Inflation Expectations and the Supply Chain*

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Abstract

We show that firms rely on price changes observed along their supply chain to form beliefs about future aggregate inflation. Leveraging on a unique dataset merging expectation surveys and records from the VAT registry for Chilean firms, we find that firms operate as if they were located on different islands à la Lucas, learning from a subset of islands they have relationships with. Our results reject the full-information rational expectation hypothesis because firms respond to shocks idiosyncratic to their supply chain that do not have relevance for aggregate inflation, effectively extrapolating an aggregate value from an unrelated local signal. Due to the volatile and dispersed nature of supply chain inflation, the channel we highlight in this paper can be reconciled with disagreement in inflation expectations and rational inattention.

Keywords: Forecast disagreement, inflation expectations, information frictions, rational inattention, supply chain

JEL Codes: E30, E31

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1 Introduction

Understanding how firms form expectations about inflation is crucial to many aspects of policymaking. *In primis*, it is relevant to monetary policy, which targets aggregates—prices and employment—that depend on firm-level expectations and decisions (Coibion, Gorodnichenko and Kumar, 2018). Unfortunately, as Bernanke (2007) puts it: "Information on the price expectations of businesses who are, after all, the price setters (...) is particularly scarce" and therefore surveys of professional forecasters or households are not substitutes for surveys of firms.[1] In this paper, we take advantage of a unique dataset merging confidential information from the expectation survey of Chilean firms and administrative records from the VAT registry. Leveraging on this information, we explore the relationship between price changes that firms observe along the supply chain and their expectations about aggregate inflation.

One would expect that firms use economy-wide information to generate their forecasts about aggregate inflation and that idiosyncratic shocks observed along the supply chain should be ignored. As a result, cross-firm disagreement should tend to zero and inattention to easy-to-consult macroeconomic news should be low.[2] We show instead that firms' disagreement about next year's inflation is substantial and that a large share of firms does not react to news about aggregate inflation. Our main result is that firms form their views about aggregate inflation based on changes in input costs and sales prices in *their* supply chain, even if these do not predict aggregate inflation either contemporaneously nor in the future. These findings are supportive of the "island model" of Lucas (1972), in which firms operate as if they were located on different islands and learn only from a subset of islands they have some relationships with. That is, our evidence is supportive of the hypothesis for which firms extrapolate an *aggregate value* from an unrelated *local* signal.

The channel we highlight in this paper can be reconciled with disagreement in inflation expectations and rational inattention. As firms produce and sell different goods and services, input price inflation can vary in different points of the supply chain. For example, a shortage of a given input that a firm uses to produce its products and services is a

[1] Survey of firms cannot be replaced with surveys of professional forecasters or households not only because firms are the actual price setters in the economy, but also because they reveal different information. Using surveys for different countries, Candia, Coibion and Gorodnichenko (2021*b*) document that mean inflation forecasts of firms deviate significantly from that of professional forecasters and households and present a more pervasive disagreement, among other things.

[2] Candia, Coibion and Gorodnichenko (2021*a*) and Fuster and Zafar (2022) point out that many survey-based studies use data on advanced economies with a history of low and stable inflation. One of the advantages of focusing on an emerging market is that inflation was generally higher and more volatile, making economic agents more attentive to it (Cavallo, Cruces and Perez-Truglia, 2017; Candia, Coibion and Gorodnichenko, 2021*b*).

bottleneck in the supply chain of that firm, but it does not necessarily affect the rest of the economy nor firms in the same sector that source their inputs from other suppliers. We show in fact that supply-chain inflation displays significant dispersion across firms, both on the purchasing and the selling side. Thus, if firms form their beliefs according to the prices observed on the supply chain, dispersion in supply chain inflation gets reflected in inflation forecast disagreement. Also, supply chain inflation volatility can lead to inattention to macroeconomic developments. In fact, firms may just allocate most of their attention to volatile idiosyncratic shocks which are more immediately relevant to their businesses.

Our results have policy implications in a number of areas. If firms form their beliefs based on local conditions which do not have aggregate implications, monetary policy can be thrown off its optimal path by reacting to changes in inflation expectations that are not leading to any actual change in inflation. Also, when firms set their inflation expectations according to the price conditions observed along the supply chain and these are different across firms, the channel we highlight in this paper can lead to de-anchoring of inflation expectations.[3] This is particularly relevant in the post-COVID-19 recovery, in which the mix of a gradual re-opening and strong demand generated supply bottlenecks in the global supply chains. Finally, if firms act on the basis of their beliefs by setting their prices accordingly, forecast disagreement can translate into welfare-costly price dispersion.

This paper contributes to the literature documenting information frictions in the expectation formation mechanism, highlighting a new channel through firms form their beliefs about aggregate inflation, namely the supply chain. The closest paper to ours is Andrade et al. (2022), where firms learn from inflation observed in the industry to which they belong. We find some evidence of that in Chile and a much stronger one for firms learning with firms they trade with. This is, after all, consistent with the fact that firms may operate at the intersection of different industries (especially when these are finely defined) and that we can observe a more direct measure of what prices firms actually observe from the VAT registry.

The literature about firms learning from observed prices is limited, largely owing to data limitations. Beyond Andrade et al. (2022), only Kumar et al. (2015) provides some

[3]The literature defines inflation expectation anchoring in a number of ways. These include the deviation of long-term mean inflation forecasts from target, the variability of mean inflation forecast, the sensitivity of long-term inflation forecasts to inflation surprises, as well as the dispersion of inflation forecasts (Capistrán and Ramos-Francia, 2010; Dovern, Fritsche and Slacalek, 2012; Demertzis, Marcellino and Viegi, 2012). Our argument builds on the latter definition, for which inflation expectations should be close to each other to be well-anchored.

evidence that in New Zealand firm managers form expectations about aggregate inflation based on the prices observed when they go on personal shopping. Similarly, Cavallo, Cruces and Perez-Truglia (2017) and D'Acunto et al. (2021) find that shopping prices faced by households lead to changes in their inflation expectations. Also, Coibion and Gorodnichenko (2015*b*) show that gasoline prices have an impact for inflation expectations. Compared to the literature based on household surveys, we argue that our results have a more direct relationship with monetary policy as, in the end, firms are the actual price setters in the economy.

The paper is also related to other strands of literature. In showing that firms respond to idiosyncratic shocks that have no aggregate consequences, it contributes to the literature showing violations of the full-information rational expectations hypothesis (Coibion and Gorodnichenko, 2012, 2015*a*). Also, it relates to the literature on rational inattention, which shows that firms devote resources to process volatile information that is more relevant for them (Mackowiak and Wiederholt, 2009; Pasten and Schoenle, 2016). Finally, it relates to the granularity hypothesis pushed forward by Gabaix (2011) for which idiosyncratic shocks can lead to aggregate consequences.

The rest of the paper is organized as follows. Section 2 describes the data used in the analysis and how we construct measures of supply chain inflation. Section 3 presents some key stylized facts about firms' inflation expectations, highlighting disagreement and inattention to macroeconomic news; and discusses their relationship with supply chain inflation. Section 4 presents the empirical results along with a series of robustness tests. Section 5 concludes.

2 Data

Our empirical setting is Chile during January 2015–September 2021. Consumer prices experienced some significant swings during this period. Inflation fell from an average of 4.3 percent in 2015 to less than 2 percent in 2017. Then, it increased towards the central bank target of 3 percent in late 2018. During 2019 and 2020 it hovered within the target band of 2–4 percent and then it spiked in the last months of 2020 and in early 2021 to about 7 percent. Such variation provides an ideal setting to study the expectation formation mechanism.

We draw from two main data sources at the micro level. The first one is the expectation survey (*Índice Mensual de Confianza Empresarial*), which is sent to an average of about 600 firms each month. Of these, two thirds answer the questions. The survey has been sent to firms since December 2004 and reached a total of 1,526 firms across waves and

questions, which account for an unbalanced panel of 150 firms. It targets all large firms and randomly selected smaller firms, representing 35.5 percent of sales on average. Firms that answer the survey operate in four broad sectors: manufacturing, retail, construction, and mining.

