

Gödl-Hanisch, Isabel; Menkhoff, Manuel

Working Paper

Pass-Through of Cost-Push Shocks

CESifo Working Paper, No. 10520

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: Gödl-Hanisch, Isabel; Menkhoff, Manuel (2023) : Pass-Through of Cost-Push Shocks, CESifo Working Paper, No. 10520, Center for Economic Studies and ifo Institute (CESifo), Munich

This Version is available at:

<https://hdl.handle.net/10419/279270>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Pass-Through of Cost-Push Shocks

Isabel Gödl-Hanisch, Manuel Menkhoff

Impressum:

CESifo Working Papers

ISSN 2364-1428 (electronic version)

Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH

The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute

Poschingerstr. 5, 81679 Munich, Germany

Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de

Editor: Clemens Fuest

<https://www.cesifo.org/en/wp>

An electronic version of the paper may be downloaded

- from the SSRN website: www.SSRN.com
- from the RePEc website: www.RePEc.org
- from the CESifo website: <https://www.cesifo.org/en/wp>

Pass-Through of Cost-Push Shocks

Abstract

This paper examines the pass-through of cost-push shocks to customers at a granular level. Using unique firm-level survey data, we document five facts about pass-through across firms, sectors, and over time. We highlight a new channel relevant for pass-through: beliefs about the expected duration of the shock and its interaction with price rigidities. We then employ a hypothetical vignette to study the causal effect of nominal and real rigidities as well as the nature of the shock - size, duration, and economic environment - on pass-through. We observe gradual pass-through stretching over 24 months, especially for idiosyncratic shocks, undershooting the pass-through of aggregate shocks by 40%, in line with the presence of real rigidities. The survey design further allows us to infer the implied slope of the Phillips curve, which flattens after accounting for strategic complementarities.

JEL-Codes: E240, E310, E500, E600.

Keywords: pass-through, cost shocks, firms, heterogeneous expectations, uncertainty, nominal rigidities, real rigidities.

Isabel Gödl-Hanisch
LMU Munich / Germany
isabel-goedl-hanisch@econ.lmu.de

Manuel Menkhoff
ifo Institute – Leibniz Institute for Economic
Research at the University of
Munich / Germany
menkhoff@ifo.de

This version: June, 2023

Click here for the latest version:

https://www.dropbox.com/s/y8k8zgpcaue64x/GM_pass_through_cost_push_shocks_recent_version.pdf?dl=0

First draft: May 2023. Thank you to Adrien Auclert, Benjamin Born, Davide Debortoli (discussant), Max Godl, Pete Klenow, Monika Schnitzer, Mirko Wiederholt, Peter Zorn, and the seminar participants at LMU Munich, and conference participants at CEPR ESSIM 2023 for valuable feedback. We thank the team of the LMU-ifo Economics & Business Data Center (EBDC) and Katrin Demmelhuber for assistance with the survey and data.

1 Introduction

This paper examines the pass-through of cost-push shocks to customers. While price stickiness is at the heart of New Keynesian models, empirical evidence on the micro-foundations and determinants of incomplete pass-through is still scarce. Even with rich granular pricing data at hand, it is challenging to measure pass-through while at the same time observing other firm characteristics. We propose a new approach by *directly* eliciting price pass-through in a large-scale business survey, containing valuable information on firms' business situation and expectations, allowing us to study determinants of pass-through on a broad basis. We then complement this with survey experiments bringing new causal insights into the role of the nature of shocks for pass-through implemented by exogenously varying the information set of firms.

Existing literature has highlighted that pass-through depends on the nature of competition and the extent of nominal and real rigidities. An additional factor is the heterogeneity of firm-level expectations regarding the duration of the underlying shock. Our contribution is to study how and whether nominal and real rigidities interact with expectations about the nature of the shock. To build intuition, consider an environment where firms face high price adjustment costs; in this case, firms would be reluctant to increase prices in response to transitory shocks but do so to permanent shocks. Also, firms operating in an environment with fierce competition likely do not react to a transitory cost-push shock, as the first mover would have to sacrifice market share. Similarly, firms might react less to idiosyncratic shocks compared to industry-wide shocks. Hence, in addition to nominal and real rigidities, heterogeneous expectations about the nature of the shock may amplify coordination failures among firms and affect aggregate pass-through.

This paper consists of two parts. In the first part, we provide descriptive evidence from the ifo Institute's business survey panel data on the extent of pass-through over time and across firms. The monthly business survey covers 6,500 firms across all sectors of the economy, containing information on the business's current standing and expectations about the business's outlook and, on top of that, a couple of one-time questions, such as subjective beliefs about the duration of supply chain disruptions. In addition, we explore a *supplementary question* posed three times since the onset of the energy and input price surge in 2021: "To what extent do you [the firm] pass through higher prices for energy, raw material, and intermediate input costs to your customers?"¹

¹The supplementary quantitative pass-through question was asked in June 2021, April 2022, and October 2022. The October 2022 survey further differentiated between pass-through so far and planned pass-through over the next six months. Gödl-Hanisch and Menkhoff (2022) summarize insights on the gradual pass-through in a policy report.

We document five facts based on the novel survey approach: (i) gradual, sluggish adjustment over time leads to incomplete pass-through, (ii) substantial variation within and across narrowly defined sectors, (iii) pass-through increases in the firm's expected duration of the shock, (iv) pass-through increases with the firm's idiosyncratic uncertainty, and (v) pass-through increases with past price-setting frequency. Overall, the pass-through results emphasize the presence of real and nominal rigidities, where large within-industry variation and the role of firm-specific beliefs take center stage.

To further investigate the causal link between the nature of the shock and pass-through, we employ a survey experiment in the ifo Management-Survey conducted in January/February 2023. We confront firms with a hypothetical scenario about facing an exogenous global supply shock raising costs by 20%, but varying the nature of the shock – permanent, transitory, or uncertain duration – and the underlying general economic conditions.² In the style of the supplementary questions, we then ask: given a certain scenario, to what extent do you [the firm] pass through these cost increases to your customers at specific horizons (one month up to two years)? We exploit within-firm variation to discern the marginal effect of shock duration, uncertainty, and the underlying economic conditions. Furthermore, to determine the impact of the competitive environment and coordination failure, we contrast the results for idiosyncratic vs. aggregate shocks. In doing so, we are the first paper to provide causal evidence on the relevance of these factors and the economic size of pass-through at different horizons.³

We find a concave increase in pass-through over time for all hypothetical scenarios at the aggregate level, converging to a level of below 100% after 24 months. In the first three months, pass-through is evolving similarly, independent of the nature of the shock, and is largely driven by the extensive margin. In the medium run, the permanent shock scenario is associated with significantly higher pass-through compared to the temporary and uncertain shock duration scenario. We observe for the majority of firms several gradual increases in pass-through as well as a lower pass-through for idiosyncratic shocks, both indicating the presence of real rigidities. The results are qualitatively and quantitatively similar for two assumed economic conditions: low and high aggregate demand. Then, we quantify the findings and calculate an implied Phillips curve coefficient based on the sufficient statistics of Auclert et al. (2022). Overall, the survey experiments are closely in

²Similarly, e.g., Roth et al. (2023) and Drechsel et al. (2022) employ hypothetical vignettes in the context of households and monetary policy, and firms and oil price rises. The ifo Management-Survey regularly asks decision-makers in German companies about current economic policy issues and changes in the macroeconomic environment since 2020.

³Arguably, the vignette delivers variation that is *exogenous* and can be interpreted in a causal way because all other things are held constant.

line with our empirical analysis, which we also interpret as further proof of concept for directly eliciting pass-through of firms. Both sets of results emphasize the existence of nominal and, especially, real rigidities as well as the important role of the expected nature of the shock for pass-through.

Related literature. This paper builds on several strands of the literature on pass-through and price-setting practices and competition, uncertainties, and nominal and real rigidity. Importantly, this is the first paper leveraging experimental methods to inform the literature about the respective mechanisms.

We start by revisiting Blinder et al. (1998)'s firm-level survey on price stickiness in the context of pass-through of cost-push shocks and supply chain disruptions. For this, the period 2021-2022 delivers a unique setting concerning the nature of the shock, particularly uncertainty about the duration and size of the shock, to study how pass-through depends jointly on nominal and real rigidities as well as the nature of the shock.

On the empirical side, most of the literature so far focused on exchange rate pass-through and the relevance of market structures (e.g., Auer and Schoenle 2016, Garetto 2016, or Amiti et al. 2019), whereas this paper focuses on cost shocks more generally. Similar to our paper, Amiti et al. (2019) distinguish between own and competitor cost shocks and market share, finding that large firms facing strategic complementarities respond less to own and competitor cost shocks compared to small firms. Also, Muehlegger and Sweeney (2021) show that pass-through varies from near zero, for firm-specific shocks, to full, for industry-wide shocks. Closely related, Kleshchelski and Vincent (2009) highlight that pass-through is incomplete and depends on the persistence of cost shocks and switching costs. We add to that considering the size of the shock, uncertainty and market structure, which is closely related to the presence of switching costs.

In a similar vein to our paper but in an Italian context, Riggi and Tagliabracchi (2022) document limited pass-through from input prices to output prices listing three channels relevant for setting prices: previous choices, current cost-pressures from input prices and firm-level input price expectations. Likewise, Dedola et al. (2021) provide evidence for gradual and sluggish, and heterogeneous pass-through using a structural dynamic price adjustment model built on Danish PPI data combined with firm-level data. Their framework also allows nominal rigidities and imperfect competition to matter. Our paper expands on that, showing that nominal and real rigidities interact with expectations and uncertainty. Similarly, Loupias and Sevestre (2013) use French business survey data for the manufacturing sector to analyze the extensive margin of adjustment of producer prices to input prices and emphasize the difference between transitory and permanent shocks and

increases vs. decreases. In contrast, we focus only on cost increases but differ in the shock size and quantify the extent of pass-through (intensive margin).

This paper also contributes to the recent rising literature on understanding the factors behind the resurgence of inflation. More broadly related, Bunn et al. (2022) analyze the drivers of price setting since 2020 and introduce a measure of price uncertainty. However, they do not focus on the rate of pass-through. Closely related to us, Jousier et al. (2022) focus on the pass-through of increasing costs to producer prices between 2018 and 2022, distinguishing between energy costs and intermediate input prices. Their average pass-through estimates are in the range of our results: 25% and 50% for intermediate input prices and energy costs, respectively. In contrast to our paper, their pass-through estimates are based on micro-level price data underlying the French or Danish producer price index, which comes with advantages and disadvantages. While their pass-through estimates focus on pass-through at a specific point in time, we dynamically assess pass-through (and the whole adjustment process) over time. Their paper mainly focuses on larger firms (importers) and the role of industry leaders, whereas our paper covers the entire spectrum from small and medium-sized enterprises to large enterprises. Most importantly, we can also look at subjective beliefs and firm-level uncertainty as relevant factors, while papers using micro-level pricing data rely only on observables.

On the theoretical side, closely related, Wang and Werning (2022) study pass-through in an oligopolistic market and provide analytical results for decreasing pass-through in size. In line with Rotemberg (1982), we deliver a micro foundation of price stickiness, wherein firms are concerned about upsetting their customers, incurring a cost to price changes. Further, we expand on different papers on real rigidities (Gopinath and Itskhoki, 2010; Ball and Romer, 1990; Dotsey and King, 2006). In a similar way to our paper, Rotemberg and Woodford (1996) make the link to the aggregate macroeconomy and study the transmission of an oil shock under different models of imperfect competition in the product market, finding that imperfect competition leads to a larger contraction of output and real wages.

The remainder of this paper is structured as follows. Section 2 describes the data set. Section 3 documents facts based on the novel survey approach. Section 4 presents the results from the survey experiment. Section 5 concludes.

2 Data Description

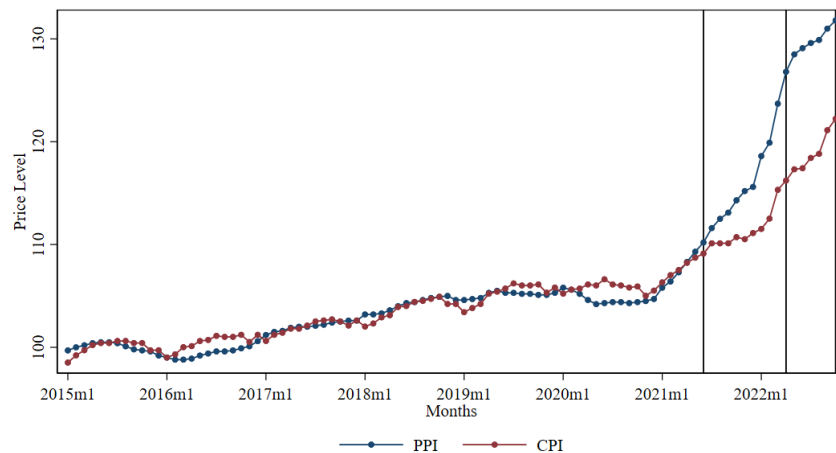
This paper combines multiple survey data sources to analyze the pass-through of cost-push shocks to consumer prices. First, we build on the well-established Ifo Institute's business

survey panel data.⁴ The monthly business survey covers approximately 6,500 firms across all sectors of the economy, containing information on the business’s current standing and expectations about the business’s outlook. At the heart of our analysis is a *supplementary* quantitative pass-through question posed at three points in time since the beginning of the surge in input prices as highlighted in Figure 1: June 2021, April 2022, and October 2022. The specific wording of the question is:

“To what extent do you [the firm] pass through higher prices for energy, raw material, and intermediate input costs to your customers?”

One might be worried that firms strategically underreport their true pass-through. While we can not rule out underreporting entirely, we present three reasons why this is unlikely to be an issue in the survey. First, the survey is incentivized by providing granular survey results for participants whose own weight is too small to affect average results. Second, we know from past supplementary questions in the survey that firms do not answer strategically. For instance, Bachmann et al. (2022) elicited potential production reductions if the gas supply were to be cut by 10 (or 50) %. The median firms reported no (or 25 %) decline in production in this scenario. Third, our estimates are very much in line with other pass-through estimates in the literature.

Figure 1: Producer and consumer prices over time



Notes: German manufacturing sector’s producer price index (PPI) and consumer price index (excl. energy, food). The vertical lines correspond to the dates of the supplementary pass-through questions in the ifo Institute’s business survey: June 2021, April 2022, and October 2022. Source: Federal Reserve Economic Data (FRED).

⁴For example, Bachmann et al. (2013) and Bachmann et al. (2019) use the ifo Institute’s business survey panel data to study the role of firm-level uncertainty for price setting and economic activity.

The October 2022 survey further differentiated between pass-through so far and planned pass-through over the next six months. In addition, we explore one-time questions, such as subjective beliefs about the duration of supply chain disruptions. For more details on the specific questions in the business survey, we refer to Appendix A.

Second, we build on the ifo Management-Survey. Since 2020, the Management-Survey asks a selected group of decision-makers in German companies about current economic policy issues and changes in the macroeconomic environment. The ad-hoc survey covers approximately 300 firms across all sectors of the economy.⁵ We conduct a hypothetical vignette on the link between the nature of the shock and pass-through in January and February 2023. We confront firms with the following hypothetical scenario as well as a graphical representation of the scenario, as described in detail in Appendix B:

"Suppose that the production costs for you and your competitors in the industry [permanently] increase by 20% due to a global supply shock (see figure). All other factors, such as interest rates and fiscal policy measures, remain unchanged. Assume [good economic conditions] with normal capacity utilization for your company and the overall economy.

To what extent would you pass through the cost increase to your customers in this scenario? Indicate the level of pass-through at the respective point in time."

