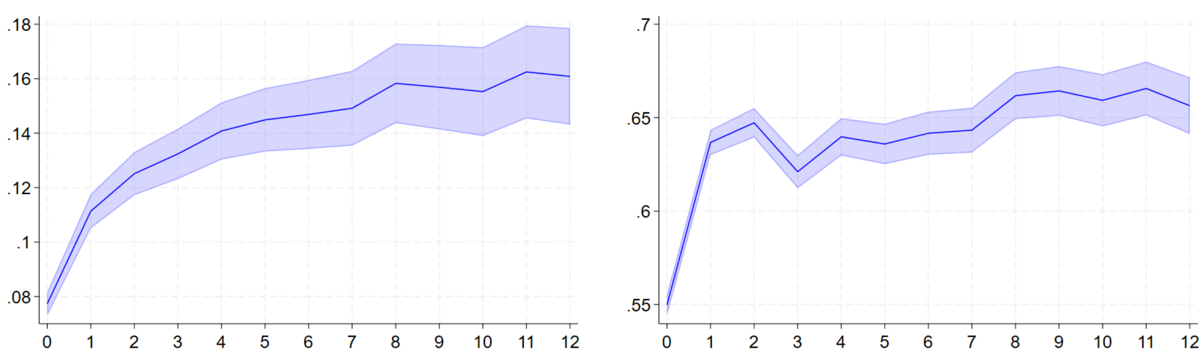


Notes: The figure shows the percent change in retail firms' sales prices one year after a change in their marginal costs and competitors' prices, conditional on the firm's number of competitors, market share, and number of buyers, along with the 90 percent confidence intervals. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

H Other IV regressions

Figure H.1: Instrumenting changes in marginal costs
(Percent)

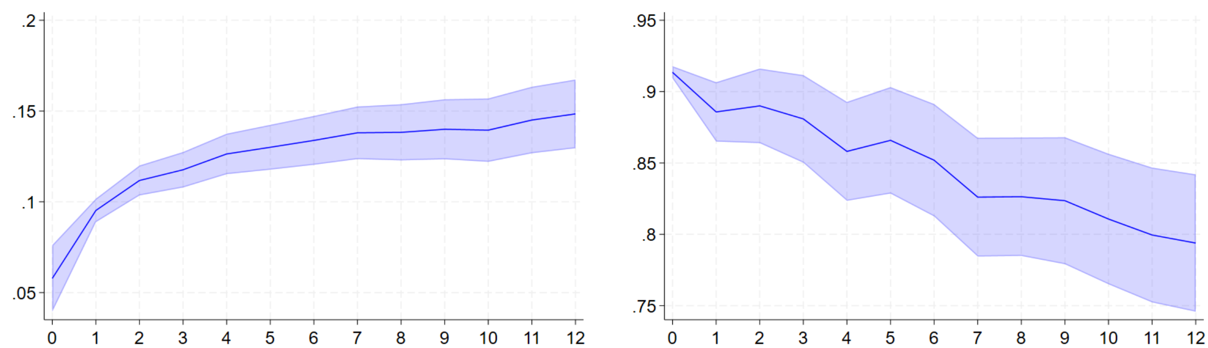
(a) Pass-through, change in marginal costs (b) Pass-through, change in competitors' prices



Notes: The figure shows the percent change in retail firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The figure reports the results from IV regressions, in which changes in marginal costs are instrumented. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.

Figure H.2: Instrumenting changes in competitors' prices
(Percent)

(a) Pass-through, change in marginal costs (b) Pass-through, change in competitors' prices



Notes: The figure shows the percent change in firms' sales prices, the percent change in the frequency of sales price adjustments, and the percent change in the size of non-zero sales price adjustments in response to a one percentage point change in marginal costs and a one percentage point change in competitors' prices, along with the 90 percent confidence intervals. The figure reports the results from IV regressions, in which changes in competitors' prices are instrumented. The specification includes firm and time fixed effects. Standard errors are clustered at the firm and time level.