The expectation survey asks 18 questions. Of these, 16 are qualitative and two are quantitative; seven questions are about the current situation and 11 are about the future. However, the number of questions varies across sectors. The question we focus on in this paper elicits firms' expectations about aggregate CPI inflation expectations, and specifically asks: "What do you think inflation will be in the next 12 months (measured by the Consumer Price Index CPI)?". This question targets firms in the manufacturing and retail sectors, which represent 35 percent and 23 percent of each sector's sales, respectively, over the period January 2015–September 2021.

The second data source consists of the administrative records on the universe of Chilean firms. In particular, we draw from firm-to-firm electronic invoices which became mandatory in Chile in 2014. From the invoices, we obtain information about which firms are transacting, what goods, in what quantities, and at what prices. We convert sales in Chilean Pesos into real values called *Unidad de Fomento*, a CPI inflation-indexed unit of account calculated and published by the Central Bank of Chile.[4]

Finally, we complement our dataset with information at the country level on CPI inflation and GDP growth.

2.1 Supply chain inflation

We construct firm-level indexes of input costs and sales price inflation as follows. First, we restrict the sample of the firms that answer the survey to those that purchase and sell at least five different products in any given month t.[5] This criterion, which only leads to the loss of very few firms, reduces the sparsity of the firm-level input prices. That is, firms may not purchase their inputs each month, especially if they only need one input in their production process. With a minimum of five products purchased, we make sure that we observe input costs more frequently over time.

From the electronic invoices, we collect price and quantities for each product j purchased and sold by firm i, P^r_{ijt} and Q^r_{ijt} where $r = [p, s]$ denotes whether the product is purchased or sold. We reduce the probability of erroneous records by dropping obser-

[4] See https://si3.bcentral.cl/estadisticas/Principal1/metodologias/EC/IND_DIA/ficha_tecnica_UF_EN.pdf.

[5] Products are classified using the *Clasificador Único de Productos*, which includes approximately 12,000 goods and services.

vations for which the purchasing/selling price is less than 10 pesos, $P^r_{ijt} \leq 10$, and the purchased/sold quantity is zero or negative, $Q^r_{ijt} \leq 0$. Then, for each purchased/sold product j and firm i, we compute the year-on-year log difference of the median price observed in each month, $\pi^{r,50}_{ijt}$.

Finally, to obtain the indicators of supply chain inflation at the firm level, we compute the average of product inflation weighted by the transaction amount, $\pi^r_{it} = \sum_j \frac{P^r_{ijt}Q^r_{ijt}}{P^r_{it}Q^r_{it}} \pi^{r,50}_{ijt}$. We limit extreme volatility in the supply chain inflation indicators by trimming observations that lie outside of the $-20 \leq \pi^s_{it} \leq +20$ percent change band, which leaves us with 6,672 firm-month observations for input price inflation and 5,010 firm-month observations for sales price inflation.[6] To maximize the number of observations, we use two different samples for the regressions with input price inflation and sales price inflation. However, as we show in the robustness section, results are virtually unchanged when using data that are the intersection of the two datasets.

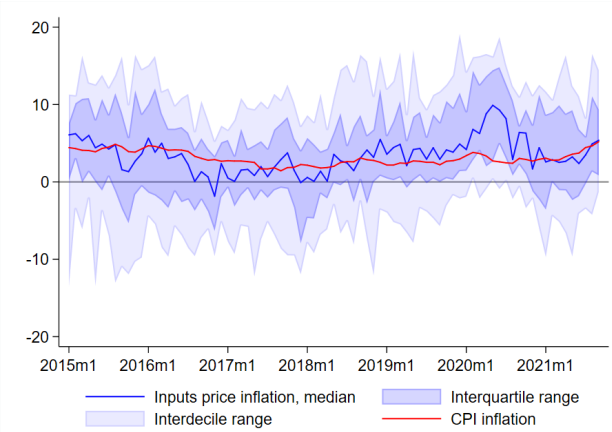
To summarize, our indicators of supply chain inflation consist of the percent change in the input costs that firms observe when they purchase inputs and percent change in the sales prices that firms observe when they sell their products. Figure 1 shows the cross-firm distribution over time of these indicators. A few facts stand out. First, both input and sales price inflation display significant cross-firm dispersion. Averaging the cross-sectional standard deviation over the sample period we obtain 7.3 percent for the former and 6.4 percent for the latter, suggesting that firms observe markedly different conditions along the supply chain. This is unsurprising, as firms buy and sell different—and possibly unrelated—products and services with different prices, but it is consequential if firms use conditions observed along the supply chain to form their beliefs about aggregate variables. Second, both input and sales price inflation display significant volatility over time compared to aggregate inflation. Input price inflation for the median firm hovered between -2 and 11 percent during 2015–2021, while sales price inflation fluctuated slightly less between 0 and 8 percent. As a point of comparison, aggregate CPI inflation moved between 1.6 and 5.1 percent. Third, despite the cross-firm heterogeneity and time volatility, the medians of both indicators track the evolution in aggregate CPI inflation relatively well, with a correlation coefficient of 40 percent for input price inflation and 57 percent for sales price inflation.[7]

[6] Widening the size of the band does not affect the results, but introduces more volatility in the estimated impulse responses.

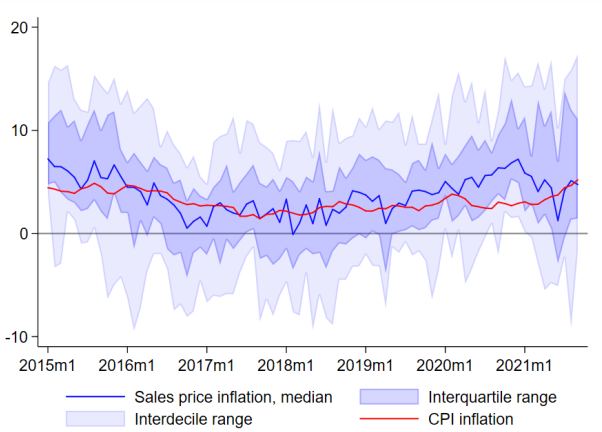
[7] Figure A.1 in Appendix A provides some further illustrations of the distribution of supply chain inflation as well as CPI inflation. The histograms in panels A.1a and A.1b show a larger probability mass for positive price changes, suggesting that price increases are more frequent than price declines. As a reference, a 10 percent increase in input (sales) price inflation is about twice (thrice) as likely than a 10 percent decline. Panel A.1c shows the probability distribution of CPI inflation, which support is narrower than for

Figure 1: Supply chain inflation

(a) Input price inflation



(b) Sales price inflation



Notes: Panel 1a and panel 1b present the cross-firm distribution of input price inflation and sales price inflation, respectively. The blue lines denote the median of the corresponding variable, the shaded areas denote the cross-firm interquartile range (dark blue) and the cross-firm interdecile range (light blue), and the red line denotes actual CPI inflation.

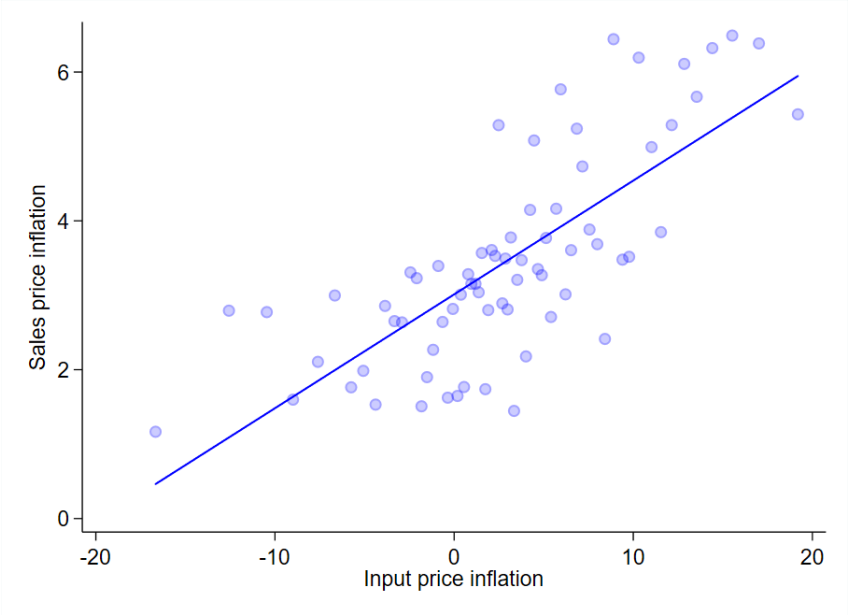
As the binned scatter plot in Figure 2 shows, input cost inflation and sales price inflation are tightly correlated. However, a simple visual inspection suggests that the pass-through to changes in sales prices is higher for small increases of input costs. On the other hand, input price declines tend to be translated into (small) sales price increases. This heterogeneity in the pass-through likely reflects strategic considerations of firms that may take advantage of input price declines to boost their profits while absorbing large increases in input costs to maintain their customer base.