We vary the nature of the shock (permanent, transitory, or uncertain duration) within firms and the underlying general economic (good economic conditions, bad economic conditions) across firms. We ask the participants to provide quantitative pass-through estimates *across time horizons* and given different shock duration (for up to 24 months). This allows us to assess the gradual adjustment to a given shock over time and the marginal contribution of shock duration within firms. Appendix B.1 presents the original survey questionnaire, including the hypothetical vignettes. Appendix B.2 offers an English translation.

3 Empirical Results

This section delivers stylized facts about pass-through over time and space, building on novel evidence from the ifo Institute's business survey panel. The aim is to ascertain the strength of our approach for deepening the understanding of firms' pass-through,

⁵51% of the firms operate in the manufacturing sector, 27% in services, 12% in trade, and the remaining part in construction. About 44% of the firms are classified as medium-sized (50-249 employees), 26% as small-sized with less than 50 employees, and 30% as large-sized with more than 500 employees.

particularly along the dimension of firms' beliefs about the nature of the shock and its interaction with nominal and real rigidities.

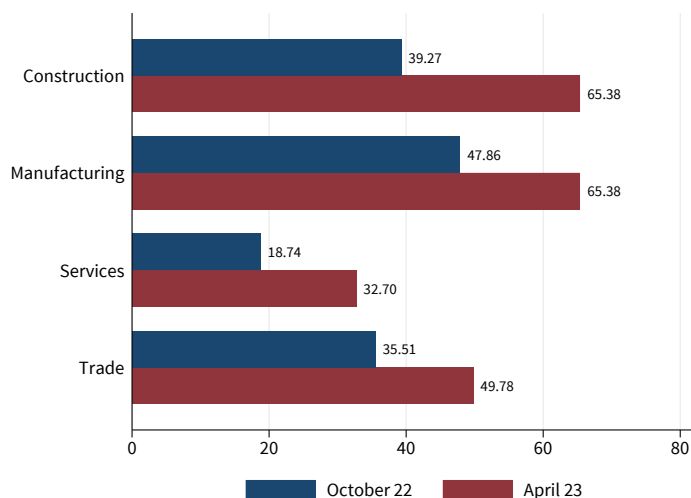
We document realized and planned pass-through of the rise in energy, raw material, and intermediate input costs to customers. In October 2022, we elicited the pass-through of cost increases to customers of around 6,500 firms. In addition to the current pass-through, we asked for the planned pass-through six months out.

3.1 Pass-through dynamics over time

We start by looking at the dynamics of pass-through over time at the aggregate and sector levels. Figure 2 presents the average pass-through for four major industries, manufacturing, services, trade, and construction, separately. Importantly, we differentiate between past pass-through and planned pass-through in the following six months, given the same information set for firms. In standard price-setting models, firms base their price decision on the discounted sum of expected marginal costs. While nominal rigidities can lead to incomplete pass-through, as firms might expect only a transitory increase in costs (see Section 3.3), they would not be in line with a planned gradual increase of pass-through given the same information set. The average pass-through for the entire sample is around 34.20% and is expected to increase by 16.61 percentage points in the following six months. The gradual increase in prices and multiple price hikes indicate the presence of substantial frictions in the pass-through in line with micro-level real rigidities. Real rigidities primarily affect the intensive margin of adjustment and lead to a lower adjustment per price hike and over time. Most firms face real rigidities in the form of competitive pressure and, to a lesser extent, nominal frictions in the form of long-term contracts, as shown in Table C.6 in Appendix C.

Theoretically, the gradual increase in pass-through in Figure 2 could be driven by the extensive margin. To further illustrate the gradual increase in pass-through over time, Figure 3 shows the planned pass-through by April 2023 as a function of the level of pass-through by October 2022. The difference between the smoothed pass-through line and the dashed 45-degree line corresponds to the change in pass-through. Firms with an incomplete pass-through by October 2022 expect to increase the pass-through by April 2023. Quantitatively, firms at a pass-through level of 20% in October 2022 plan to increase pass-through by another 20 percentage points to 40% over the next six months. Similarly, firms at a zero pass-through level plan to increase pass-through by almost 20 percentage points to roughly 20% over the next six months. To put these numbers in perspective, a constant pass-through rate of 20 percentage points increase every six months would

Figure 2: Sluggish and heterogeneous pass-through of cost-push shocks over time



Notes: The figure shows the average (planned) firm-level pass-through of cost changes to sales prices for October 2022 and April 2023. Source: ifo Institute’s business survey.

imply that firms would reach full pass-through over the course of 2.5 years. However, the relationship between past and planned pass-through is also non-linear and decreasing in magnitude, reflected by the concave shape of the graph. In other words, firms with a pass-through level of close to 100% in October 2022, and hence already complete pass-through, do not plan to increase prices further. The pass-through shape holds for all sectors: manufacturing, services and trade, as shown in Figure C.1 in Appendix C, with the trade sector exhibiting a slightly slower pass-through pace.

Accordingly, we can summarize our first fact as follows:

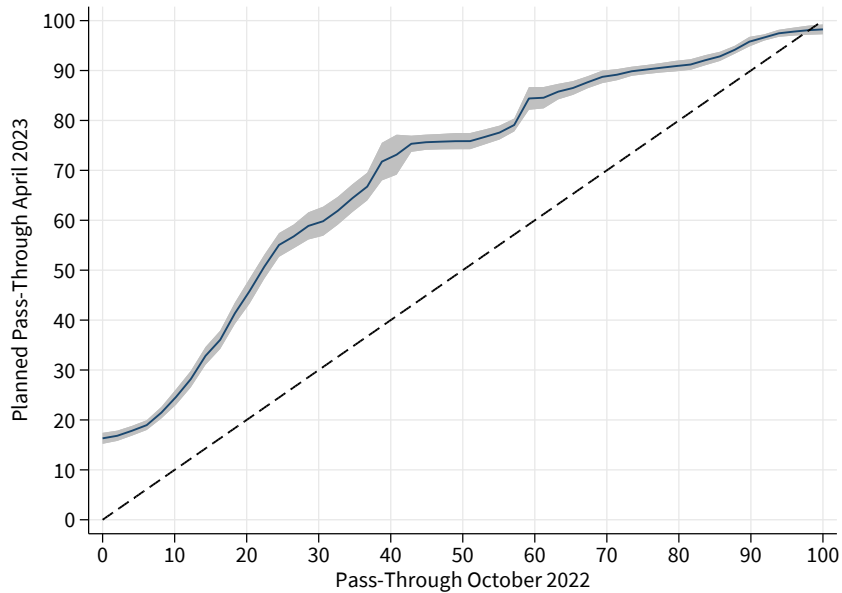
Fact 1: Gradual, sluggish adjustment over time leads to incomplete pass-through.

The gradual and sluggish adjustment over time supports the presence of nominal and real rigidities. We observe both infrequent adjustments (zero adjustment on impact), potentially due to nominal rigidities such as menu costs, and disproportional adjustment, i.e., several cost hikes instead of a one-time adjustment, potentially due to real rigidities. The following section delivers additional causal evidence in support of real rigidities.

As a proof of concept for the reliability of the elicited pass-through estimates, we can investigate the relationship between a firm’s elicited pass-through estimate and its return on sales, an ex-post realized profitability.⁶ We expect to observe, on average, a decrease in return on sales (ROS) for firms that declare to pass through cost increases to a lower extent to customers. Appendix Table C.1 presents the results of regressing the change in ROS on

⁶The ROS of the current year is elicited in September in the survey.

Figure 3: Gradual increase of pass-through over time



Notes: The figure shows the change in pass-through of cost changes to sales prices from October 2022 to April 2023, conditional on cost changes until October 2022. The gray shaded area is the 95% confidence interval. Source: ifo Institute’s business survey.

pass-through in October 2022.⁷ Indeed, we find a strong positive relationship between the change in return on sales and the pass-through of cost-push shocks. This result is robust to controlling for sectoral fixed effects (Column 2), and instrumenting pass-through in October 2022 with previous pass-through in April 2022 to diminish the attenuation bias due to measurement error (Column 3). A one standard deviation decrease in pass-through (35) is associated with a decrease in the change of ROS by 0.5-1.5 percentage points.

3.2 Pass-through dynamics within and across sectors

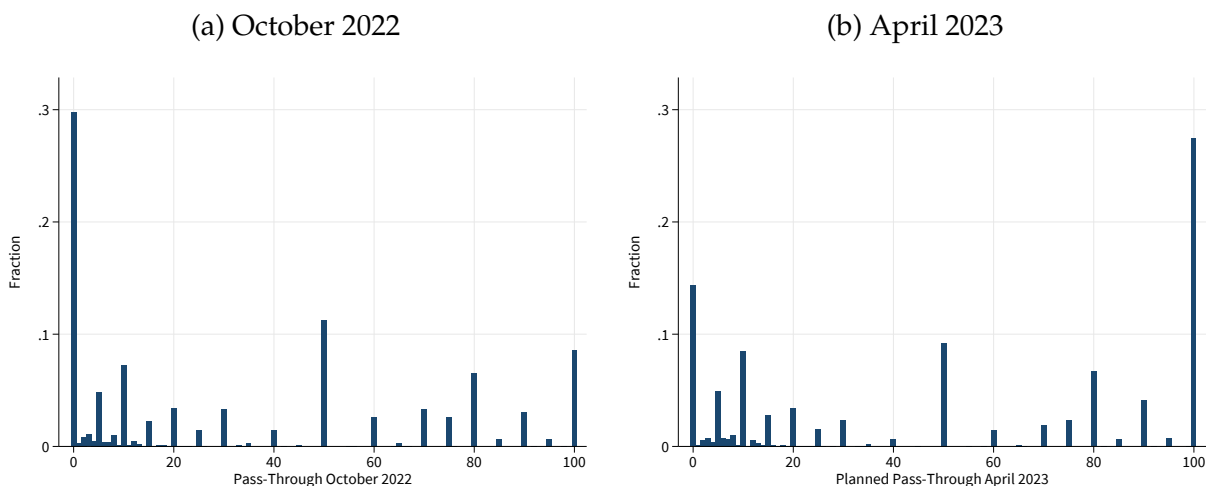
The granular survey panel allows us to study pass-through dynamics at a disaggregated level, both across sectors and firms within sectors. There is substantial heterogeneity in the degree of pass-through across firms. Figure 4 presents the distribution of firm-level pass-through until October 2022 and planned until April 2023. While 30% of firms have not passed through cost changes at all by October 2022, 12% have passed through cost changes by 50%. Less than 10% of firms fully pass-through costs hikes to their customers. The pattern looks similar for the planned pass-through until April 2023, but we observe a right shift. Almost 30% of firms now expect to fully pass-through cost increases to consumers.

⁷To abstract from fixed firm-level differences, we calculate the change in ROS from 2019 to 2022.

At the same time, the share of firms with zero pass-through declined from 30% to 15%, indicating an important role of nominal frictions, particularly in the short run. Overall, there is a wide range in pass-through and considerable heterogeneity, with some bunching at zero, 50, and 100 but also many values between them. Figure C.2 in Appendix C delivers similar evidence for the survey rounds in June 2021 and April 2022.

Even within narrowly defined sectors, there remains substantial cross-sectional variation. Decomposing the total variation into within-sector and between-sector variation shows in Figure 5 that the former outweighs the latter. At the 2-digit sector level, between-sector variation explains roughly 20% of variation in pass-through, and within-sector, the remaining 80% variation. Almost by construction, the between-component gains slightly higher importance at the 4-digit sector level, but still, the between-sector variation explains roughly 25% of variation in pass-through. One potential concern is that measurement errors bias the within component upwards. To further address this point, we restrict our sample to respondents who spent sufficient time on the question following Giglio et al. (2021). Appendix Table C.3 shows that we obtain similar estimates when we are cutting out the bottom 25 percent of the time spent distribution.⁸

Figure 4: Heterogeneous pass-through across firms



Notes: The figure shows the distribution of firm-level pass-through of cost changes to sales prices for October 2022 and planned pass-through until April 2023 (conditional on cost changes until October 2022). Source: ifo Institute’s business survey.

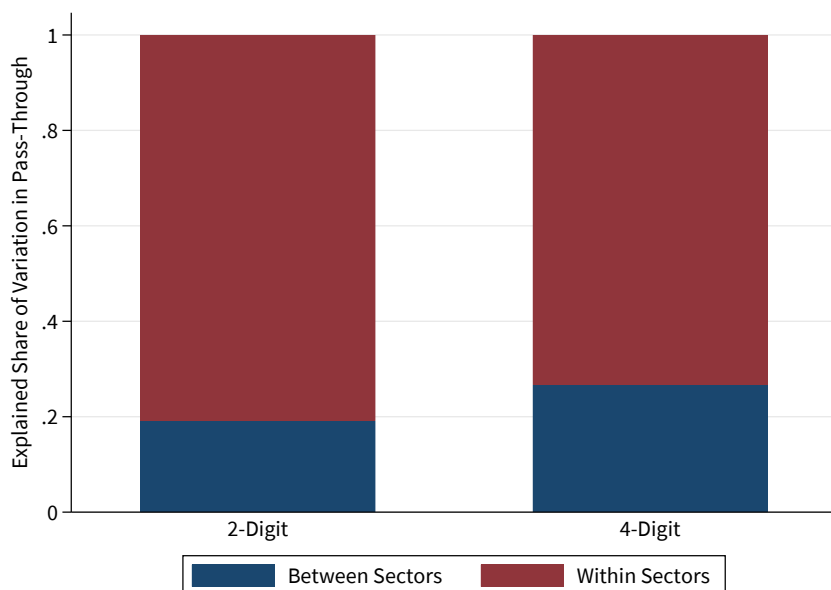
Accordingly, we can summarize our second fact as follows:

Fact 2: Substantial variation within and across sectors.

⁸As there is no information about time spent for each question, we proxy this by the total time spent on the survey (only available for firms who participate online, 76% of all participants). Appendix Figure C.4 shows the distribution of time spent in October 2022.

The considerable variation within narrowly defined industries suggests that not only nominal and real rigidities are at play, but also other factors matter. Arguably, firms within a narrowly defined sector face similar nominal rigidities, such as long-term contracts or other menu costs. Similarly, firms face the same competitive environment within narrow industries. Hence, we next shift gears and consider other idiosyncratic firm-level characteristics and factors to explain heterogeneous pass-through.

Figure 5: Cross-sectional variation in pass-through within and between sectors



Notes: The stacked bar figure shows the R^2 of sector fixed effects on 2-digit and 4-digit level of pass-through in October 2022 (blue). The remaining variation is within sectors (red). Source: ifo Institute’s business survey.

3.3 Pass-through and firm’s expectations about the duration of the shock

We focus on several factors to understand the significant disparities in pass-through within industries across firms. First, we investigate a *novel channel*: the influence of firms’ beliefs about the expected duration of cost-push shock for the extent of pass-through. For this analysis, we turn to firms in the manufacturing sector, where the expected duration of supply shortages in months has been elicited in October 2021 and June 2022. There is large heterogeneity between firms regarding the expected duration, with a standard deviation of 5 (7) months in October 2021 (June 2022). To estimate the effect of firms’ expected duration of the shock on pass-through, we regress firm i in industry j pass-through, PT_i , on the firms’ expected duration of the supply shortage, $Exp.Duration_i$, controlling for business

conditions, utilization, costs, as well as industry fixed effects:

$$PT_i = \alpha_j + \beta Exp.Duration_i + \gamma X_i + \varepsilon_i, \quad (1)$$

where α_j reflects the 4-digit sector fixed effects, and X_i is a vector of control variables, including firms' range of orders, capacity utilization, change in revenues, change in orders, production expectations, energy intensity, and cost changes.

