Energy Prices and Inflation Expectations: Evidence from Households and Firms*

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Abstract

I investigate how households and firms adjust their inflation expectations when experiencing an energy price shock. Using monthly panel survey data and a difference-in-difference approach, I show that households increase their inflation expectations when they experience an increase in their personal electricity prices. This result is in line with households extrapolating their personal experience. As a result, their inflation forecasts become less accurate and diverge more from professional forecasts. By contrast, firms expect to shift part of the energy price hike to their own prices, but they do not extrapolate it to their inflation expectations. I find evidence that information frictions can explain the different behavior of households and firms.

Keywords: inflation expectations, households, firms, energy prices, extrapolation

JEL classification: D14, D22, D84, E31, Q41

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1 Introduction

Starting in 2021, there has been a rise in inflation around the world, to levels not seen in decades. In many European countries, the increase in inflation has largely been driven by rising energy prices, especially after the Russian invasion of Ukraine (see, for example, Bunn et al., 2022). At the same time, the inflation expectations of firms and households have also increased substantially. This has raised concerns about price-wage spirals and a potential de-anchoring of inflation expectations (see, for example, Powell, 2022). Therefore, it is important to understand the role energy prices play in the formation of inflation expectations. In this paper, I contribute to a better understanding of this question by analyzing how German households and firms form their inflation expectations during the recent rise in energy prices. Since both households and firms were affected by the rise in energy prices at a similar time, I can also study the differences in their expectation formation process when reacting to a significant real-world shock.

Unlike previous research that concentrated on aggregate energy price shocks, particularly in oil prices (Coibion and Gorodnichenko, 2015), I employ an alternative identification strategy that exploits a natural experiment at the micro level. I exploit variation in the timing of individual energy price changes based on contract tenure and duration which allows me to effectively control for other macroeconomic shocks that might be correlated with energy prices. Households or firms whose contracts have just ended will experience the impact of an aggregate price change immediately, whereas others will not experience the price change until their contract runs out. Therefore, I compare agents that experience a price change with agents that have not experienced a price change yet in a difference-in-difference setup. Assuming full-information rational expectations, agents that personally experience a price change should not react differently from those that did not experience a price change, since both form expectations for the overall economy simultaneously. Any differential reaction indicates a deviation from either full information or rationality in the expectation formation process. The data also allow me to contribute to the understanding of differences in the expectation formation of households and firms. To the best of my knowledge, this paper is the first to compare the effect of a real-world

shock on both households' and firms' expectations during the same time period using the same methodology and very comparable data sets.

For households, I use monthly data from the Bundesbank Online Panel: Households (BOP-HH) on whether and when they experienced a change in their electricity price. Using that information, households are grouped into a control group that did not experience a price change throughout the sample period and a treatment group that did experience a price change. This gives rise to a difference-in-difference setup which I estimate with the imputation method of Borusyak et al. (2023) to account for potential heterogeneous treatment effects. I find that households increase their inflation expectations differentially when faced with an increase in their electricity price. This experience effect is sizeable and particularly strong for large price increases, which have a lasting impact on inflation expectations. The effect is driven by uninformed households, proxied by their knowledge of past inflation, and those who have lower trust in the ECB. It is also concentrated in low-income households and rises with the share of income spent on electricity. These results are consistent with uninformed households using their personal experience as a source for aggregate expectation formation. The treatment and control groups exhibit parallel trends in their inflation expectations before the price increase and there is no evidence of selective recall inducing reverse causality. Similarly to Kuchler and Zafar (2019), I find that there is no spillover on expectations of other variables, such as interest rate expectations, income expectations, or house price expectations.

For firms, I employ an analogous difference-in-difference strategy using the Bundesbank Online Panel: Firms (BOP-F). The only difference is that firms are asked for price changes in any of their energy inputs (electricity, natural gas, oil, coal) instead of only their electricity price since the energy mix of firms is quite heterogeneous. Firms' own-price expectations do increase significantly when a firm is hit by a price increase as firms expect to shift some of the change in their input price to their own prices. They are also more likely to report problems with high production costs. However, there is no differential effect on firms' inflation expectations. Importantly, this does not mean that firms' expectations do not change when market prices change, but rather that both affected and

unaffected firms change their expectations similarly. Therefore, firms' expectation formation appears to be more consistent with full-information rational expectations. Thus, firms on average do not extrapolate firm-specific shocks to aggregate outcomes. Analogously to households, less informed firms, proxied by them not monitoring or targeting their energy use, exhibit extrapolation behavior similar to households.