3 Disagreement, inattention, and the supply chain

In this section, we present a few facts about firms' expectations of aggregate inflation. First, we document that firms have substantially different views about next year's CPI inflation. Figure 3a shows that the cross-sectional dispersion of firms' expectations is generally wide. However, such dispersion varies over time, narrowing when actual CPI inflation converges towards the central bank's target and widening when it deviates from the target. During the sample period, the interdecile range can be as large as 2 percentage points and collapse to about 0.5 percentage points when inflation approaches the target. Despite the disagreement, Figure 3b indicates that firms' predictions tend to correlate

supply chain inflation. In this case, the distribution resembles a bimodal one, with a larger mass for a range of about 2 to 3 percent.

Figure 2: Correlation between input price inflation and sales price inflation



Notes: This figure presents a binned scatter plot in which each dot represents the cross-firm average at any given time of input cost inflation and sales price inflation, and the line denotes the linear fit. Data is residualized with respect to firm fixed effects.

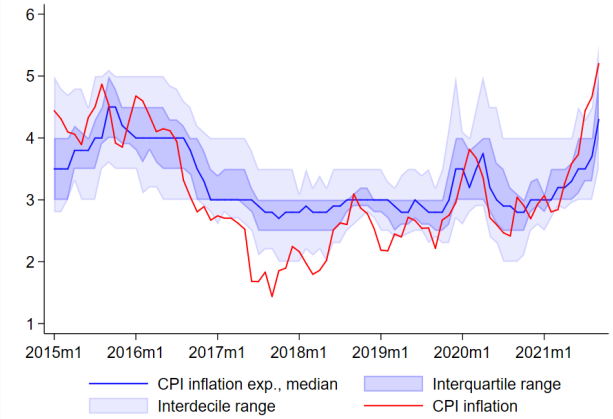
with the inflation outcome.

We then examine whether firms react to changes in CPI inflation. To do that, we compute the share of firm-month observations that display a change in expectations in response to a change in CPI inflation larger than half of its standard deviation. To avoid that mild variations in inflation affect our calculations, we classify changes smaller than half of its standard deviation as periods of unchanged CPI inflation. Figure 4 shows that in more than 40 percent of the cases, firms did not change their predictions of inflation when the previous period's CPI inflation changed, regardless of whether it increased, fell, or remained broadly the same, which is suggestive of inattention. This is notable given that Chile is an emerging market that experienced swings in inflation during the sample period. Such swings, in fact, should lead firms to pay more attention to recent price developments.

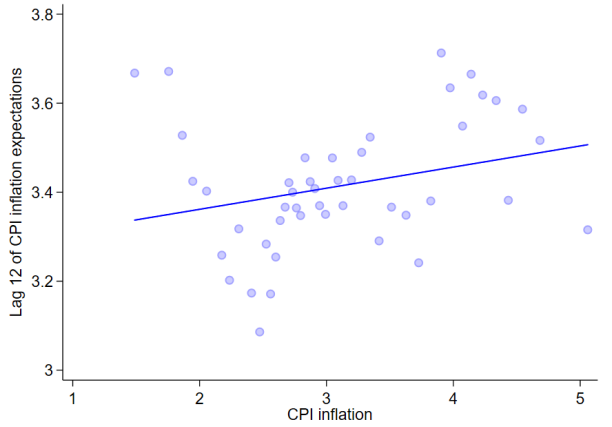
As expected, when inflation declines, we observe more instances of falling inflation expectations compared to when inflation increases or remains the same; and similarly, when inflation increases, we observe more firms increasing their projections than when inflation stays the same or falls. Yet, more than one-fifth of firms predicts a change in inflation in the opposite direction compared to the direction of the change in actual inflation observed in the previous month, possibly suggesting that other factors could in-

Figure 3: Firms' Disagreement about aggregate inflation

(a) Inflation expectations dispersion



(b) Inflation and firms' expectations



Notes: In panel 3a, the blue line denotes the median of firms' expectations about aggregate inflation, the shaded areas denote the cross-firm interquartile range (dark blue) and the cross-firm interdecile range (light blue), and the red line denotes actual CPI inflation. Panel 3b presents a binned scatter plot in which each dot represents the cross-firm average at any given time of the twelfth lag of firms' expectations against actual CPI inflation, and the line denotes the linear fit. Data is residualized with respect to firm fixed effects.

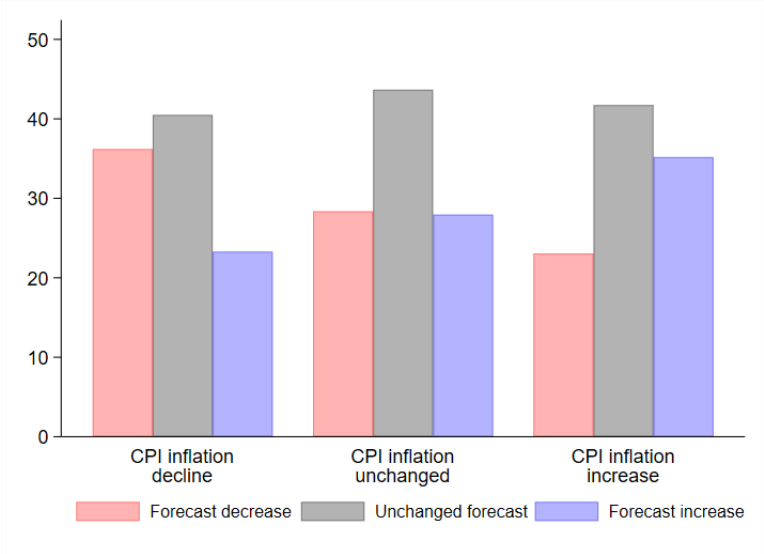
fluence the way in which firms form their views.

Disagreement and inattention are related. Recent inflation is expected to determine future inflation. However, if firms are inattentive to recent inflation because incentives to collect and process information are weak (e.g., because the information is not relevant to the firms), then firms may not change their inflation expectations and disagreement would arise (Coibion and Gorodnichenko, 2015*a*).

We posit that there exist information frictions such that firms observe prices changes along the supply chain and, based on those changes, form their expectations about aggregate inflation. That is, as in Lucas (1972), firms operate as if they were located on different islands and learn only from a subset of islands they have some relationships with. Thus, firms extract a signal about future aggregate inflation from realized supply chain inflation (i.e., input price and sales price inflation). If this is true, forecast disagreement may then arise because firms would rely on "local" conditions of firms they trade with, which are not necessarily the same across firms and that do not have an aggregate effect. This, in turn would lead firms to be inattentive to inflation developments because they deem aggregate information less relevant than supply chain information for their business.[8]

[8] Born et al. (2021) show that German firms overreact to firm-specific developments and underreact to macroeconomic news.

Figure 4: Inattention to aggregate inflation developments

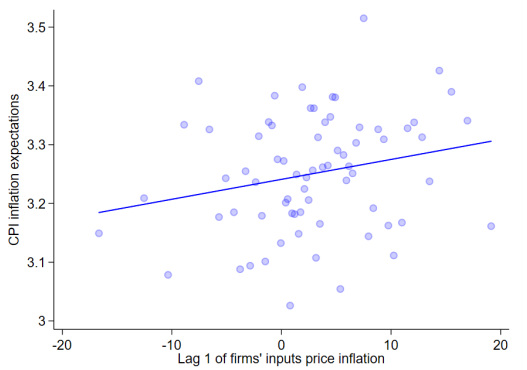


Notes: This figure shows the share of firm-month observations that display a change in inflation expectations a month after a change in CPI inflation. No change is defined as a variation in the relevant variable that is smaller than half of its standard deviation.