Table 1 shows a positive relationship between the firm's expected duration of supply shortages and pass-through in April 2022. This relation remains robust after conditioning on a battery of potential firm-level confounders.⁹ In terms of magnitude, pass-through increases by 6.8 to 8.3 percentage points if the expected duration of supply shortages increases by 10 months, depending on the model specification. This result underlines the economic significance of the beliefs about the duration of the underlying shock. In other words, heterogeneity in beliefs is directly connected to heterogeneity in pass-through and can explain variation in pass-through *within* narrowly defined industries, as well as, potentially, across sectors.

Intuitively, in an environment with excessive nominal or real rigidities, firms may be reluctant to increase prices in response to transitory shocks but do so to permanent shocks. More specifically, high costs, whether in the form of menu costs or declining demand, may prevent firms from raising prices at all or to the desired level. Therefore, we only observe a reaction and pass-through in response to sufficiently large shocks.

To prove the point, we can similarly look at related concepts: the role of shock size and energy exposure. A larger shock size would also trigger firms to adjust prices. Likewise, firms' exposure to energy prices may play a role. Similar to regression model (1), we regress firm i in industry j pass-through, PT_i , on the firms' shock size, $Size_i$, and energy exposure, $Energy_i$, controlling for business conditions, as well as industry fixed effects:

$$PT_i = \alpha_j + \beta_1 Energy_i + \beta_2 Size_i + \gamma X_i + \varepsilon_i, \quad (2)$$

where α_j reflects the 4-digit sector fixed effects, and X_i is a vector of control variables, including firms' state of business, and expected business situation.

Table C.2 shows the regression results for pass-through on shock size and energy exposure.¹⁰ A more significant cost increase is associated with a larger pass-through. The basic principle is that firms exhibiting a significant cost increase must pass-through cost

⁹The coefficients of the confounders are of interest to itself. For instance, the negative coefficient on the range of orders indicates the existence of nominal frictions. Firms with an extended range of orders cannot pass through increased costs due to existing contracts with fixed prices.

¹⁰We have only data for energy exposure and cost changes from the June 2021 survey.

Table 1: Expected duration of the shock and pass-through in 04/2022

	Pass-Through (April 2022)					
	(1)	(2)	(3)	(4)	(5)	(6)
Duration Supply (Oct. 21)	0.68*** (0.22)	0.75*** (0.27)	0.83*** (0.31)			
Duration Supply (June 22)				0.37*** (0.12)	0.46*** (0.17)	0.54** (0.22)
Range of Orders (April 2022)		-0.79** (0.34)	-0.95** (0.46)		-0.74*** (0.26)	-0.96** (0.39)
Capacity Utilization (April 2022)		0.52*** (0.094)	0.64*** (0.13)		0.24*** (0.078)	0.43*** (0.12)
Change in Revenues (April 2022)		3.17 (1.94)	3.82 (2.69)		6.46*** (1.71)	5.61** (2.67)
Change in Orders (April 2022)			-1.25 (2.74)			0.68 (2.89)
Production Expectations (April 2022)			-1.53 (2.85)			-1.13 (3.07)
Energy Intensity 2021			-0.93*** (0.24)			-0.59** (0.27)
Cost Changes (March-May 2021)			0.12** (0.053)			0.13 (0.081)
Constant	45.1*** (1.75)	4.06 (7.92)	-1.91 (11.0)	44.8*** (1.26)	28.0*** (6.82)	14.0 (11.2)
4-Digit Sector FE	✓	✓	✓	✓	✓	✓
Observations	951	762	561	1094	904	511
R^2	0.202	0.264	0.287	0.180	0.214	0.260

Notes: The table reports estimates from linear regressions of the firm-level pass-through of cost changes to sales prices in April 2022 on expected duration of supply shortages in months (elicited in October 2021 and June 2022). Columns 2 and 5 control for the range of orders in months, capacity utilization in percent and the qualitative change in revenues. Columns 3 and 6 additionally control for the qualitative change in orders, qualitative production expectations, the energy intensity (measured as the share of energy costs in terms of revenues), and cost changes between March and May 2021. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: ifo Institute's business survey.

changes; otherwise, it is not affordable. However, there is a negative effect of energy exposure on pass-through. This may be attributed to two potential factors: first, energy costs are part of firms' fixed costs and are therefore to a first order irrelevant for pricing off marginal costs; second, firms' energy costs are very volatile and hence, as just discussed, firms may not have the incentive to respond to transitory shocks. At the firm level, energy exposure and shock size are positively correlated. Thus, once including both variables in one regression, the effect of energy exposure becomes more strongly negative. Tables C.3 and C.4 in Appendix C decompose pass-through in extensive and intensive margin.¹¹ We find that the extensive margin of pass-through is mostly driven by shock size (in line with a menu cost model) but the intensive margin is affected by both energy exposure and shock size.

Accordingly, we can summarize our third fact as follows:

Fact 3: Pass-through increases in the expected duration of the shock as well as in shock size.

This evidence is in line with Taylor (2000) theoretical work showing that pass-through increases in the perceived persistence of the shock. We deliver analogous empirical evidence about the persistence of the shock as well as the size of the shock. Different beliefs about the duration of the shock can also explain differential pass-through dynamics across firms. If competitors are reluctant to increase prices in response to a perceived transitory shock, this amplifies potentially real rigidities and leads to sluggish pass-through. Vice versa, perceived permanent shocks can be a self-enforcing amplification mechanism for inflation.

3.4 Pass-through and firm's idiosyncratic uncertainty

The next factor for explaining pass-through differences within sectors across firms is firm-level uncertainty about future demand and business performance. Uncertainty can have ambiguous effects on firms' price-setting decisions. Bachmann et al. (2019) document that higher uncertainty leads to more frequent price adjustments (extensive margin) as firms are experiencing larger shocks. However, it could also trigger a "wait-and-see"-strategy, with firms' postponing further price adjustments (Vavra, 2014). We measure uncertainty at the firm level: respondents move a slider between zero and 100 depending on the uncertainty about their business development in the next six months. Appendix Figure C.5 shows the average uncertainty over time. The advantage of this measure is that it is not based on

¹¹In the extensive margin specification, the dependent variable is a dummy that is one if pass-through is larger than zero.

nominal values in contrast to other measures in the literature which are based on revenue expectations (e.g., Altig et al. 2022 or Bachmann et al. 2021). While Bachmann et al. (2019) rely on an indirect qualitative measure of uncertainty variation over time, we exploit the cross-sectional variation of a direct quantitative measure between sectors and firms.

Figure 6 presents the relationship between pass-through of cost changes to sales prices until 10/2022 to firms' idiosyncratic uncertainty both at the sector and firm level. In line with Bachmann et al. (2019), we find that sectors and firms with a higher idiosyncratic level of uncertainty pass through cost changes by more. The highest level of uncertainty face industries of Paper Products (17), Printing (18), Other Admin. (82), Hotels (55), Movie & TV Production (59), Travel Agencies (79), Other Personal Services (96), Arts (90), and Textiles (13), whereas most service industries face a low level of uncertainty, e.g., Real Estate (68), Other Financial Services (66), Legal Services (69), Architects (71), Programming (62), and Facility Management (81). Quantitatively, an increase in uncertainty by ten is associated with an increase in pass-through by two percentage points. To further control for potential endogeneity in firm's uncertainty, we regress firm i in industry j pass-through, PT_i , on firms uncertainty, $Uncertainty_i$, and control also for business conditions, as well as industry fixed effects:

$$PT_i = \alpha_j + \beta Uncertainty_i + \gamma X_i + \varepsilon_i, \quad (3)$$

where α_j reflects the 4-digit sector fixed effects, and X_i is a vector of control variables, including firms' state of business, and expected business situation.

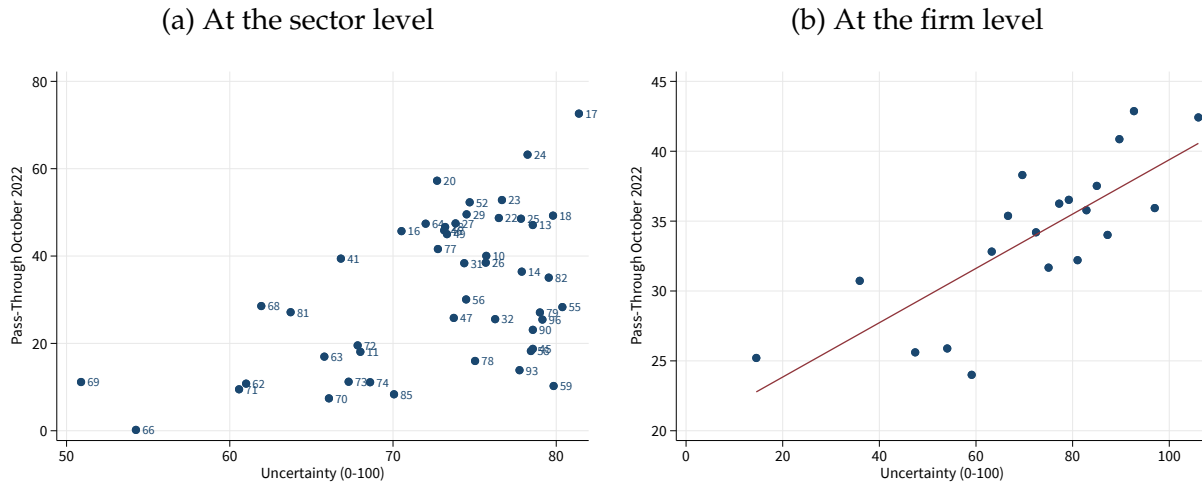
Table C.5 in Appendix C shows that the positive relation also holds once controlling for the state of the business and expected business situation, as well as sector fixed effects. The coefficient drops in terms of magnitude by half but remains statistically significant.

Accordingly, we can summarize our fourth fact as follows:

Fact 4: Pass-through increases with idiosyncratic uncertainty.

Idiosyncratic uncertainty also partly explains differences in pass-through within industries and across industries. We provide micro-level evidence that idiosyncratic uncertainty does not only affect the extensive margin of firm-level price-setting behavior but also the intensive margin of adjustment with uncertain firms' adjusting on both margins by more. This implies that cost-push shocks propagate faster in an environment with high uncertainty and amplify inflation dynamics. However, at the same time, this also implies that inflation dynamics become less persistent and monetary policy less effective.

Figure 6: Pass-through until 10/2022 and uncertainty



Notes: The figure relates the pass-through of cost changes to sales prices until 10/2022 to uncertainty of firms. Uncertainty is elicited on a continuous scale from 0 (low) to 100 (high). The left panel shows the relation as a scatter plot at the sector level (2 digits, at least 20 observations per sector). The right panel shows the relation as a binned scatter plot at the firm level and additionally controls for the business situation and business expectations. Appendix A lists the wording of the respective survey question. Source: ifo Institute’s business survey.

3.5 Pass-through and price-setting frequency

The intensive margin of pass-through is tightly linked to the average frequency of price changes. To that end, we calculate the average frequency of price changes for each firm between 2014-2019.¹² This is a reduced form measure of price stickiness and indicates the degree of nominal rigidities. Our focus is on the *intensive margin* of pass-through to examine the role of real rigidities. In the absence of strategic complementarities, firms would pass-through the cost increases to their customers at the first opportunity. Hence, we would expect no relation between nominal rigidities, proxied by the frequency of price changes, and the intensive margin of pass-through. Figure 7 depicts this relation at the sectoral level and the firm level in the left and right panels.¹³ At both level, a higher frequency of past price changes is associated with a higher pass-through of the cost-push shock. Intuitively, the more often firms change their prices, the better works the price coordination among them. Firms pass through the cost increases to a larger extent if competitors are also more likely to be able to adjust, ensuring that the price is close to the competitors (relative price close to 1). Interestingly, firms in the trade sectors—marked with red crosses—have a comparably low pass-through despite a high frequency of price

¹²We take the pre-crisis average price change frequency because it is arguably exogenous to other factors, such as shock size, exposure to the pandemic, or current idiosyncratic shocks, that influence pass-through.

¹³This analysis excludes services as the realization of price changes was not elicited until 07/2018.

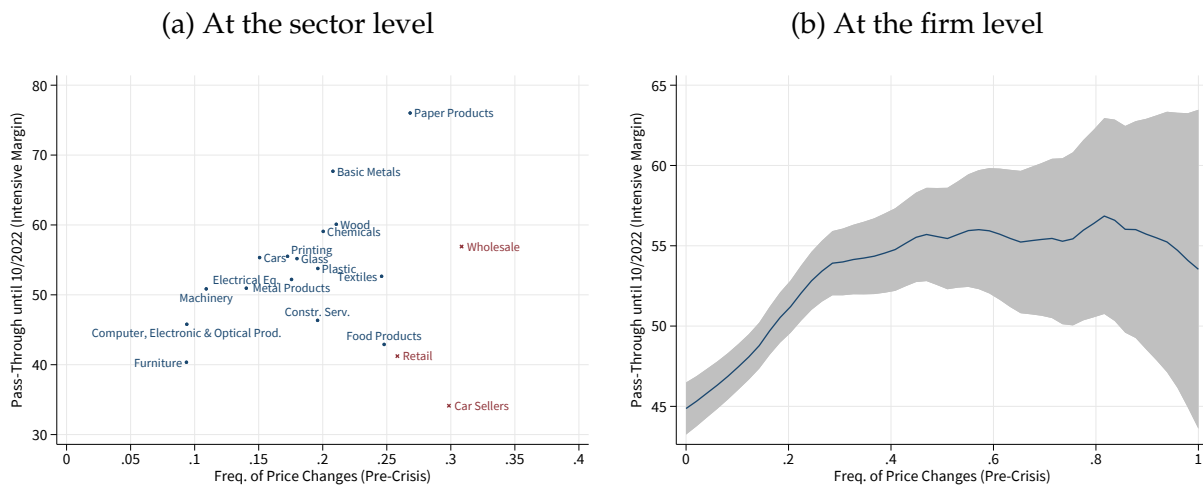
changes. This indicates the high importance of strategic complementarities in these sectors. The relation at the firm level is highly non-linear. While firms that almost never changed their prices between 2014-2019 have an average pass-through around 45%, firms that changed their prices roughly twice a year in this period have an 8-10 percentage points higher pass-through on average. Firms that have changed their prices even more often exhibit a similar pass-through.

Accordingly, we can summarize our fifth fact as follows:

Fact 5: Pass-through increases in firms' past price-setting frequency.

Observing the history of a firm's price adjustments informs about future pass-through in response to shocks. More specifically, if firms adjusted prices infrequently in the past, future shocks will trickle through the economy and slowly trigger inflation. In this, we add to previous work by Gopinath and Itskhoki (2010) finding that the firms with a higher frequency of adjustment exhibit a higher long-run pass-through of exchange rate shocks. We generalize their result and further demonstrate that this relationship holds across and within sectors.

Figure 7: Intensive margin of pass-through until 10/2022 and nominal rigidities



Notes: The figure relates the intensive margin (> 0) of pass-through until 10/2022 to the average frequency of price changes before the crisis. The left panel shows the average frequency of price changes in the period 2014-2019 and the pass-through of cost changes to sales prices until October 2022 at the sector level (2 digits, at least 20 observations per sector). Blue points indicate manufacturing sectors, and red points indicate trade sectors. The right panel shows the non-parametric relation between the frequency of price changes in the period 2014-2019 and the pass-through of cost changes to sales prices until October 2022 at the firm level. The gray shaded area is the 95% confidence interval. Only firms with at least 12 observations in the period 2014-2019 are considered in the figure. Source: ifo Institute's business survey.