Comparing households and firms shows that on average households extrapolate their personal experience, whereas firms do not extrapolate firm-specific shocks. Therefore, firms seem to have a more sophisticated expectation formation process than households. My results are consistent with households using their personal experience when forming expectations because they lack other sources of information as only less-informed households extrapolate their personal experience. Similarly, less-informed firms exhibit extrapolation behavior. This interpretation can explain why on average firms react differently from households as the average decision-maker within firms is likely better-informed than the average household. Finally, I show that households extrapolating their personal experience makes their inflation forecasts less accurate and causes them to deviate further from professional forecasters. Thus, households are over-extrapolating and do not use their personal experience to improve their forecasts.

This paper adds to several strands of the literature. First, it contributes to the literature that explores how households form their inflation expectations. Regarding the role of energy prices, there are only a few papers that are either correlative or using VAR methods. Coibion and Gorodnichenko (2015) show that aggregate oil prices correlate strongly with US households' inflation expectations and attribute this to households paying disproportional attention to oil prices due to their high visibility. Aastveit et al. (2023) show similar results using a structural VAR model of the global oil market. On the contrary, Binder (2018) and Kilian and Zhou (2022) argue that households do not overweight gas prices when forming their inflation expectations. In contrast to earlier papers, I adopt a quasi-experimental method, which can effectively control for other macroeconomic shocks that might be correlated with energy prices. Household inflation expectations react strongly to a rise in their personal electricity price. While previous

literature has emphasized the importance of prices that households frequently observe for their inflation expectation formation, such as in supermarkets (D'Acunto et al., 2021), I show that large shocks to energy prices also play a role. This result is consistent with Goldfayn-Frank and Wohlfart (2020), who show that a different large shock, the division of Germany, had a lasting impact on the inflation expectations of East Germans.

Second, I add to the literature on how households and firms form their inflation expectations more generally (see Weber et al. (2022) for an extensive review of the literature). There is mounting evidence that households do not form their inflation expectations rationally incorporating all prices in the economy. D'Acunto et al. (2021) show that frequency-weighted supermarket prices are a good predictor of households' inflation expectations arguing that the frequency and visibility of prices matter more than their expenditure share. Cavallo et al. (2017) provide evidence via survey experiments that households have weak priors when inflation is low and value supermarket prices over official statistics when forming their expectations. Life experiences, such as experiencing periods of high inflation, also play an important role (Malmendier and Nagel, 2016). Furthermore, Kuchler and Zafar (2019) show that households also extrapolate local house prices to their expectations about national house prices. There is less work on decision-makers in firms extrapolating from their experience. One exception is Andrade et al. (2022) who show that the dispersion in firm expectations is partly driven by industry conditions that firms extrapolate to their aggregate expectations. I add to this literature by highlighting that households extrapolate energy prices they personally experience and I provide evidence that firms do not exhibit this behavior on average.

Finally, I also contribute to a recent literature that studies differences in expectation formation between households and firms. Coibion et al. (2018) find that firms in New Zealand have similarly dispersed beliefs as households. On the contrary, several other papers find that firms' expectations are less dispersed than those of households in the case of French (Savignac et al., 2021), US (Candia et al., 2021), and German firms (Link et al., 2023). Link et al. (2023) also show that firms update their expectations less than households when they are provided with an expert forecast. To my knowledge, this

paper is the first to compare the expectation formation of households and firms when faced with an analogous real-world shock using the same empirical setting. Therefore, I can compare the formation of inflation expectations of households and firms directly. My results suggest that on average households extrapolate their personal experience to aggregate inflation expectations, whereas firms do not. My results also shed light on the reasons for the different expectation formation processes of households and firms. Well-informed households update their expectations very similarly to the average firm and less-informed act closer to the average household. Thus, differential information frictions appear to play an important role in explaining the differences in the expectation formation processes of households and firms.

2 Data & Institutional Background

I employ two survey data sets: the Bundesbank Online Panel Households (BOP-HH) and the Bundesbank Online Panel Firms (BOP-F). Using these two data sets ensures a high degree of comparability in the wording of the expectation questions (see de Bruin et al., 2012, for potential framing effects in the context of inflation expectations). This section describes both data sets.