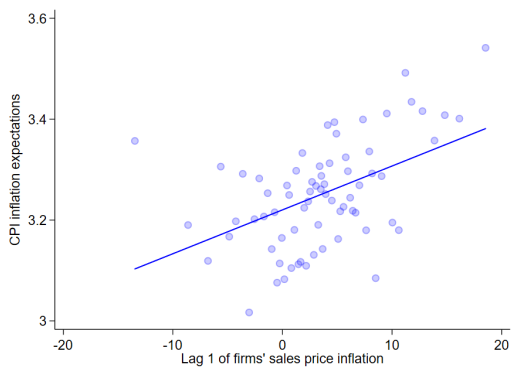
Figure 5 reports some descriptive evidence of the relationship between supply chain inflation and aggregate expectations. The binned scatter plots in panels 5a and 5b depict a positive association between the previous month value of input price inflation and sales price inflation, respectively, and firms' aggregate inflation expectations. In the next section, we investigate this relationship further.

Figure 5: Supply chain inflation and aggregate expectations

(a) Input price inflation



(b) Sales price inflation



Notes: Panel 5a presents a binned scatter plot in which each dot represents the cross-firm average at any given time of input price inflation and firms' aggregate inflation expectations, and the line denotes the linear fit. Panel 5b presents the same binned scatter plot replacing input price inflation with sales price inflation. In both panels, data is residualized with respect to firm fixed effects.

4 Supply chain inflation and aggregate inflation expectations

The goal of this section is to empirically uncover the role of the supply chain in the expectation formation mechanism adopted by firms when they try to predict aggregate inflation. To do that, we estimate a reduced-form specification in the spirit of Andrade et al. (2022):

$$\pi^{e,agg}_{i,t+h} - \pi^{e,agg}_{i,t-1} = \alpha^h_i + \sum_{p=1}^{P} \beta^h_p \pi^{agg}_{t-p} + \sum_{p=1}^{P} \gamma^h_p \pi^r_{i,t-p} + \sum_{p=1}^{P} \theta^h_p X_{i,t-p} + \varepsilon_{i,t+h} \quad (1)$$

where the dependent variable is the cumulative change in firm's i beliefs about aggregate inflation in month $t+h$, $\pi^{e,agg}_{i,t+h}$ with $h =, \ldots, 24$, with respect to its views as of the last month, $\pi^{e,agg}_{i,t-1}$. The independent variables include two lags of supply chain inflation, $\pi^r_{i,t-p}$, which is either input or sales price inflation; two lags of aggregate CPI inflation, $\pi^{agg}_{i,t-p}$; and a set of controls, $X_{i,t-p}$, which consists of two lags of the dependent variable, one lag of aggregate activity (i.e., the latest reading of the quarterly real GDP growth) and two lags of firms' sales in real terms.[9, 10] Finally, the specification includes firm fixed effects α^h_i.[11] Time fixed effects cannot be included as they would be collinear to the country-level information we want to condition on and retrieve a coefficient for, namely CPI inflation.[12] Standard errors are clustered at the time level.

The coefficient of interest is γ^h_p, which traces the cumulative responses to innovations in prices that firms observe along the supply chain. As the specification includes aggregate CPI inflation, it effectively reveals the effect of supply chain shocks that do not have consequences aggregate implications for inflation. If firms were rational, they would discard the information regarding shocks that do not have aggregate effects when forecasting aggregate inflation and therefore the coefficient should be statistically insignificant. Yet, in presence of information frictions, firms may not be able distinguish between shocks that have aggregate effects and those that do not, and they could assign some weight to

[9] We convert sales in Chilean Pesos into real values called *Unidad de Fomento*, a CPI inflation-indexed unit of account calculated and published by the Central Bank of Chile (see https://si3.bcentral.cl/estadisticas/Principal1/metodologias/EC/IND_DIA/ficha_tecnica_UF_EN.pdf for more details).

[10] Since real GDP growth is observed at the quarterly frequency, we repeat the observation for three consecutive months. This is in line with the idea that firms observe the latest available real GDP growth number.

[11] The specification is related to the one in Boivin, Giannoni and Mihov (2009), where the authors use a factor-augmented vector autoregression for a large set of macroeconomic indicators and disaggregated prices.

[12] In the robustness section, we test whether the results hold replacing country-level information with time fixed effects.

the latter when forecasting aggregate inflation. The other coefficient of interest is β_p^h, which describes the effect of changes in CPI inflation on firms' forecasts of CPI inflation. The expected sign in this case is positive as aggregate shocks should lead to changes in inflation expectations, unless inattention is so pervasive that firms become unresponsive to aggregate signals.

In the case of input price changes, we argue that the associated coefficient can be interpreted in a causal sense, as input prices are generally exogenously determined for firms. There is, however, the possibility that some firms answering the survey have a market power that allows to impose prices on their suppliers. While this might be true for a few but not for many of the firms in the sample, in the robustness section we further mitigate this concern by excluding firms that have less than 50 suppliers, effectively dropping firms potentially able to set sales prices on their suppliers.

Our empirical approach differs from the one of Andrade et al. (2022) in a number of aspects and we argue that these differences allow for a better identification of the effects we are interested in. First, the survey question about aggregate inflation expectations is a quantitative one instead of a qualitative one, which allows us to obtain a quantitative estimate for the impact of a shock in supply chain inflation on firms' expectations about aggregate inflation. Second, the survey is sent to firms each month rather than each quarter. The higher frequency reduces the time span between the moment in which firms observe price changes along the supply chain and the moment in which they submit the answers to the survey, thereby reducing the possibility that confounding factors taking place between these two moments end up biasing the estimates. Third, and perhaps most importantly, rather than using the sectoral price indices, we rely on price indices at the firm level. In other words, if firms are "islands" as in Lucas (1972) and they only observe the prices of the firms they trade with, our measures of supply chain inflation provide more direct measures of the prices that firms actually observe at any given time. In addition, as we observe the prices at which firms buy and sell, the risk of not capturing well the information that the firm obtains is minimized. That is, if a firm operates in more than one sector (e.g., because it buys or sells from/to different sectors with respect to the one to which it is assigned), which is often the case if sectors are defined at a very detailed level, sectoral price indices may not provide the signal that firms actually observe.

Figure 6 shows the results of the estimations. Panel 6a reports the response of firms' expectations of CPI inflation to a shock in their input price inflation, conditional on CPI inflation. The plot indicates that firms' expectations of aggregate inflation are indeed responsive to conditions observed along the supply chain even when these have no effect on aggregate inflation: a 10 percentage point increase in input price inflation leads to a 0.12

percentage point increase in inflation expectations a year and a half after the shock. In terms of standard deviations, this effect corresponds to an increase in aggregate inflation expectations of about 0.1 percentage point. The effect dies out over a 2-year period, likely reflecting the time needed for firms to realize that these changes in input prices are not determining aggregate inflation.

In panel 6b we report the response of firms' inflation expectations to a change in CPI inflation. A one percentage point increase in actual inflation leads firm to increase their expectations for next year inflation by almost 0.48 percentage point a month after the shock. Translating this in terms of a one standard deviation shock, the size of estimated increase in inflation expectations at the peak reaches 0.43 percentage points, which is about four times larger than we the one obtained for an increase in input price inflation. The timing of the response, however, is different. While the response of inflation expectations to an input price shock takes a few months to materialize, the one to CPI inflation is immediate but short-lived. Panels 6c and 6d report the results for the specification that replaces input price inflation with sales price inflation. The results are largely consistent with the ones of input price inflation, which is unsurprising given the tight correlation between the two variables.

All in all, we interpret these results as evidence of firms confounding price variation along the supply chain with aggregate shocks. Put differently, firms attribute supply chain inflation shocks to aggregate forces, even if they do not have any aggregate consequences. Because firms react to volatile and dispersed price conditions along the supply chain prices, cross-firm disagreement about future aggregate inflation can arise.