3.6 Connection to direct evidence of limiting factors

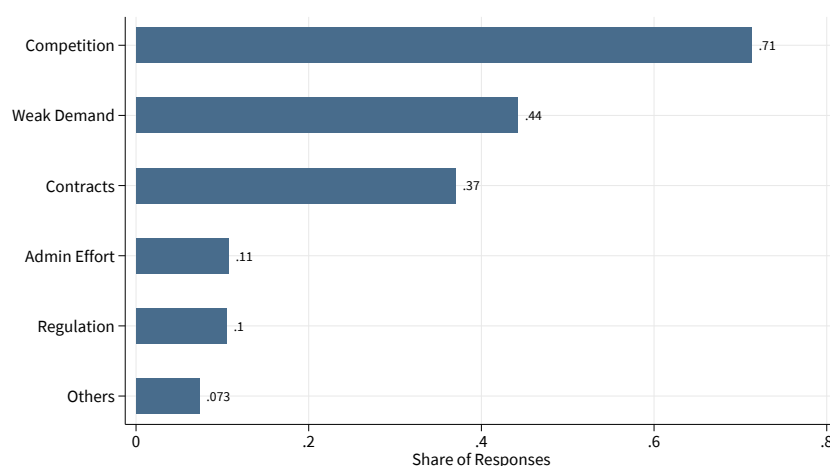
What do we learn about pass-through dynamics from the micro-level data? Overall, sluggish and gradual pass-through point towards the role of nominal and real rigidities. Substantial heterogeneity within industries suggest that nominal and rigidities are only part of the story. Furthermore, we find that the perceived nature of the shock, i.e., idiosyncratic expectations about the duration of the shock and size of the shock, as well as uncertainty and past price-setting frequency, matter for pass-through dynamics.

The survey also allows to ask the participants directly about the reasons for slow and sluggish pass-through. For this, we explore a supplementary question in the October 2022 survey:

What factors limit complete pass-through?

We distinguished between competition, weak demand, long-term contracts, administrative effort/burden, regulatory reasons, and other factors. Figure 8 shows that competition, weak demand, and long-term contracts are the key limiting factors for pass-through. About 70% of firms state that competition limits their potential to adjust prices, clearly favoring micro real rigidities. Similarly, about 45% listed that weak demand limits pass-through—another factor pointing towards the role of real rigidities. The role of nominal rigidities is smaller. About 35% state that long-term contracts limit pass-through, and actually, administrative effort/burden and regulation have only a share of less than 10%.

Figure 8: Limiting factors for pass-through



Notes: The figure presents the share of respondents reporting that the following factors limit pass-through: competition, weak demand, long-term contracts, administrative effort/burden, regulatory reasons, and others. Source: ifo Institute's business survey.

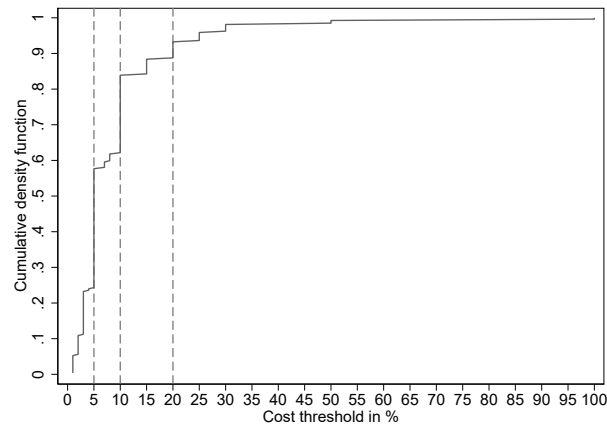
Subsequently, we want to investigate closer the connection between real and nominal rigidities and the new channels to understand better pass-through dynamics. In how far do nominal and real rigidities interact with expectations and uncertainty? Using a survey experiment, we next address these points.

4 Survey Experiments

This section turns to the survey experiments to examine the causal link between the nature of the shock and pass-through. Our objective is to quantify how firms' pass-through of a cost-push shock changes over time depending on the nature of the shock and the underlying economic environment. We use the new insights from the survey experiments to bridge our previous descriptive evidence and theoretical predictions from the literature on nominal and real rigidities. The specific details of the experiment's design are outlined in Section 2. Appendix B presents the survey questionnaire.

Our approach allows isolating the marginal effect of the nature of the shock, particularly the duration and diffusion of the shock, in a *within* firm setting, by keeping all other factors the same. On top of that, it allows discerning the importance of the economic environment by comparing responses *across* firms, again keeping all other factors the same. This way, our approach comes with the advantage of abstracting from other channels that do not influence the findings. More precisely, first, firms may choose not to pass through the cost increase at all due to facing high fixed (menu) costs for price adjustment. To address this, we surveyed firms on their *general* threshold for adjusting prices before presenting the hypothetical scenarios. Figure 9 displays the cumulative density function of this threshold, supporting the relevance of menu costs in general. However, there is substantial heterogeneity. The median firm adjusts prices already for a 5% increase in costs. At a cost increase of 10%, over 80% of firms typically adjust prices, and at a 20% increase, over 90% of firms typically adjust prices. In other words, this provides an "inaction area" for which firms remain idle and pass-through is zero. Menu costs, therefore, are unlikely to be the primary driver of firms' (non-)response since the scenarios concern a 20% cost increase. Second, the results cannot be influenced by macro real rigidities similar to Basu (1995), as all firms in our hypothetical vignette *directly* face a 20% cost increase. In other words, this allows us to completely abstract from any dilution in pass-through from input-output linkages.

Figure 9: Threshold of cost increases for pass-through



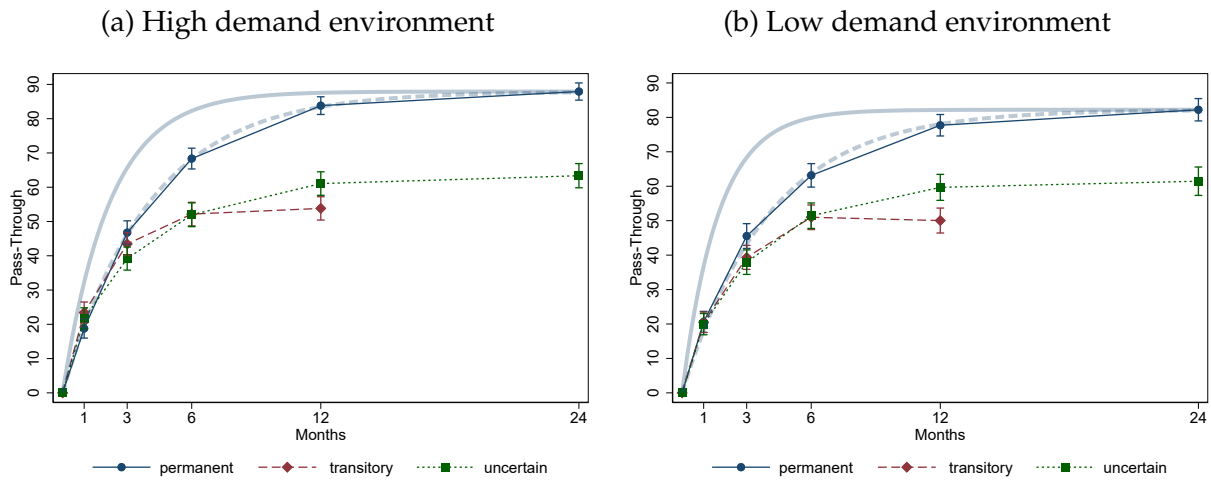
Notes: The figure plots the cumulative density function of the minimum level required cost increase (in %) for a firm to change prices. Source: ifo Institute’s management survey.

Aggregate pass-through dynamics. Figure 10 presents the main result of the survey experiment. The first row shows the time path of the respective average pass-through of firms faced in three cost-push shock scenarios: (i) a *permanent* increase in costs by 20% (blue, solid lines) (ii) a *transitory* 20% cost increase in place for 12 months (red, dashed lines) , and (iii) a 20% cost increase with *uncertain* duration (green, dotted lines), during high- and low-demand economic environments, respectively. The light-blue lines reflect Calvo-implied counterfactuals, explained in detail in the nominal vs. real rigidities paragraph. The overall trend observed is a gradual, concave increase in the pass-through at the aggregate level, eventually approaching a level below 100%. This result is consistent with previous studies based on micro price-level data, such as, e.g., Gopinath and Itskhoki (2010), Dedola et al. (2021), or Joussier et al. (2022). However, our setup has two critical advantages over existing studies: i) the respective pass-through coefficients are estimated with substantially higher precision, despite a small sample size, and ii) by fixing the information set and firms’ expectations, we can differentiate between the nature of the shock as well as the economic environment. This gives a clean setup to estimate the causal effect of a cost-push shock on pass-through.

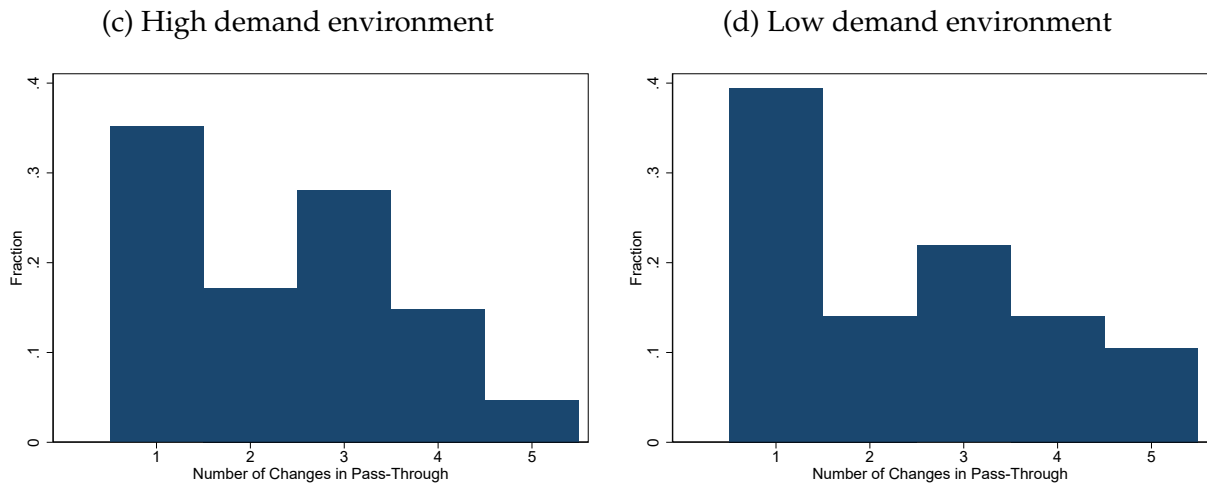
Nature of the shock. To what extent do expectations about the nature and duration of the shock matter for firms’ pass-through of cost-push shocks? A comparison of the three cost-push shock scenarios - permanent, transitory, or uncertain duration - indicates no significant difference between them in the first three months but a consistently steep increase in pass-through of roughly 40%. This evidence is in line with the presence of

Figure 10: Pass-through of cost-push shocks across horizons depending on nature of shock

Average pass-through



Number of changes in pass-through (permanent cost shock)



Notes: The first row plots the pass-through of cost-push shocks across horizons depending on the nature of the shock, differing between permanent, transitory, and uncertain duration shocks, in blue, green, and red colors, respectively. The whiskers reflect the 68% confidence interval (one standard deviation). The light-blue lines reflect the Calvo-implied counterfactuals. The second row plots histograms of the firm-level number of changes in pass-through in the permanent shock scenario. Source: ifo Institute's management survey.

nominal frictions leading to a gradual increase in pass-through in the aggregate, as not all firms can change their prices immediately. Similarly, Figure C.6 in Appendix C shows that 63% do not increase prices at all in the first month supporting the importance of nominal rigidities at the beginning. Afterwards, the pass-through increases only slightly for the temporary shock and the shock with uncertain duration. For the permanent scenario, we observe further increases in pass-through that are significantly stronger than for the other two scenarios highlighting the *importance of expectations* about the nature of the shock for the extent of pass-through. Figure C.8 in Appendix C confirms that the gradualness and the increasing pass-through in the shock duration are similar across sectors and along the firm size distribution. In line with the findings in the field (see Section 3.1), pass-through is higher across all scenarios for firms in the manufacturing and construction sector compared to services and trade. There is no consistent pattern across the size distribution.

Robustness across economic conditions. We next examine whether the underlying economic environment affects the decision of firms to pass through cost-push shocks. Comparing pass-through in times of high and low demand (left and right panel respectively), we generally observe a very similar pattern, even quantitatively. This demonstrates the robustness of our results and also holds for the more detailed analysis below. While we can not rule out granular differences in pass-through conditioning on the state of the economy, we conclude that it is not a main driving force for the characteristics of pass-through. A potential reason might be that a lower ability to pass through prices due to low demand comes along with the necessity to increase prices to ensure solvency.

Nominal vs. real rigidities. Our framework enables us to *directly* assign the observed sluggish pass-through to the presence of nominal and real rigidities. To this end, we take a closer look at pass-through changes at the firm level. While one-time increases favor nominal rigidities,¹⁴ several gradual increases would be in line with the existence of micro real rigidities. The second row of Figure 10 presents the number of changes in pass-through at the firm level in the scenario of the permanent cost shock. The majority of firms change their pass-through level more than once in the given scenario.¹⁵ Hence, this is strong evidence of the important role of real rigidities in the pass-through of cost-push shocks.

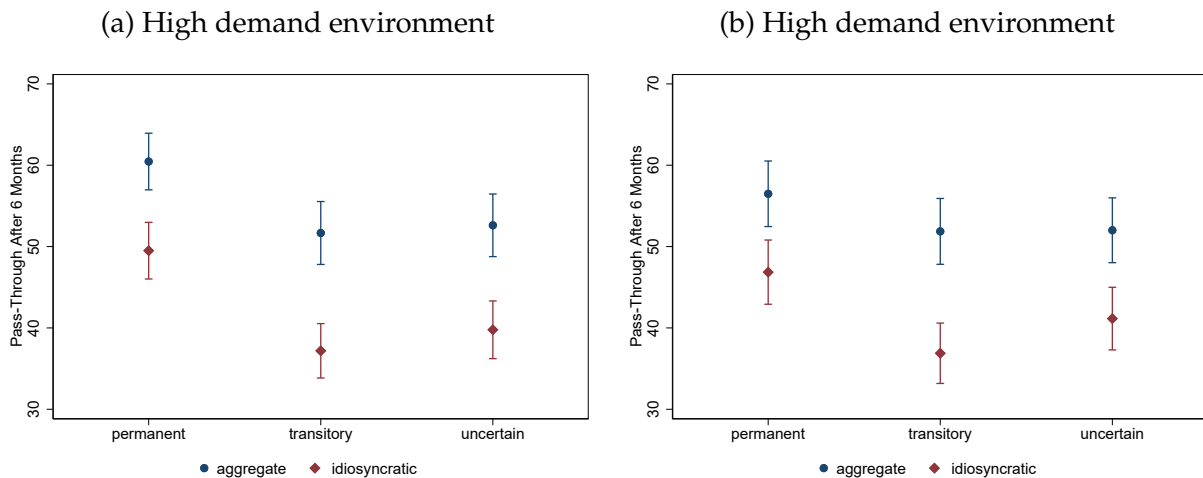
To further quantify the importance of real rigidities, we contrast pass-through under

¹⁴Both Calvo-type and menu-cost models would support a one-time adjustment.

¹⁵This is likely a rather conservative estimate due to potential survey fatigue. Further, this may be amplified by our data cleaning procedure, where we fill up/down the pass-through values over time if firms have not entered a value to all five horizons (applies to less than 10% of firms).

a sector-wide and idiosyncratic cost-push shock. The underlying idea is such: A firm facing an idiosyncratic cost-push shock bears in mind that competitors may keep their prices constant, so any price adjustment on the firm’s side distorts relative prices, entailing possible customer resentment and demand drops. Under the existence of micro real rigidities, a firm facing an idiosyncratic shock thus does not pass it through as strongly to keep the relative price close to one. This can be modeled by a price elasticity that is increasing in the price relative to the competitors. Figure 11 shows that the average pass-through of the idiosyncratic shock is significantly lower vs. the aggregate shock. This pattern arises robustly across the different shock scenarios and for the high and low-demand environments. Quantitatively, the difference in pass-through of aggregate vs. idiosyncratic shocks is approx. 10-15 percentage points. A particularly strong difference is visible for the transitory shock scenario. This might be due to the fact that the relative price difference exists only for a limited period of time, which additionally reduces the incentive to deviate from the competitors. Figure C.7 in Appendix C shows that this pattern also holds across sectors and along the firm size distribution.

Figure 11: Pass-through of aggregate vs. idiosyncratic cost-push shocks across horizons

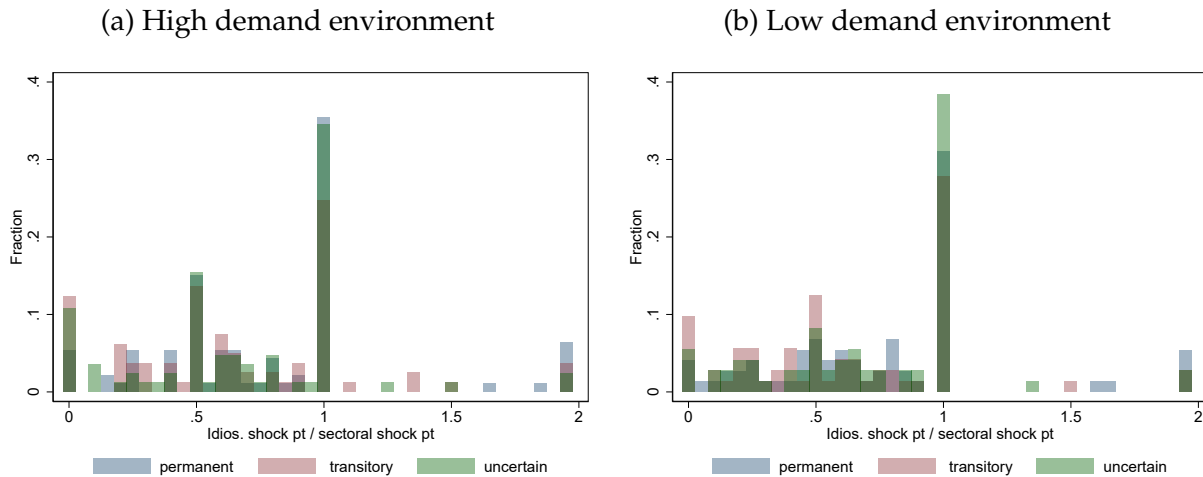


Notes: The figure shows the pass-through of permanent vs. idiosyncratic cost-push shocks after 6 months depending on the nature of the shock, differing between permanent, transitory, and uncertain duration shocks. The whiskers reflect the 68% confidence interval (one standard deviation). Source: ifo Institute’s management survey.

In addition, we can construct a measure of real rigidities, χ , as the ratio of the idiosyncratic shock pass-through level over the aggregate shock pass-through level. In a similar vein, Nakamura and Steinsson (2013) refer to the denominator as micro strategic complementarity, little incentive for a firm to raise its price as such rises relative to others, and the numerator as macro strategic complementarity, little incentive for a firm to raise its

price as aggregate demand change. χ smaller than one indicates strategic complements, χ larger than one strategic substitutes. Figure 12 plots the histogram of χ across firms. Most firms face strategic complementarities, as the mass of χ is below one. Strategic complementarities can also explain sluggish and incomplete pass-through to shocks, serving as a sufficient statistic.

Figure 12: Extent of real rigidities (χ)



Notes: The histogram plots the extent of real rigidities (χ) for the pass-through of cost-push shocks with a permanent, transitory, and uncertain duration. Source: ifo Institute's management survey.

Connection to the empirical results. The survey experiment allows us to rationalize the pattern in the cross-section and over time presented in Section 3. The empirical results have shown that firms with a higher expected duration increase their prices by more, thus exhibiting a higher pass-through. While, in reality, the distribution of beliefs about the duration of supply chain disruptions is continuous, the survey experiment maps this to the two extreme cases: permanent vs. transitory. Similar to the empirical results, we find a statistically significant increasing pass-through with the expected duration in the survey experiments, confirming the importance of the duration of the shock. Belief updating can also affect pass-through over time and explain an increasing pass-through (even in the absence of any real and nominal rigidities). More specifically, firms' learning over time about the nature of the shock may lead to an adjustment in pass-through.

Likewise, the survey experiment indicates that both - nominal and real rigidities - play a significant role in the pass-through of cost-push shocks. Specifically, (i) roughly 60% of all firms do not react on impact (Figure C.6 in Appendix C), and (ii) firms only increase prices gradually. These results from the experiment can be directly linked to the earlier empirical results in Section 3: i) firms that adjust prices infrequently also exhibit a lower

pass-through (Figure 7), and ii) firms plan a granular increase of the pass-through over 6 months (Figure 2). In addition, 41% of the firms that participate in the survey experiment listed competition as a limiting factor for price setting and the main source of lack of pass-through in open-ended questions, as shown in Table C.6 in Appendix C. This number aligns fully with the survey panel evidence of 40% listing competitive pressure as the main limiting factor for pass-through.

Quantifying the pass-through dynamics and implications for the Phillips curve. We next rationalize our survey experiment results for transitory vs. permanent shocks building on sufficient statistics developed by Auclert et al. (2022). Our survey design allows us to directly read off the pass-through coefficient in an environment with and without strategic complementarities and then make inferences on the slope of the Phillips curve.

We start by contrasting our pass-through estimates with canonical Calvo pricing model predictions. To calculate the implied pass-through under a Calvo pricing model, we calibrate the adjustment probability θ such that it matches the share of zero pass-through on impact ($\theta = 0.37$) in Figure C.6 and the accumulated pass-through to a permanent shock after 24 months in Figure 10. Thereby, we treat the close to 80% pass-through after 24 months as complete and assume that firms can roughly substitute the remaining 20% of increased costs.¹⁶ The light-blue, solid lines in the upper panels of Figure 10 reflect the pass-through dynamics under Calvo pricing for the permanent shock scenario. The Calvo model does not fit the observed average pass-through estimates since firms adjust prices gradually. The Calvo coefficient must be lowered to match the observed pass-through estimates. θ equal to 0.22 (light-blue, dashed lines in Figure 10) fits the observed pass-through estimates best and closely matches the survey experiment. Hence, the Calvo coefficient based on the extensive margin is 68% too high. This “Calvo counterfactual” is a reduced-form way to quantify the role of strategic complementarities.

We build on the analytical solution for the pass-through matrix, Ψ , for a time-dependent (e.g., Calvo) model from Auclert et al. (2022) to rationalize pass-through patterns across shocks and for varying the nominal rigidities:

$$\Psi \equiv \frac{1}{\sum_{s \geq 0} (1 - \theta)^s \sum_{s \geq 0} \beta^s (1 - \theta)^s} \begin{pmatrix} 1 & 0 & 0 & \dots \\ (1 - \theta)^1 & 1 & 0 & \dots \\ (1 - \theta)^2 & (1 - \theta)^1 & 1 & \dots \end{pmatrix} \begin{pmatrix} 1 & \beta(1 - \theta)^1 & \beta^2(1 - \theta)^2 & \dots \\ 0 & 1 & \beta(1 - \theta)^1 & \dots \\ 0 & 0 & 1 & \dots \end{pmatrix}$$

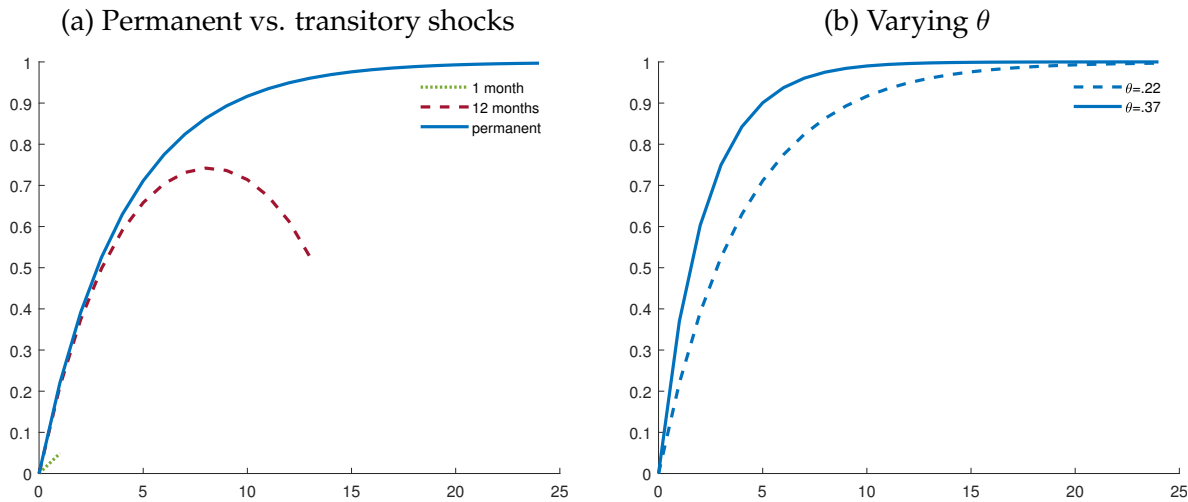
where θ reflects the adjustment probability and β the discount factor.¹⁷ The expression

¹⁶We do not want to stretch this point too much as the median is at 100%.

¹⁷We set the discount factor β to .9966 in accordance with the monthly frequency.

above gives exact analytical mapping for the estimated Calvo model dynamics in Figure 10. We can use this relationship to also look at pass-through dynamics for different durations: transitory vs. permanent shocks. Panel (a) in Figure 13 presents the results for a shock of 1 month, 12 months, and permanent duration. In line with the survey experiment results in Figure 10, pass-through is lower for the transitory shocks. The model predicts a declining pass-through close to the end of the shock duration. In the survey experiment, there is no indication of that on average, suggesting further downward price rigidity at play.

Figure 13: Calvo-model implied pass-through dynamics



Notes: The figures show the estimated pass-through implied by a Calvo pricing model. Panel (a) shows the implied estimated pass-through setting the adjustment probability $\theta=0.22$ and varying the shock duration: 1 month, 12 months, and permanent duration. Panel (b) shows the implied estimated pass-through varying adjustment probability θ for a shock of permanent duration.

Similarly, we can adjust the adjustment probability parameter θ and study its implications on pass-through. Focusing on a permanent shock, Panel (b) in Figure 13 shows the implied pass-through for θ equal to 0.22 and 0.37 reflecting an expected mean duration of prices of 4.54 months and 2.7 months, respectively. As in Figure 10, we find a faster adjustment for a higher θ , i.e., in an environment with a smaller extent of frictions.

What do our pass-through results tell about inflation-output dynamics and monetary policy transmission? The pass-through estimates can be directly mapped to coefficients for the slope of the Phillips curve (PC) building on Auclert et al. (2022). The pass-through matrix delivers a sufficient statistic and is the only ingredient to calculate the Phillips curve slope coefficient matrix \mathbf{K} . The PC reflects the inflation response to output depending on the coefficient matrix \mathbf{K} and the elasticity of intertemporal substitution and intertemporal labor supply elasticity:

$$\pi = (\varphi + \sigma)\mathbf{K}\hat{y},$$

The PC slope coefficient matrix \mathbf{K} is calculated as: $\mathbf{K} = (\mathbf{I} - \mathbf{L})\Psi(\mathbf{I} - \Psi)^{-1}$, where \mathbf{I} reflects the identity matrix and \mathbf{L} the lag-matrix. The implied PC coefficients from our survey experiment are presented on a monthly level in Table 2.

Table 2: Implied coefficients of Phillips curve slope \mathbf{K}

	nominal rigidities	nominal + real rigidities	
	$\theta=0.37$	calvo counterfactual $\theta=0.22$	based on idios. shock PT $\theta=0.37; \chi=0.625$
\mathbf{K}	0.2186	0.0628	0.1366

Notes: The table presents the implied coefficients of Phillips curve slope based on $\mathbf{K} = (\mathbf{I} - \mathbf{L})\Psi(\mathbf{I} - \Psi)^{-1}$ for different values of θ . In the third column, the \mathbf{K} based on nominal rigidities is multiplied by χ , capturing the extent of real rigidities.

In the first column, we show the implied PC coefficient based on the nominal rigidities that we observe in the survey experiment. The implied slope coefficient for the Phillips curve is with 0.22 relatively steep. Intuitively, inflation is sensitive to output variation in an environment where prices change frequently. In the second and third columns, we display the PC coefficients that also consider real rigidities based on two approaches. Either we rely on the “Calvo counterfactual” - as described above - or we use the PC coefficient based on nominal rigidities and adjust for strategic complementarities in a second step, based on the pass-through of the idiosyncratic shock scenario.

Following Auclert et al. (2022), in an environment with strategic complementarities, the Phillips curve coefficient extends to:

$$\pi = (\varphi + \sigma)\chi\mathbf{K}\hat{y},$$

where χ reflects the strategic complementarities for values smaller than one and down-scales the slope of the Phillips curve. We can derive χ by comparing the idiosyncratic and aggregate shock results presented in Figure 11. Focusing on the permanent shock, we obtain $\chi = 0.625$ in the high-demand environment.¹⁸ The degree of strategic complementarities is likely to be even stronger in the low-demand environment or for transitory shocks

¹⁸ χ is calculated as pass-through of idiosyncratic shock after six months divided by pass-through of aggregate shock after 24 months.

(as the gap between idiosyncratic and aggregate shocks is wider in these scenarios).

The PC coefficient gets substantially flatter for both approaches that account for real rigidities. Based on the “Calvo counterfactual,” it shrinks to 0.06 and, based on the idiosyncratic shock PT approach to 0.14. This flat PC is in the range of the recent literature (e.g., Hazell et al. 2022).

5 Conclusion

We document sluggish and incomplete pass-through of cost-push shocks to customers using a novel firm-level survey approach. The gradual and piece-by-piece pass-through attributes an important role to nominal and micro real rigidities limiting pass-through at the firm level. Significant heterogeneity in pass-through within narrowly defined industries suggests additional idiosyncratic factors play a role. In particular, we highlight the importance of firm-specific expectations about the duration of the shock and its interaction with nominal and real rigidities. Both popular pricing models - Calvo or menu cost models - fail to explain the observed pass-through dynamics as (i) the pass-through between zero and one and (ii) the observed gradualness are at odds with these models.

Our results have implications for the propagation of shocks and the transmission of monetary policy. First, sluggish adjustment implies persistent effects of monetary policy. In fact, New Keynesian models that rely on a strong degree of real rigidities to match the high persistence of monetary shocks in the data, such as Smets and Wouters (2007), might be better micro-founded than previously thought. The persistence is driven by conventional real rigidities as well as additional rigidities from different information sets of firms. Here, communication about the nature of the shock could significantly affect and amplify aggregate transmission. Second, our estimates indicate that the Phillips curve becomes much flatter once accounting for the extent of real rigidities we observe in the data.