4.1 Industry-level inflation

To relate our results to the ones of Andrade et al. (2022)—where firms learn from inflation observed in the industry to which they belong—we estimate a specification that includes industry-specific inflation:

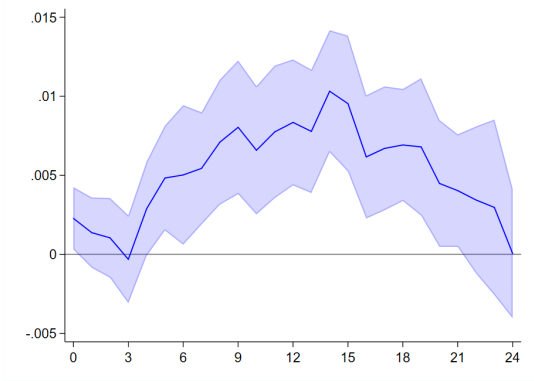
$$\pi^{e,agg}_{i,t+h} - \pi^{e,agg}_{i,t-1} = \alpha^h_i + \sum_{p=1}^{P} \beta^h_p \pi^{agg}_{t-p} + \sum_{p=1}^{P} \gamma^h_p \pi^r_{i,t-p} + \sum_{p=1}^{P} \psi^h_p \pi_{s,t-p} + \sum_{p=1}^{P} \theta^h_p X_{i,t-p} + \varepsilon_{i,t+h} \qquad (2)$$

where $\pi_{s,t-p}$ is the inflation observed in industry s. To this end, we use a classification into 170 different industries, most of which are part of the manufacturing sector.[13] Panel 7a of Figure 7 shows that an innovation in industry inflation leads firms to forecast higher

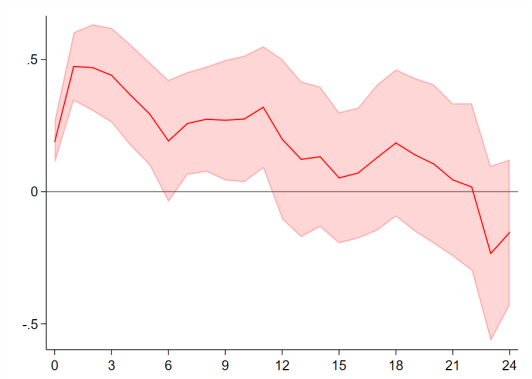
[13] We use the *Clasificador Chileno de Actividades Económicas*, which is an adaptation of CIIU Revision 4. The results are virtually unchanged when we use a less detailed classification with 42 industries.

Figure 6: Supply chain inflation and aggregate expectations

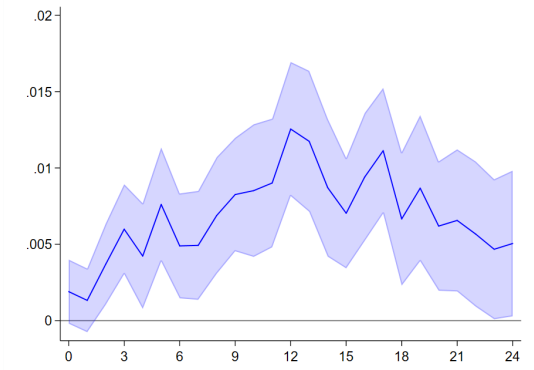
(a) 1pp increase in firms' input price inflation



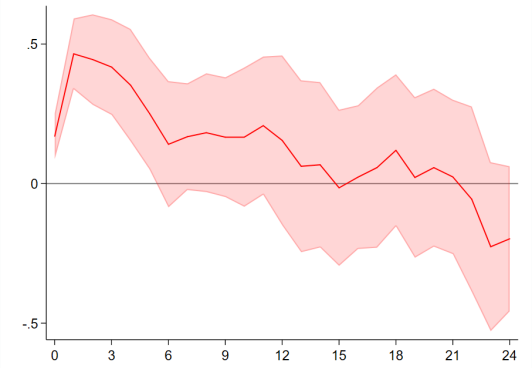
(b) 1pp increase in CPI inflation
(regression with input price inflation)



(c) 1pp increase in firms' sales price inflation



(d) 1pp increase in CPI inflation
(regression with sales price inflation)

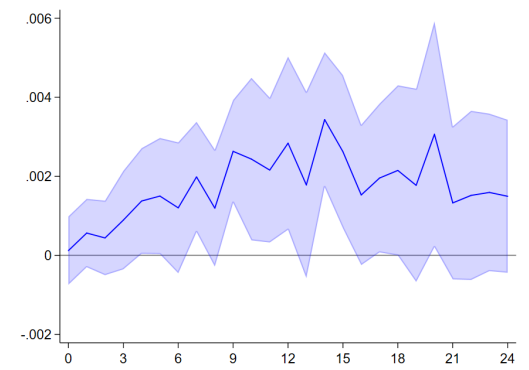


Notes: The x-axes denote the number of months, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the time level.

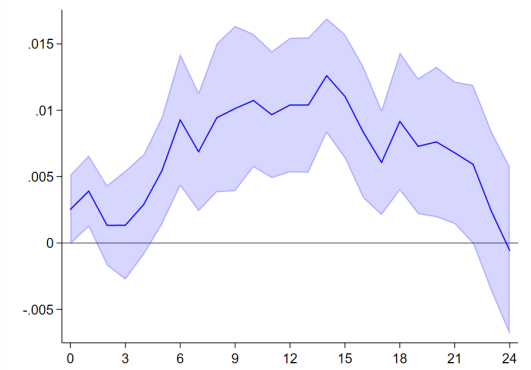
aggregate inflation, but the effect is significant only at some horizons. Panel 7b reports the response of inflation expectations to a shock in input price inflation. Despite the inclusion of industry inflation in the specification, the effect remains generally significant and describes an effect very similar in magnitude and shape to the one obtained from estimating our baseline specification. These results are consistent with the notion that firms may operate at the intersection of different industries and that we can observe a more direct measure of what prices firms actually observe from the VAT registry.

Figure 7: Sectoral inflation

(a) 1 pp increase in sectoral inflation



(b) 1pp increase in firms' input price inflation



Notes: The x-axes denote the number of months, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the time level.

4.2 Orthogonality with respect to future inflation

We established that changes in prices along the supply chain that have no impact on aggregate inflation lead to changes in firms' inflation expectations. This result rejects the full-information rational expectations hypothesis, which posits that (idiosyncratic) shocks without aggregate consequences should leave firms' expectations about aggregates unaffected.

This interpretation hinges on the orthogonality of supply chain prices to aggregate inflation. The specification in equation (1) imposes by construction that conditions observed by firms along the supply chain are *contemporaneously* orthogonal to aggregate inflation. Yet, there is the possibility that changes in input prices or sales price have predicting power with respect to *future* aggregate inflation. In other words, it can be the case that firms are anticipating that a surge in input prices will lead to higher aggregate inflation in the future.

To ensure orthogonality with respect to future aggregate inflation, we follow the procedure that Andrade et al. (2022) used for sectoral inflation applying it to supply chain

price data at the firm level. First, we run a battery of firm-level regressions to assess the non-predictability of future aggregate inflation with current supply chain inflation:[14]

$$\pi^{agg}_{t+h} = \iota + \gamma^h \pi^r_{t-1} + \eta^h y_{t-1} + \nu_{t+h} \tag{3}$$

where non-predictability of future aggregate inflation would deliver a statistically insignificant γ^h coefficient. Then, for each horizon we compute the share of firms for which supply chain inflation cannot predict aggregate inflation. And finally, we re-estimate our baseline specification in (1) excluding firms which supply chain prices predict future aggregate inflation.

Figure 8 reports the results. At any given horizon, only a few firms present a statistically significant estimate for γ^h, already granting credibility of our baseline results. Panels 8a and 8b indicate that at least 85 percent of firms' input and sales price inflation do not have any predictive power with respect to future aggregate inflation. Panels 8c and 8c report the results of the specification in equation (1) excluding firms for which input and sales price inflation are not orthogonal to future aggregate inflation, respectively. The estimated responses are very similar to the ones obtained in our baseline set of results of Figure 6.

4.3 A placebo test

As in Andrade et al. (2022), we perform a placebo test aimed at showing that our results are not an artifact of the empirical approach. In our case, however, the placebo test uses firm-level data rather than industry-level data. The test consists of constructing a placebo series for input price inflation and another placebo series for sales price inflation, and examine their relevance for firms' inflation expectations compared to the actual supply chain inflation series.