Further work on rationalizing the empirical findings is in progress. A model featuring menu costs, micro real rigidities in the form of a Kimball-demand function (following Aruoba et al. (2022) and Klenow and Willis (2016)), and idiosyncratic expectations about the duration of the shock can potentially capture the observed heterogeneous and gradual and incomplete pass-through over time.

References

- Altig, D., Barrero, J. M., Bloom, N., Davis, S. J., Meyer, B., and Parker, N. (2022). Surveying business uncertainty. *Journal of Econometrics*, 231(1):282–303.
- Amiti, M., Itskhoki, O., and Konings, J. (2019). International shocks, variable markups, and domestic prices. *The Review of Economic Studies*, 86(6):2356–2402.
- Aruoba, S. B., Oue, E., Saffie, F., and Willis, J. L. (2022). Real rigidities, firm dynamics and monetary non-neutrality: Role of demand shocks.
- Auclert, A., Rigato, R. D., Rognlie, M., and Straub, L. (2022). New pricing models, same old phillips curves? Technical report, National Bureau of Economic Research.
- Auer, R. A. and Schoenle, R. S. (2016). Market structure and exchange rate pass-through. *Journal of International Economics*, 98:60–77.
- Bachmann, R., Born, B., Elstner, S., and Grimme, C. (2019). Time-varying business volatility and the price setting of firms. *Journal of Monetary Economics*, 101:82–99.
- Bachmann, R., Carstensen, K., Lautenbacher, S., and Schneider, M. (2021). Uncertainty and change: survey evidence of firms' subjective beliefs. Technical report, National Bureau of Economic Research.
- Bachmann, R., Carstensen, K., Menkhoff, M., and Schneider, M. (2022). Umsatzunsicherheit und Umsatzerwartungen deutscher Firmen zur Zeit des Ukraine-Kriegs: Gas und Gasausfall spielen eine eher geringe Rolle. *ifo Schnelldienst*, 75(06):33–36.
- Bachmann, R., Elstner, S., and Sims, E. R. (2013). Uncertainty and economic activity: Evidence from business survey data. *American Economic Journal: Macroeconomics*, 5(2):217–49.
- Ball, L. and Romer, D. (1990). Real rigidities and the non-neutrality of money. *The Review of Economic Studies*, 57(2):183–203.
- Basu, S. (1995). Intermediate goods and business cycles: Implications for productivity and welfare. *The American Economic Review*, 85(3):512.
- Blinder, A., Canetti, E. R., Lebow, D. E., and Rudd, J. B. (1998). *Asking about prices: a new approach to understanding price stickiness*. Russell Sage Foundation.

- Bunn, P., Anayi, L. S., Bloom, N., Mizen, P., Thwaites, G., and Yotzov, I. (2022). Firming up price inflation. Working Paper 30505, National Bureau of Economic Research.
- Dedola, L., Kristoffersen, M. S., and Zullig, G. (2021). The extensive and intensive margin of price adjustment to cost shocks: Evidence from danish multiproduct firms. *Manuscript, April*.
- Dotsey, M. and King, R. G. (2006). Pricing, production, and persistence. *Journal of the European Economic Association*, 4(5):893–928.
- Drechsel, D., Mikosch, H., Sarferaz, S., and Bannert, M. (2022). What do firm managers tell us about the transmission channels of oil price shocks? *KOF Working Papers*, 507.
- Garetto, S. (2016). Firms' heterogeneity, incomplete information, and pass-through. *Journal of International Economics*, 101:168–179.
- Giglio, S., Maggiori, M., Stroebel, J., and Utkus, S. (2021). Five facts about beliefs and portfolios. *American Economic Review*, 111(5):1481–1522.
- Gödl-Hanisch, I. and Menkhoff, M. (2022). Inwieweit geben Unternehmen die gestiegenen Einkaufspreise an ihre Kunden weiter? *ifo Schnelldienst*, 75(12):32–34.
- Gopinath, G. and Itskhoki, O. (2010). Frequency of price adjustment and pass-through. *The Quarterly Journal of Economics*, 125(2):675–727.
- Hazell, J., Herreno, J., Nakamura, E., and Steinsson, J. (2022). The slope of the phillips curve: evidence from us states. *The Quarterly Journal of Economics*, 137(3):1299–1344.
- Joussier, R. L., Martin, J., and Mejean, I. (2022). Cost pass-through and the rise of inflation.
- Klenow, P. J. and Willis, J. L. (2016). Real rigidities and nominal price changes. *Economica*, 83(331):443–472.
- Kleshchelski, I. and Vincent, N. (2009). Market share and price rigidity. *Journal of Monetary Economics*, 56(3):344–352.
- Loupias, C. and Sevestre, P. (2013). Costs, demand, and producer price changes. *Review of Economics and Statistics*, 95(1):315–327.
- Muehlegger, E. and Sweeney, R. L. (2021). Pass-through of own and rival cost shocks: Evidence from the us fracking boom. *The Review of Economics and Statistics*, pages 1–32.

- Nakamura, E. and Steinsson, J. (2013). Price rigidity: Microeconomic evidence and macroeconomic implications. *Annu. Rev. Econ.*, 5(1):133–163.
- Riggi, M. and Tagliabracci, A. (2022). Price rigidities, input costs, and inflation expectations: understanding firms' pricing decisions from micro data. *Bank of Italy Occasional Paper*, (733).
- Rotemberg, J. J. (1982). Sticky prices in the united states. *Journal of Political Economy*, 90(6):1187–1211.
- Rotemberg, J. J. and Woodford, M. (1996). Imperfect competition and the effects of energy price increases on economic activity. *Journal of Money, Credit and Banking*, 28(4):549–577.
- Roth, C., Wiederholt, M., and Wohlfart, J. (2023). The effects of monetary policy: Theory with measured expectations.
- Smets, F. and Wouters, R. (2007). Shocks and frictions in us business cycles: A bayesian dsge approach. *American Economic Review*, 97(3):586–606.
- Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. *European economic review*, 44(7):1389–1408.
- Vavra, J. (2014). Inflation dynamics and time-varying volatility: New evidence and an ss interpretation. *The Quarterly Journal of Economics*, 129(1):215–258.
- Wang, O. and Werning, I. (2022). Dynamic oligopoly and price stickiness. *American Economic Review*.

A Survey Questions in the ifo Business Survey

Pass-Through

- June 2021: “Zu welchem Grad können Sie die höheren Einkaufspreise an Ihre Kunden weitergeben? Wir können die höheren Einkaufspreise zu ___ % an unsere Kunden weitergeben.”
- April 2022: “Zu welchem Grad können Sie höhere Einkaufspreise für Energie, Rohstoffe und Vormaterialien an Ihre Kunden weitergeben? Wir können die höheren Einkaufspreise zu ___ % an unsere Kunden weitergeben.”
- October 2022: “Zu welchem Grad haben Sie die höheren Einkaufspreise für Energie, Rohstoffe und Vormaterialien bereits an Ihre Kunden weitergegeben?” ___%
- October 2022: “Zu welchem Grad planen Sie, in den kommenden 6 Monaten die höheren Einkaufspreise für Energie, Rohstoffe und Vormaterialien (inklusive bisheriger Preisanpassungen*) an Ihre Kunden weiterzugeben?” ___%

Duration of supply shortages

- October 2021: “Falls Ihre Produktionstätigkeit zurzeit durch einen Mangel an Rohstoffen / Vormaterialien behindert wird: Was vermuten Sie, wie lange werden diese Probleme noch anhalten?”
- May 2022: “Falls Ihre Produktionstätigkeit zurzeit durch Mangel an Rohstoffen oder Vormaterialien/ Lieferengpässe/ Materialknappheit behindert wird: Was vermuten Sie, wie lange werden diese Probleme noch anhalten?”

Range of orders

- “Unsere Auftragsbestände entsprechen derzeit einer durchschnittlichen Produktion von ___ Monat(en)”

Change in orders

- “Unser Auftragsbestand ist gestiegen/etwa gleich geblieben/gesunken”

Energy intensity

- “Was schätzen Sie, welchen Anteil des Umsatzerlöses musste Ihr Unternehmen 2021 für Energiekosten aufwenden (Energieintensität)?” ___ %

Business state, expectation, and uncertainty

- “Wir beurteilen unsere Geschäftslage als:” [continuous slider from 0 (bad) over 50 (satisfactory) to 100 (good)]
- “Erwartungen für die nächsten 6 Monate: Unsere Geschäftslage wird in konjunktureller Hinsicht:” [continuous slider from 0 (rather worse) over 50 (the same) to 100 (rather better)]
- “Die Unsicherheit hinsichtlich unserer Geschäftsentwicklung in den nächsten 6 Monaten schätzen wir wie folgt ein:” [continuous slider from 0 (low) over 50 (average) to 100 (high)] ___ %

B Questionnaire ifo Institute's Management Survey

B.1 Original



Die letzten zwei Jahre waren weltweit geprägt von steigenden Preisen. Im Folgenden wird abgefragt, wie Ihr Unternehmen generell sowie in der aktuellen Situation die **Preissetzung** gestaltet.

Ihre Antworten helfen dabei, das Verständnis für die Inflationsentwicklung und entscheidende Einflussfaktoren zu verbessern.

Wie gut sind Sie persönlich über die Preisstrategien Ihres Unternehmens informiert?

gar nicht informiert sehr gut informiert

Wie groß müsste ein Anstieg der **Einkaufspreise** für Energie, Rohstoffe und Vormaterialien (in %) **grundsätzlich** sein, damit Ihr Unternehmen die **Preise anpasst**?

 %

Um wie viel Prozent sind Ihre **Einkaufspreise** für Energie, Rohstoffe und Vormaterialien in den **letzten 2 Jahren gestiegen**?

(grobe Schätzung genügt)

 %

Zu welchem **Grad** haben Sie die höheren **Einkaufspreise** für Energie, Rohstoffe und Vormaterialien bereits an Ihre **Kunden weitergegeben**?

(keine Weitergabe = 0%, vollständige Weitergabe = 100%, überproportionale Weitergabe > 100%)

 %

Welche wesentlichen **Faktoren begrenzen den Preissetzungsspielraum** Ihres Unternehmens?

Bitte priorisieren Sie.

wichtigster Faktor

zweitwichtigster Faktor

drittwichtigster Faktor

Wie hoch war der **Jahresüberschuss nach Steuern bzw. Verlust** Ihres Unternehmens in **% des Nettoumsatzes** in den Jahren 2018 und 2022?

(grobe Schätzung genügt)

2018:

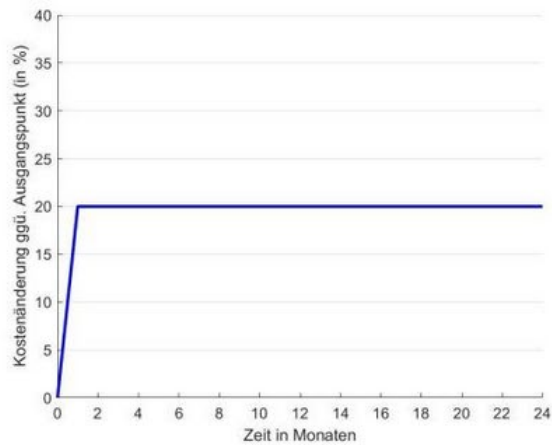
 %

2022:

 %

Versetzen Sie sich bitte nun in die folgenden **hypothetischen Szenarien**.

Stellen Sie sich vor, dass die **Einkaufspreise** für Sie und Ihre Konkurrenten in der Branche **dauerhaft um 20%** steigen aufgrund eines globalen Angebotsschocks (siehe Abbildung). Alle weiteren Faktoren, wie beispielsweise die Zinsentwicklung und fiskalpolitische Maßnahmen, bleiben unverändert. Nehmen Sie als Ausgangspunkt eine **gute wirtschaftliche Lage mit normaler Auslastung** für Ihr Unternehmen und die Gesamtwirtschaft an.



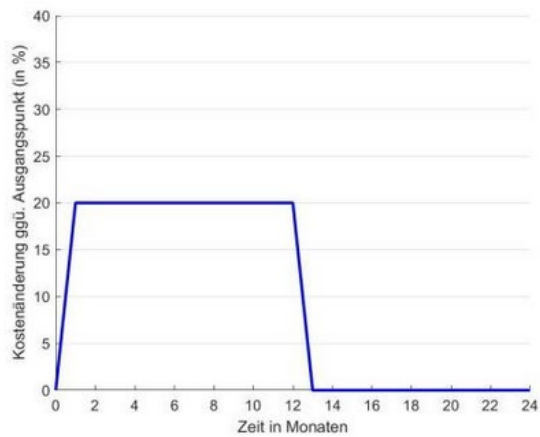
Zu welchem Grad würden Sie die Kostenanstiege in diesem Szenario an Ihre Kunden weitergeben?

(keine Weitergabe = 0%, vollständige Weitergabe = 100%, überproportionale Weitergabe > 100%)

Geben Sie an, wie hoch die Weitergabe zu dem jeweiligen Zeitpunkt ist.

	4 Wochen	3 Monate	6 Monate	12 Monate	24 Monate
Weitergabe in % innerhalb der nächsten...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Stellen Sie sich nun die gleichen Gegebenheiten vor wie in der vorhergehenden Frage, mit dem einzigen Unterschied, dass der Kostenanstieg nicht dauerhaft ist, sondern **temporär für 12 Monate** (siehe Abbildung).



Zu welchem Grad würden Sie die Kostenanstiege in diesem Szenario an Ihre Kunden weitergeben?

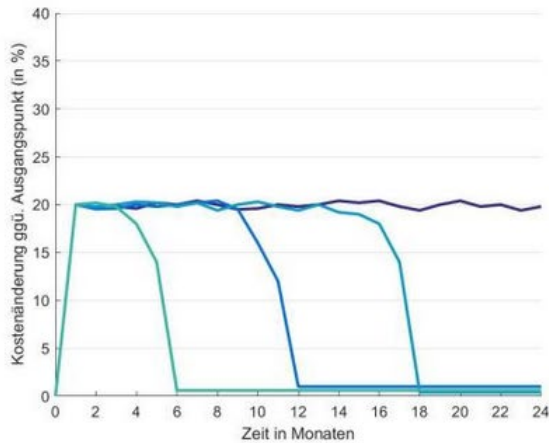
(keine Weitergabe = 0%, vollständige Weitergabe = 100%, überproportionale Weitergabe > 100%)

Geben Sie an, wie hoch die Weitergabe zu dem jeweiligen Zeitpunkt ist.

	4 Wochen	3 Monate	6 Monate	12 Monate
Weitergabe in % innerhalb der nächsten...	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Stellen Sie sich nun die gleichen Gegebenheiten vor wie in der vorhergehenden Frage, mit dem einzigen Unterschied, dass der Angebotsschock nicht dauerhaft sein muss, sondern die **Dauer** der Kostenerhöhung **ungewiss** ist (siehe Abbildung mit Beispielen für mögliche Preispfade).

Mit gleicher Wahrscheinlichkeit (~10 %) kann die Kostenerhöhung jeden Monat wieder zurückgehen.



Zu welchem Grad würden Sie die Kostenanstiege in diesem Szenario an Ihre Kunden weitergeben?

Nehmen Sie an, dass zu dem jeweiligen Zeitpunkt die Kostenerhöhung noch vorhanden ist.

(keine Weitergabe = 0%, vollständige Weitergabe = 100%, überproportionale Weitergabe > 100%)

	4 Wochen	3 Monate	6 Monate	12 Monate	24 Monate
Weitergabe in % innerhalb der nächsten..	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Zu welchem Grad würden Sie die Kostenanstiege weitergeben, wenn **nur Ihr Unternehmen** und **nicht die gesamte Branche** betroffen ist? Gehen Sie von den gleichen Rahmenbedingungen wie in den vorhergehenden Fragen aus. Bitte geben Sie die Preisweitergabe **nach 6 Monaten** in diesen Szenarien an.