Specifically, for each firm i we consider all other firms $j \in J \neq i$ and regress one-by-one all J's supply chain inflation on firm i's supply chain inflation:

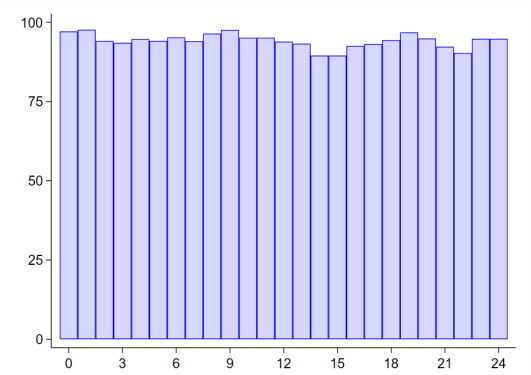
$$\pi^r_{j,t} = a^j + b^j \pi^r_{i,t} + e_{j,t} \quad \forall j \in J \tag{4}$$

where by supply chain inflation we refer to input price inflation and slaes price inflation, alternatively. We then take the supply chain inflation series of firm j that produced the smallest coefficient in absolute terms, $|b^{j*}|$ (i.e., the firm with the least predictive power), and call it placebo supply chain inflation series, $\pi^{r,placebo}_{j,t-1}$. Finally, we re-estimate

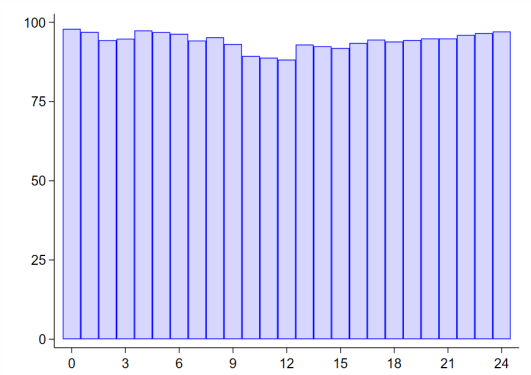
[14] We exclude firms with time series of less than 20 observations.

Figure 8: Orthogonality with respect to future aggregate inflation

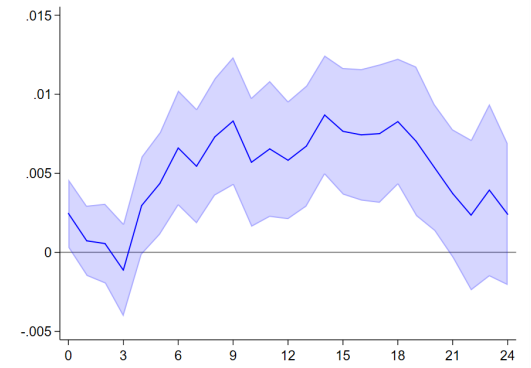
(a) Share of firms with input price inflation unrelated to future aggregate inflation



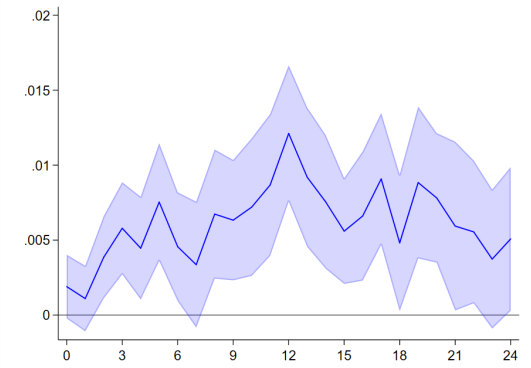
(b) Share of firms with sales price inflation unrelated to future aggregate inflation



(c) 1pp increase in firms' input price inflation after imposing future orthogonality



(d) 1pp increase in firms' sales price inflation after imposing future orthogonality



Notes: The x-axes denote the number of months. In panels 8a and 8b the bars denote the share of firms for which γ^h in equation (3) is statistically insignificant at the 95 percent confidence level. In panels 8c and 8d the lines denote the point estimates and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the time level.

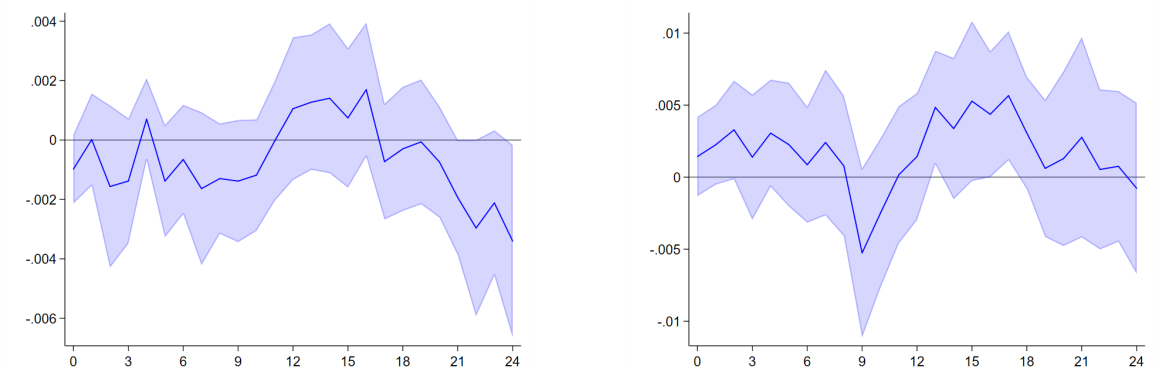
the baseline specification with the inclusion of the placebo series:

$$\pi^{e,agg}_{i,t+h} - \pi^{e,agg}_{i,t-1} = \alpha^h_i + \sum_{p=1}^{P} \beta^h_p \pi^{agg}_{t-p} + \sum_{p=1}^{P} \gamma^h_p \pi^r_{i,t-1} + \sum_{p=1}^{P} \theta^h_p \pi^{r,placebo}_{j,t-1} \sum_{p=1}^{P} \theta^h_p X_{i,t-p} + \varepsilon_{i,t+h} \quad (5)$$

If our results are not an artifact of the empirical procedure, we should find non-significant coefficients on the placebo series, indicating absence of predictive power with respect to the firms' aggregate inflation expectations. Figure 9 reports the point estimates. Both panels indicate that the point estimates cannot be distinguished from zero at virtually all horizons, providing further credibility to our results.

Figure 9: Placebo test

(a) 1pp increase in placebo input price inflation (b) 1pp increase in placebo sales price inflation



Notes: The x-axes denote the number of months, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the time level.

4.4 Robustness

To ensure the robustness of our findings, we run a set of tests. In Figure 10, we only report the results for the effect of an increase in input price inflation on firms' beliefs about aggregate inflation. However, results for sales price inflation convey the same messages and are available upon request.

As discussed in Section 2, input price inflation and sales price inflation report some extreme observations and we rule those out by limiting the sample to price changes between minus 20 and 20 percent. To maximize the number of observations in the regression, we use two different datasets depending on whether the relevant independent variable is input price inflation or sales price inflation. Panel 10a reports the estimates of the baseline specification run on a sample that is the intersection of the two datasets. The results are comparable to the ones obtained using the larger dataset.

One argument jeopardizing the exogeneity of input price inflation with respect to firms' expectations of aggregate inflation is that firms may have enough market power to impose purchasing prices on suppliers based on their expectations for future inflation. While this is unlikely to be the case for many firms in the sample, we mitigate this concern by running our baseline specification in equation (1) after excluding all firms with less than 50 suppliers in any given month. The assumption is that firms with relatively suppliers are less likely to be able to impose prices on them. As shown in panel 10b, the results are similar to the baseline ones.

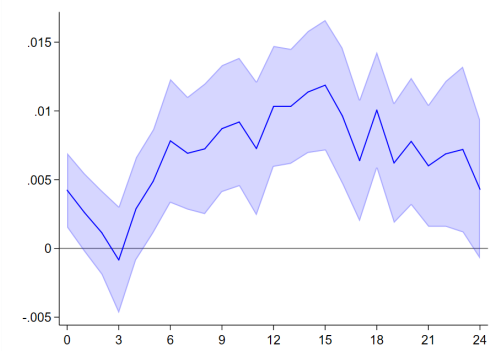
Another concern is that variables are highly autocorrelated and that we cannot interpret our shocks as innovations. Thus, we change the lag structure in equation (1) to include up to four lags of all independent variables as well as the dependent one. The results in panel 10c confirm that adding lags to our baseline specification does not affect the estimates. On the other hand, it could be argued that we are "over controlling" by adding too many lags. Hence, we run the opposite experiment by removing the second lag of the independent variables and of the dependent variable from the baseline specification. Again, the results are consistent with the baseline ones.

Chile enjoys a fully flexible exchange-rate regime since 1999, with extremely rare foreign exchange interventions. Owing to the financial market deepening, firms reduced their balance sheet currency mismatches as they became able to hedge currency exposure (Albagli et al., 2020). Yet, an exchange rate depreciation may still lead importers to revise their inflation expectations upwards, possibly confounding the effect we are interested in. Thus, we include the exchange rate depreciation weighted by the firms' import shares in the specification. Panel 10e shows that our results are robust to this change. In an additional exercise, we include time fixed effects, which inevitably takes away the possibility to estimate the effect on aggregate inflation, which is key to our analysis. The results in panel 10f show that the estimated response of inflation expectations to input price inflation is still positive and significant for most of the horizons.

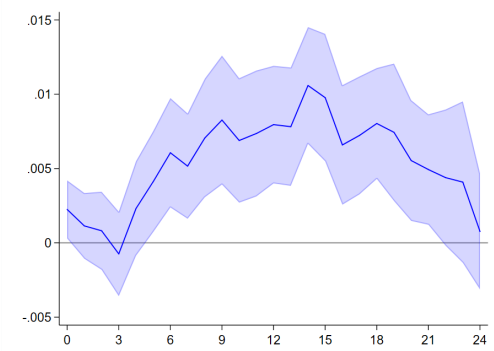
Finally, while our standard errors are robust to autocorrelation, it can be the case that they are also correlated across firms. Thus, we re-compute the standard errors following the procedure proposed by Driscoll and Kraay (1998) which corrects for spatial correlation. As shown in panel 10g, results are again in line with the baseline ones. An alternative procedure is to double-cluster the standard errors across both the firm and time dimensions. Even in this case, results are robust as shown in panel 10h.

Figure 10: Robustness tests

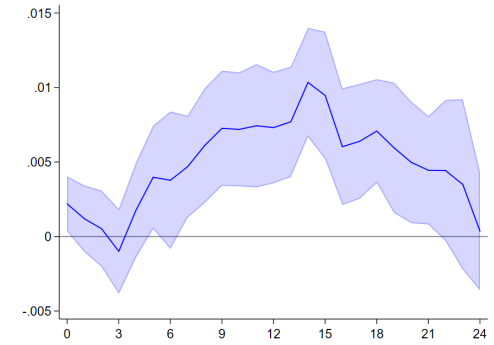
(a) Datasets intersection



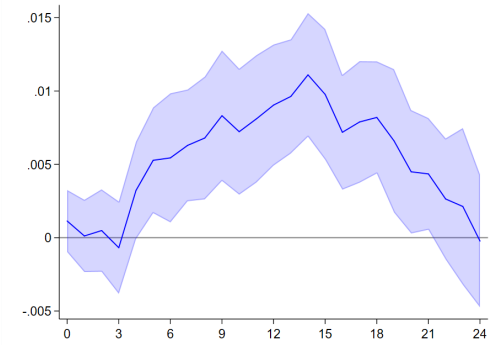
(b) At least 50 suppliers per firm



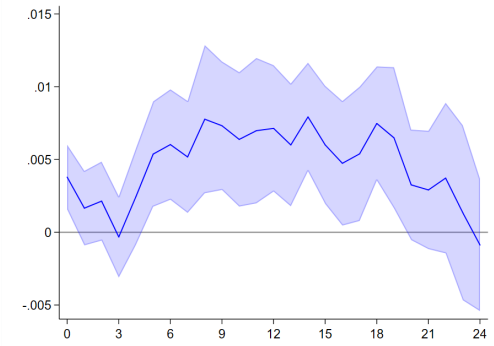
(c) More lags



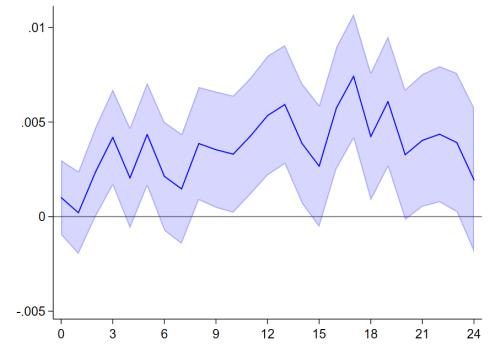
(d) No lags



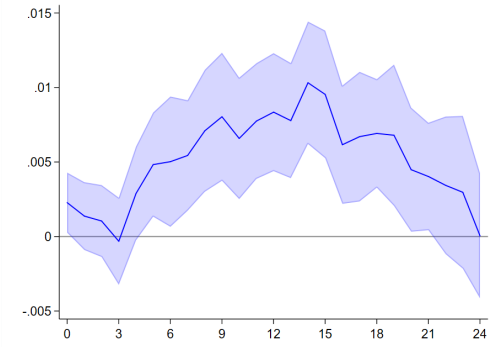
(e) Controlling for nominal depreciation



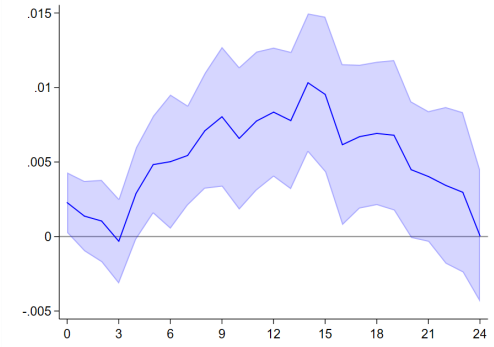
(f) Including time fixed effects



(g) Driscoll-Kraay standard errors



(h) Double-clustered standard errors



Notes: The x-axes denote the number of months, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the time level.

5 Conclusions

This paper highlights a new channel through which firms form expectations about future inflation. That is, firms rely on observed price changes along the supply chain to predict aggregate inflation, even when supply chain inflation has no relevance for aggregate inflation either contemporaneously nor in the future. Our findings are supportive of the island model of Lucas (1972), in which firms operate as if they were located on different islands and learn only from a subset of islands they have some relationships with. By doing so, firms assign an aggregate value to an local signal, even if such signal as no relevance for the aggregate.

Our results add to the evidence against the full-information rational expectations hypothesis for which firms should instead disregard idiosyncratic shocks with no aggregate consequences. Instead, these findings are consistent with empirical facts documenting high dispersion in inflation expectations and inattention to macroeconomic developments. In fact, since firms do not necessarily observe the same conditions along their supply chains (and these conditions are in fact dispersed), using observed input and sales price inflation to forecast aggregate inflation can result in more dispersed expectations. At the same time, given that supply chain inflation is volatile, firms may just allocate most of their attention to analyze the idiosyncratic shocks which are more immediately relevant to their businesses.

Finally, these findings have policy implications for monetary policy, expectation anchoring, and welfare. When firms form their beliefs based on local conditions which do not have aggregate implications, monetary policy can be thrown off its optimal path by reacting to changes in inflation expectations that are not leading to any actual change in inflation. Also, if firms set their inflation expectations according to price changes observed along the supply chain and these are different across firms, the channel we highlight in this paper can lead to de-anchoring of inflation expectations. Finally, if firms act on the basis of their beliefs by setting their prices accordingly, forecast disagreement can translate into welfare-costly price dispersion.