Permanenter

Kostenanstieg (bei dem branchenweiten Kostenanstieg haben Sie % angegeben):

Temporärer

Kostenanstieg (bei dem branchenweiten Kostenanstieg haben Sie % angegeben):

Unsichere Dauer

(bei dem branchenweiten Kostenanstieg haben Sie % angegeben):

Anmerkungen:

Wurde aufgrund von starken Kostenerhöhungen das Produktangebot umstrukturiert?

ja

nein

nicht zutreffend

B.2 English translation

The last two years have been globally marked by rising prices. The following survey asks how your company approaches price setting generally as well as in the current situation. Your answers will help improve understanding of inflation dynamics and crucial decision-making factors.

1. How well-informed are you personally about your company's pricing strategies?

uninformed ○ ○ ○ ○ ○ well informed

2. What would be the minimum cost increase for energy, raw materials, and intermediate input goods (in %) for your company to adjust prices?

_____ %

3. By how much (in %) have input prices for energy, raw materials, and intermediate input goods increased in the last 2 years?

_____ %

(Rough estimate is sufficient)

4. To what extent have you already passed through the higher input prices for energy, raw materials, and intermediate input goods to your customers?

_____ %

(No pass-through = 0%, full pass-through= 100%, disproportionate pass-through> 100%)

5. What key factors limit your company's pricing flexibility? Please prioritize them.

Most important factor: _____

Second most important factor: _____

Third most important factor: _____

6. What was your company's annual net profit or loss as a percentage of net sales in 2018 and 2022?

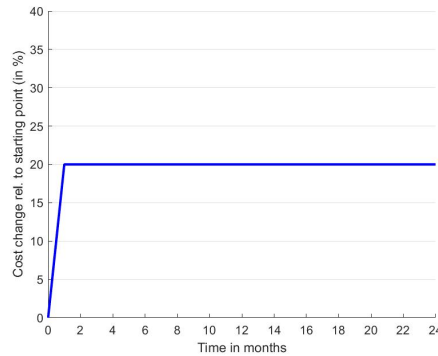
_____ %

(Rough estimate is sufficient)

7. Please now imagine the following hypothetical scenarios.

Suppose that the production costs for you and your competitors in the industry permanently increase by 20% due to a global supply shock (see figure). All other

factors, such as interest rates and fiscal policy measures, remain unchanged. Assume [good economic conditions]¹⁹ with normal capacity utilization for your company and the overall economy.

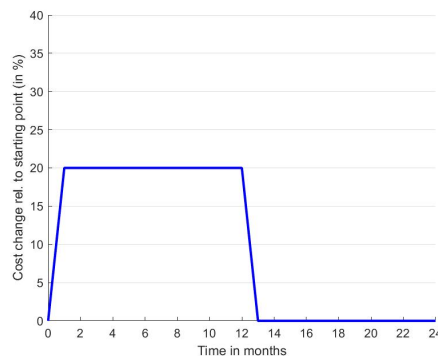


To what extent would you pass through the cost increase to your customers in this scenario? Indicate the level of pass-through at the respective point in time.

	4 weeks	3 months	6 months	12 months	24 months
Level of pass-through after ... (in %)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(No pass-through = 0%, full pass-through= 100%, disproportionate pass-through> 100%)

8. Now, imagine the same circumstances as in the previous question, with the only difference that the cost increase is not permanent but temporary for 12 months (see figure).



To what extent would you pass through the cost increase to your customers in this scenario? Indicate the level of pass-through at the respective point in time.

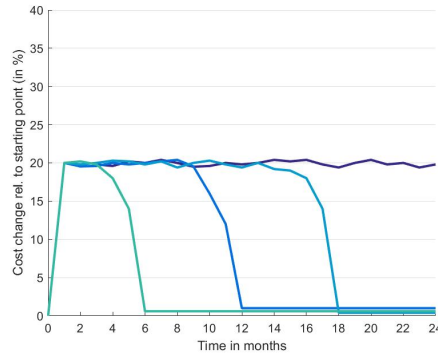
¹⁹Economic conditions vary across participants: good economic conditions vs. bad economic conditions.

4 weeks 3 months 6 months 12 months

Level of pass-through
after ... (in %)

(No pass-through = 0%, full pass-through= 100%, disproportionate pass-through> 100%)

9. Now, imagine the same circumstances as in the previous question, with the only difference that the cost increase is not necessarily permanent, but the duration of the cost increase is uncertain (see figure with examples of possible price paths). There is an equal probability (10%) that the cost increase could peak off every month.



To what extent would you pass through the cost increase to your customers in this scenario? Indicate the level of pass-through at the respective point in time. Assuming that at each respective point in time, the cost increase is still present.

4 weeks 3 months 6 months 12 months 24 months

Level of pass-through
after ... (in %)

(No pass-through = 0%, full pass-through= 100%, disproportionate pass-through> 100%)

10. To what extent would you pass through cost increases if only your company, and not the entire industry, is affected? Assuming the same conditions as in the previous questions, please indicate the degree of price pass-on after 6 months in these scenarios.

- Permanent cost increase (for the industry-wide increase you stated %): _____%
- Temporary cost increase (for the industry-wide increase you stated %): _____%

- Uncertain duration (for the industry-wide increase you stated %): _____%

11. Has your product portfolio been restructured due to significant cost increases?

Yes

No

Not applicable

12. If yes, in what manner?

Thank you for your participation!

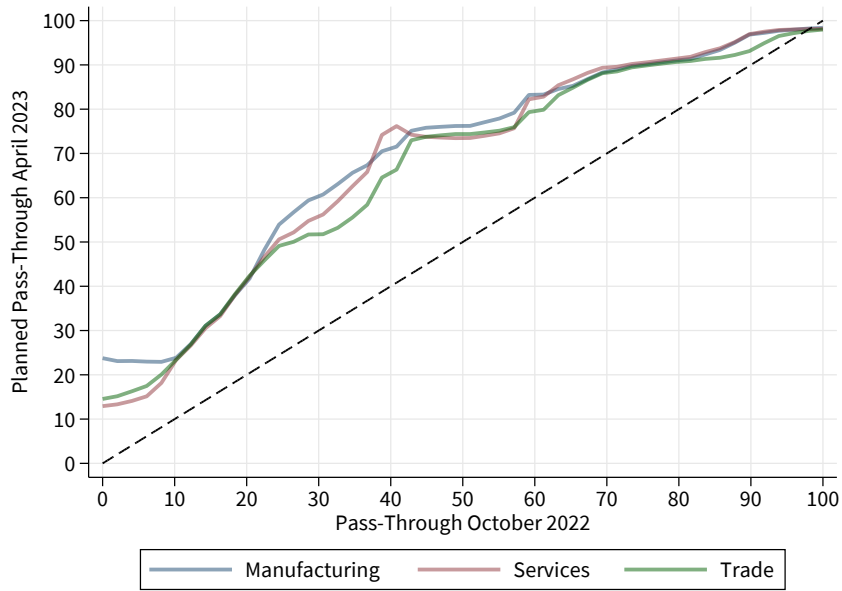
C Additional Empirical Results

Table C.1: Pass-through until 10/2022 and change in return on sales from 2019 to 2022

	(1)	(2)	(3)
Pass-Through until 10/22	0.013*** (0.0039)	0.013*** (0.0042)	0.043*** (0.0077)
Constant	-0.35 (0.25)	-0.36 (0.25)	-1.82*** (0.40)
Observations	908	908	908
R^2	0.014	0.071	.
Sector FE	No	2-Digit	No
IV (2SLS)	No	No	Yes, lagged PT

Notes: The table reports estimates from linear regressions of the firm-level change in return on sales from 2019 to 2022 (Δ profit_margin) on the pass-through of cost changes to sales prices until 10/2022. In Column (3), pass-through until 10/2022 is instrumented with the pass-through until 04/2022 and estimated with two-stage least squares. The F-statistic of the first stage is 318. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: ifo Institute's business survey.

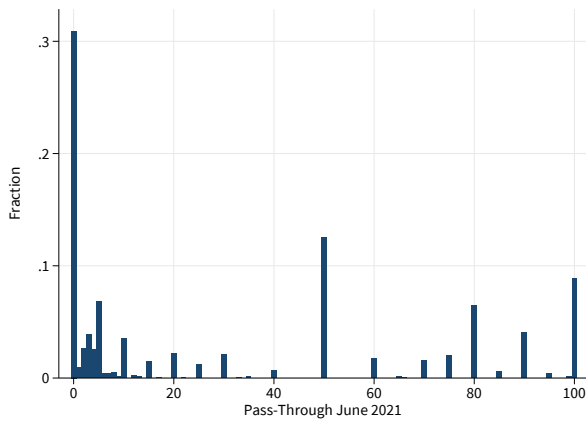
Figure C.1: Gradual increase of pass-through over time (sector split)



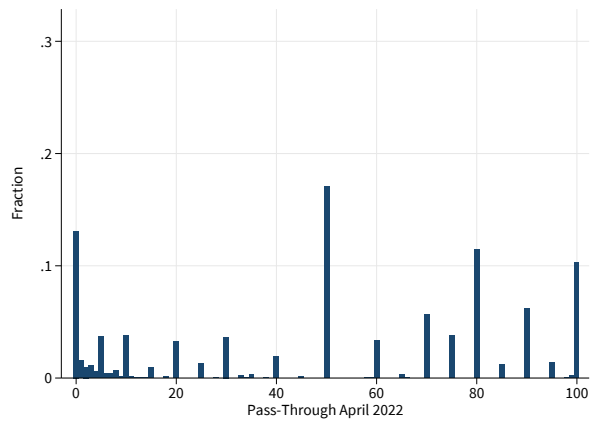
Notes: The figure shows the change in pass-through of cost changes to sales prices from October 2022 to April 2023, conditional on cost changes until October 2023 separately for the manufacturing sector, services sector, and trade sector. Source: ifo Institute's business survey.

Figure C.2: Heterogeneous pass-through across firms

(a) June 2021

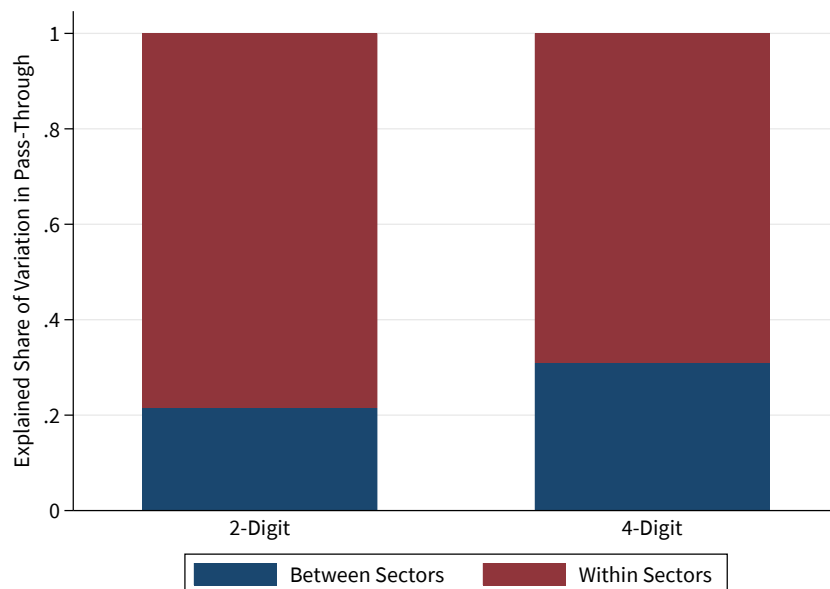


(b) April 2022



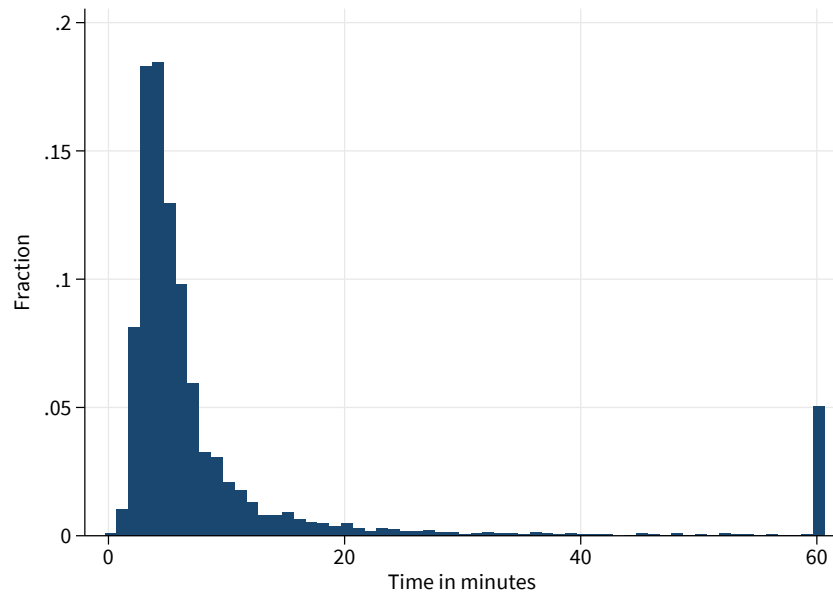
Notes: The figure shows the distribution of firm-level pass-through of cost changes to sales prices for October 2022. Source: ifo Institute's business survey.

Figure C.3: Cross-sectional variation in pass-through within and between sectors: Drop short time spent



Notes: The stacked bar figure shows the R^2 of sector fixed effects on 2-digit and 4-digit level of pass-through in October 2022 (blue). The remaining variation is within sectors (red). The decomposition is based on a subsample, where time spent on the survey is observable and time spent is above the 25th percentile. Source: ifo Institute's business survey.

Figure C.4: Cross-sectional histogram time spent



Notes: The figure shows the histogram of time spent on the survey in minutes (October 2022). The information on time spent is only observable for firms who participate online. Source: ifo Institute's business survey.

Table C.2: Pass-through until 06/2021: energy exposure and shock size

	(1)	(2)	(3)	(4)	(5)
Energy Exposure	0.014 (0.16)		-0.11 (0.16)	-0.34** (0.16)	-0.41** (0.19)
Cost Increase		0.20*** (0.046)	0.21*** (0.047)	0.11** (0.050)	0.12** (0.055)
state of business (VAS)	0.38*** (0.053)	0.37*** (0.052)	0.37*** (0.052)	0.33*** (0.053)	0.32*** (0.056)
expected business situation (VAS)	0.034 (0.061)	0.053 (0.061)	0.055 (0.061)	0.059 (0.060)	0.046 (0.063)
Constant	30.3*** (3.44)	25.5*** (3.41)	26.1*** (3.52)	31.4*** (3.60)	32.8*** (3.89)
Observations	949	949	949	949	949
R^2	0.063	0.082	0.083	0.142	0.232
Sector FE	No	No	No	2-Digit	4-Digit

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports estimates from linear regressions of the firm-level pass-through of cost changes to sales prices on energy intensity (measured as the share of energy costs in terms of revenues), and cost changes between March and May 2021. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: ifo Institute's business survey.