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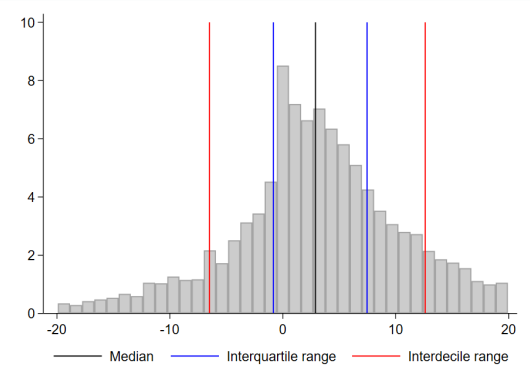
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Appendix

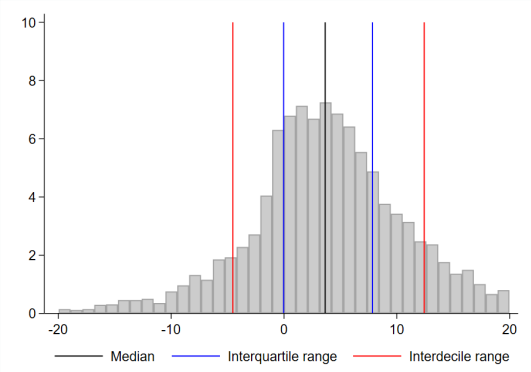
A Descriptive statistics

Figure A.1: Distribution of supply chain inflation, inflation expectations, and CPI inflation

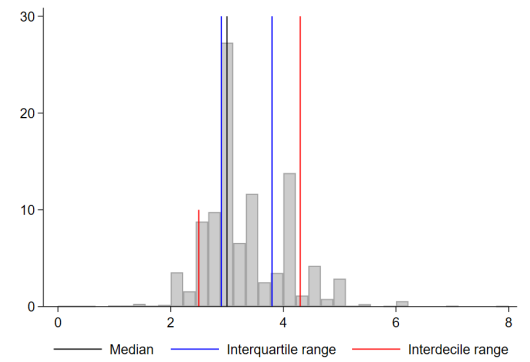
(a) Input price inflation



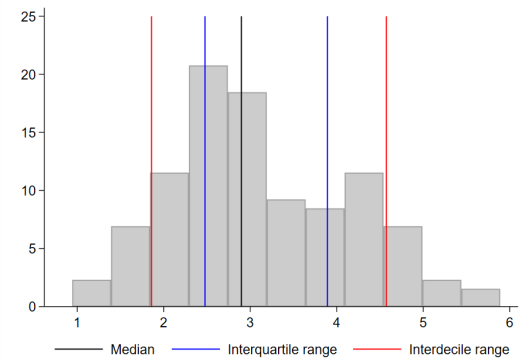
(b) Sales price inflation



(c) Inflation expectations



(d) CPI inflation



Notes: The histograms for input price inflation and sales price inflation in panels A.1a and A.1b and the histogram for inflation expectations in panel A.1c use data at the firm-month level. The histogram for CPI inflation in panel A.1d uses data at the time level.

Table A.1: Descriptive statistics

	Obs	Mean	St. dev.	Min	Max
Conditioning on input price inflation being within [-20,20] percent					
Inflation expectations	4,289	3.3	0.7	0.0	8.0
Input price inflation	5,214	2.9	7.4	-19.9	19.9
Sales growth	5,214	5.6	23.8	-49.8	99.9
Conditioning on sales price inflation being within [-20,20] percent					
Inflation expectations	6,476	3.3	0.7	0.0	7.0
Sales price inflation	6,743	3.7	6.7	-19.9	19.9
Sales growth	6,743	4.5	22.0	-50.0	99.9
Country-level variables					
CPI inflation	81	3.1	0.9	1.4	5.2
GDP growth	81	1.2	5.1	-15.4	16.6

Notes: The table reports the descriptive statistics of the variables entering the baseline regressions. All observations for which sales more than double or contract by more than half compared to the previous years are dropped.

B Regression results

Table B.1: Baseline results for input price inflation

	(1) $h = 0$	(2) $h = 4$	(3) $h = 8$	(4) $h = 12$	(5) $h = 16$	(6) $h = 20$	(7) $h = 24$
Lag of change in inflation expectations	-0.530***	-0.547***	-0.599***	-0.642***	-0.551***	-0.451***	-0.496***
	(0.072)	(0.079)	(0.074)	(0.080)	(0.075)	(0.073)	(0.075)
Lag 2 of change in inflation expectations	-0.206***	-0.260***	-0.286***	-0.306***	-0.237***	-0.222**	-0.240***
	(0.044)	(0.043)	(0.056)	(0.051)	(0.066)	(0.089)	(0.073)
Lag of input price inflation	0.002*	0.003	0.007***	0.008***	0.006**	0.004*	0.000
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Lag 2 of input price inflation	-0.001	0.004**	0.006***	0.005**	0.002	0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Lag of CPI inflation	0.189***	0.365***	0.274**	0.198	0.070	0.104	-0.154
	(0.051)	(0.117)	(0.121)	(0.185)	(0.151)	(0.184)	(0.168)
Lag 2 of CPI inflation	-0.136***	-0.422***	-0.417***	-0.494***	-0.409***	-0.646***	-0.465***
	(0.049)	(0.118)	(0.120)	(0.170)	(0.147)	(0.175)	(0.169)
Lag of sales growth	-0.001	0.002*	0.000	-0.001	-0.002	-0.002*	-0.002
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Lag 2 of sales growth	0.001	-0.001	-0.002**	-0.001	-0.001	-0.002**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Lag of GDP growth	0.013**	0.022**	0.015	-0.029	0.036	0.063	0.077*
	(0.006)	(0.010)	(0.012)	(0.018)	(0.027)	(0.073)	(0.039)
Lag 2 of GDP growth	-0.012**	-0.033***	-0.055***	0.017	0.009	0.075	0.034
	(0.005)	(0.008)	(0.014)	(0.037)	(0.057)	(0.063)	(0.056)
Observations	3,175	2,763	2,523	2,297	2,117	1,979	1,764
R^2	0.285	0.288	0.311	0.364	0.391	0.470	0.521

Notes: For This table reports the results for the contemporaneous effect and the effect at the end of each quarter. All regressions include firm fiexed effects. Clustered standard errors at the time level in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table B.2: Baseline results for input price inflation

	(1) $h=0$	(2) $h=4$	(3) $h=8$	(4) $h=12$	(5) $h=16$	(6) $h=20$	(7) $h=24$
Lag of change in inflation expectations	-0.419***	-0.500***	-0.551***	-0.569***	-0.480***	-0.441***	-0.452***
	(0.032)	(0.045)	(0.058)	(0.059)	(0.057)	(0.068)	(0.056)
Lag 2 of change in inflation expectations	-0.200***	-0.226***	-0.301***	-0.314***	-0.213***	-0.199***	-0.227***
	(0.032)	(0.041)	(0.062)	(0.054)	(0.057)	(0.071)	(0.051)
Lag of sales price inflation	0.002	0.004**	0.007***	0.013***	0.009***	0.006**	0.005*
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Lag 2 of sales price inflation	-0.001	0.002	0.007***	0.005*	0.005	0.003	0.005
	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Lag of CPI inflation	0.170***	0.353***	0.182	0.155	0.023	0.057	-0.198
	(0.050)	(0.123)	(0.130)	(0.186)	(0.157)	(0.173)	(0.158)
Lag 2 of CPI inflation	-0.136***	-0.427***	-0.356***	-0.475***	-0.402**	-0.631***	-0.473***
	(0.048)	(0.125)	(0.128)	(0.176)	(0.159)	(0.163)	(0.162)
Lag of sales growth	0.000	0.001	0.001	-0.001	-0.002*	-0.002*	-0.002
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Lag 2 of sales growth	0.000	-0.000	-0.001	-0.001	-0.001	-0.002**	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Lag of GDP growth	0.014***	0.025**	0.010	-0.028*	0.013	0.047	0.051
	(0.005)	(0.011)	(0.012)	(0.014)	(0.028)	(0.062)	(0.037)
Lag 2 of GDP growth	-0.009**	-0.031***	-0.043***	0.019	0.017	0.086	0.041
	(0.004)	(0.008)	(0.014)	(0.035)	(0.061)	(0.055)	(0.053)
Observations	4,926	4,312	3,963	3,622	3,312	3,041	2,745
R^2	0.184	0.223	0.278	0.359	0.360	0.491	0.518

Notes: This table reports the results for at horizon zero and at the end of each quarter. All regressions include firm fixed effects. Clustered standard errors at the time level in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.