Table C.3: Pass-through until 06/2021 (extensive margin): energy exposure and shock size

	(1)	(2)	(3)	(4)	(5)
Energy Exposure	0.0022 (0.0022)		-0.00014 (0.0022)	-0.00098 (0.0022)	0.00083 (0.0025)
Cost Increase		0.0041*** (0.00062)	0.0041*** (0.00063)	0.0031*** (0.00068)	0.0022*** (0.00072)
state of business (VAS)	0.0034*** (0.00072)	0.0032*** (0.00070)	0.0032*** (0.00070)	0.0025*** (0.00072)	0.0019*** (0.00074)
expected business situation (VAS)	-0.00047 (0.00083)	-0.000047 (0.00081)	-0.000044 (0.00081)	0.000068 (0.00081)	-0.00026 (0.00082)
Constant	0.51*** (0.047)	0.43*** (0.046)	0.43*** (0.048)	0.49*** (0.049)	0.55*** (0.051)
Observations	952	952	952	952	952
R^2	0.026	0.068	0.068	0.118	0.263
Sector FE	No	No	No	2-Digit	4-Digit

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports estimates from linear regressions of the firm-level pass-through of cost changes to sales prices on energy intensity (measured as the share of energy costs in terms of revenues), and cost changes between March and May 2021. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: ifo Institute's business survey.

Table C.4: Pass-through until 06/2021 (intensive margin): energy exposure and shock size

	(1)	(2)	(3)	(4)	(5)
Energy Exposure	-0.38*		-0.65***	-0.92***	-0.89***
	(0.21)		(0.21)	(0.21)	(0.24)
Cost Increase		0.31***	0.34***	0.25***	0.23***
		(0.054)	(0.055)	(0.058)	(0.064)
state of business (VAS)	0.073	0.080	0.059	0.051	0.055
	(0.069)	(0.067)	(0.067)	(0.068)	(0.072)
expected business situation (VAS)	0.079	0.10	0.12	0.11	0.074
	(0.077)	(0.075)	(0.075)	(0.075)	(0.078)
Constant	41.9***	30.5***	33.8***	38.8***	40.4***
	(4.70)	(4.66)	(4.75)	(4.88)	(5.31)
Observations	651	651	651	651	651
R^2	0.010	0.053	0.067	0.116	0.230
Sector FE	No	No	No	2-Digit	4-Digit

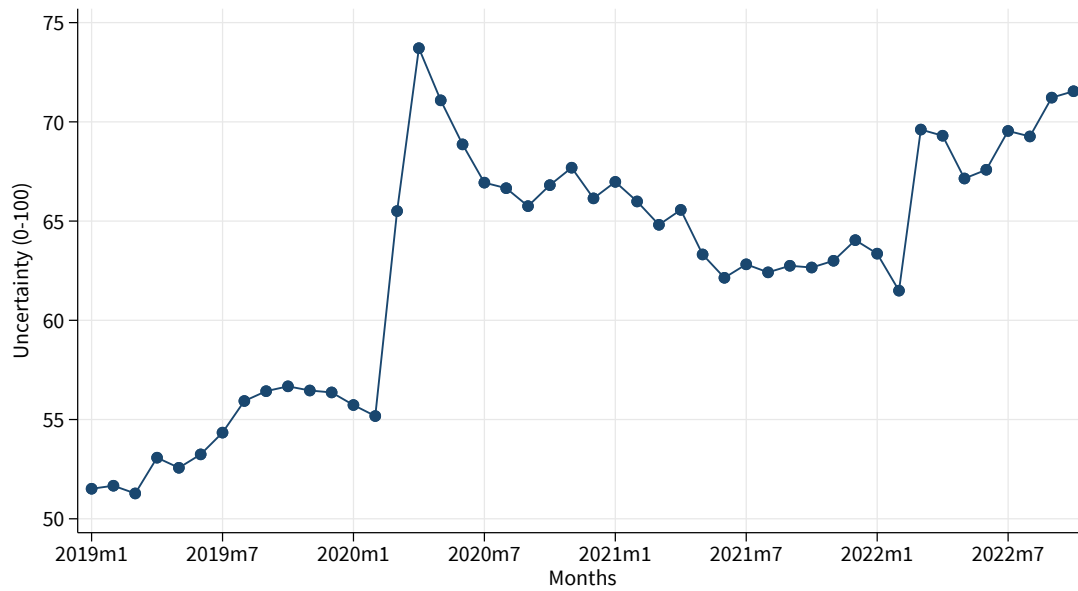
Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports estimates from linear regressions of the firm-level pass-through of cost changes to sales prices on energy intensity (measured as the share of energy costs in terms of revenues), and cost changes between March and May 2021. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: ifo Institute's business survey.

Figure C.5: Time-series of average firm-level uncertainty



Notes: The figure shows the time-series of average firm-level uncertainty, measured by a quantitative slider from 0-100 about the business uncertainty in the next six months. Source: ifo Institute's business survey.

Table C.5: Pass-through until 10/2022 and uncertainty

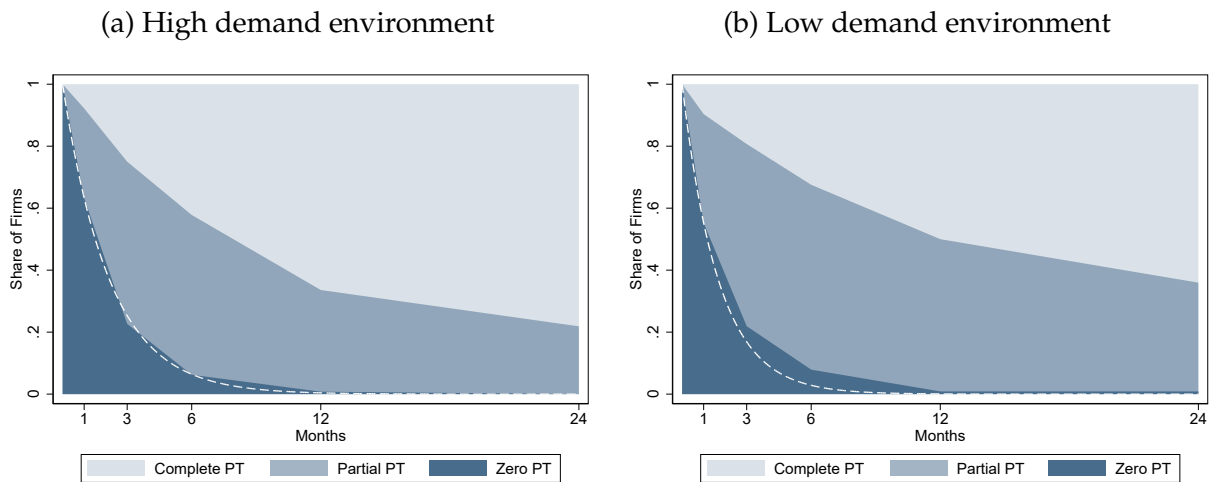
	(1)	(2)	(3)	(4)
Uncertainty	0.19*** (0.023)	0.19*** (0.024)	0.095*** (0.022)	0.10*** (0.022)
state of business (VAS)		0.26*** (0.024)	0.22*** (0.022)	0.19*** (0.023)
expected business situation (VAS)		-0.20*** (0.030)	-0.083*** (0.028)	-0.056** (0.028)
Constant	20.6*** (1.71)	14.9*** (2.56)	19.6*** (2.33)	19.3*** (2.33)
Observations	4644	4644	4644	4644
R^2	0.014	0.039	0.238	0.317
Sector FE	No	No	2-Digit	4-Digit

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The table reports estimates from linear regressions of the firm-level pass-through of cost changes to sales prices until 10/2022 on uncertainty. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Source: ifo Institute's business survey.

Figure C.6: Share of zero, incomplete, and complete pass-through (permanent cost shock)



Notes: The figure shows shares of zero pass-through, partial pass-through (between 0 and 100), and complete pass-through (equal or above 100) of cost-push shocks across horizons depending on the nature of the shock for the permanent shock scenario. Source: ifo Institute's management survey.

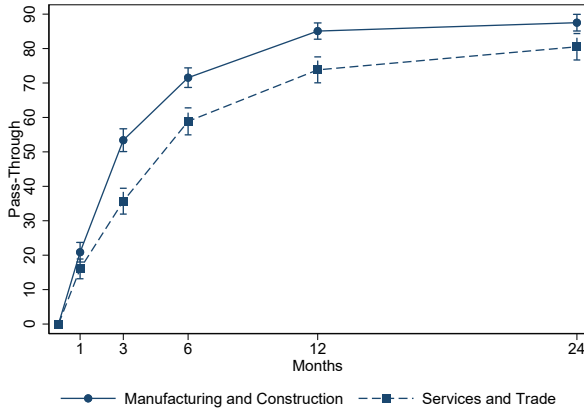
Table C.6: Factors limiting firm's price setting

Factor	%
Competition	41
Customers	16
Market	10
Contracts	9
Demand	3
Regulation	2
Fixed prices	2
Energy	2
Input prices	2
Employees	2
Others	11

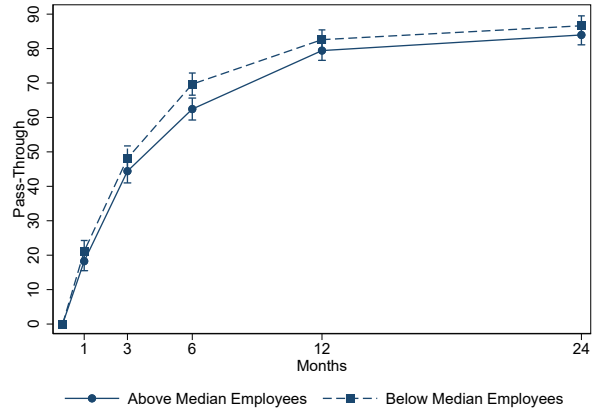
Notes: The table presents the share of respondents (in %), stating that the above factor limits the firm's price setting. The ten categories group similar answers. *Others* summarizes all factors stated once and cannot be assigned to the other categories. Source: ifo Institute's management survey.

Figure C.7: Heterogeneity of pass-through across sectors and firm size

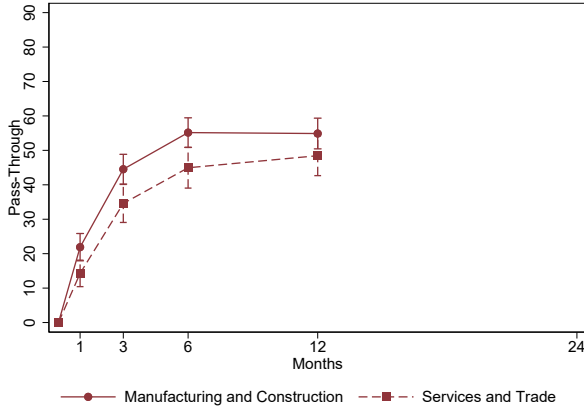
(a) Permanent shock by sector



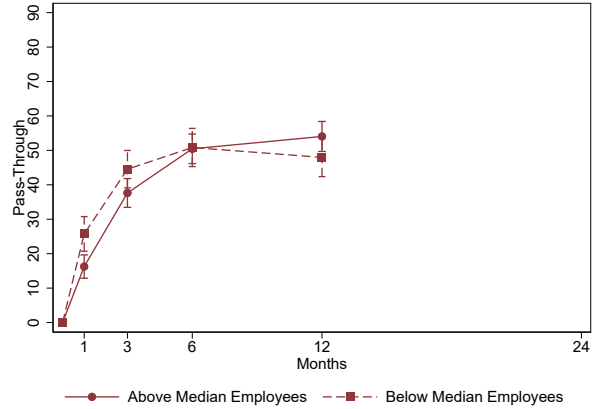
(b) Permanent shock by size



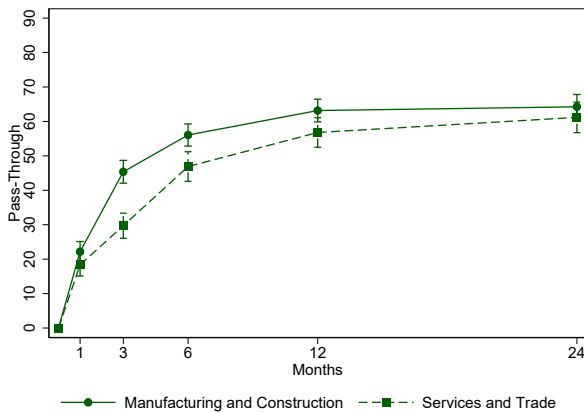
(c) Transitory shock by sector



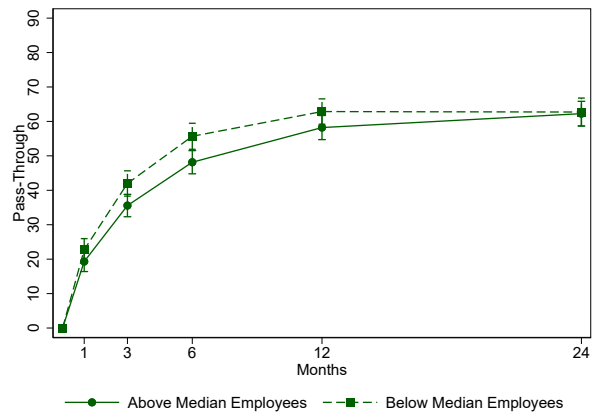
(d) Transitory shock by size



(e) Uncertain shock by sector

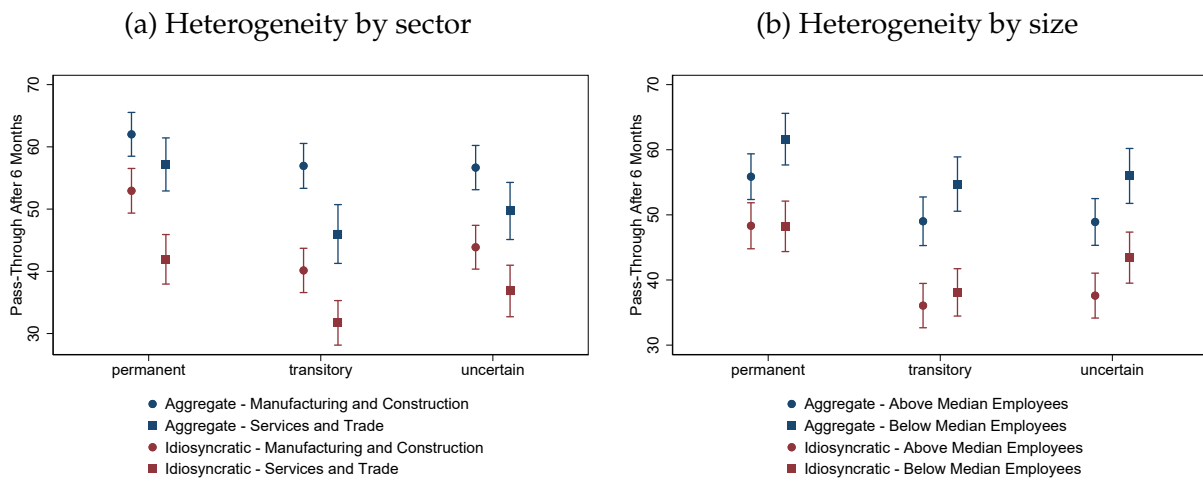


(f) Uncertain shock by size



Notes: The figure plots the pass-through of cost-push shocks across horizons, split by sector (left column) and size (right column). The rows refer to the nature of the shock, differing between permanent, transitory, and uncertain duration shocks, in blue, green, and red colors, respectively. The whiskers reflect the 68% confidence interval (one standard deviation). Source: ifo Institute's management survey.

Figure C.8: Agg. vs idiosyncratic pass-through across sectors and firm size



Notes: The figure shows the pass-through of permanent vs. idiosyncratic cost-push shocks after 6 months depending on the nature of the shock, differing between permanent, transitory, and uncertain duration shocks. The left column splits firms by sector and the right column by firm size. The whiskers reflect the 68% confidence interval (one standard deviation). Source: ifo Institute’s management survey.