2.1 Bundesbank Online Panel: Households

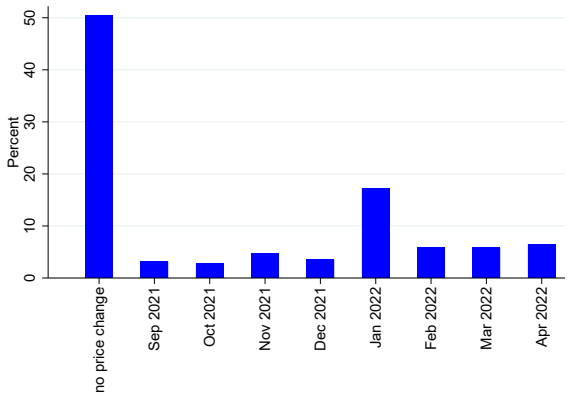
The BOP-HH is a monthly online survey representative of the German population that uses the Internet.[1] It includes between 2000 and 5000 respondents per wave and follows a rotating panel structure, in which respondents are interviewed for three consecutive months and then take a three-month break before returning to the sample for another three months. After two years in the sample, households leave the panel and are no longer interviewed to reduce learning effects (Kim and Binder, 2023). This data structure allows households to be tracked over time to identify changes in their inflation expectations.

I added several supplementary questions to the April 2022 wave of the BOP-HH. The

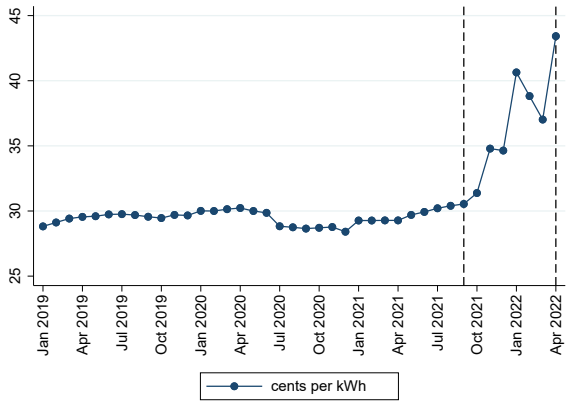
[1] See Beckmann and Schmidt (2020) for more details on the BOP-HH.

Figure 1: Price increases of households

(a) timing of price changes



(b) electricity prices

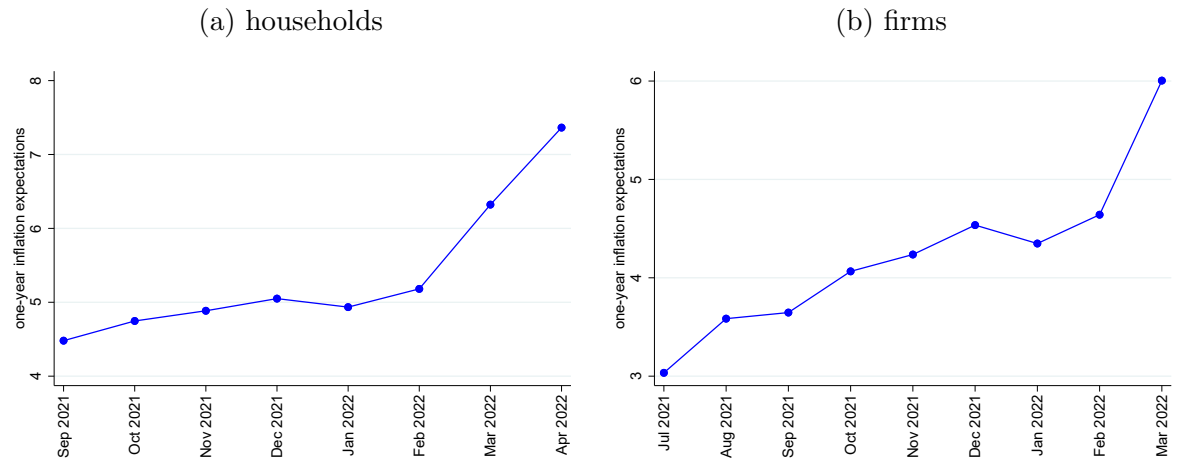


Source: BOP-HH, Verivox

first question asks respondents whether and in what month they experienced a change in their electricity price between September 2021 and March 2022.[2] Asking this question retrospectively ensures that households are not primed to think about energy prices when asked for their inflation expectations in previous survey waves. September 2021 is the start date of my sample since it coincides with a sharp increase in prices for new electricity contracts as data from Verivox, a large price comparison website, show (see Figure 1b). As Figure 1a shows, about 50% of households did not experience a price increase during these eight months. A likely reason is that they have long-term contracts with their electricity provider which temporarily shields them from price changes. Price changes are distributed relatively evenly over the sample period, except for the spike in January 2022. The next question asks for the size and sign of the price change households experienced. All households reporting a price decrease (3% of the sample) are removed from the sample. The remaining households report an average price increase of 13%. I also elicit the reasons for the price increase. Only 7% of households switched providers deliberately, which are dropped in a robustness check. The last question asks households about their monthly electricity spending. The exact wording of these questions and a translation are

[2] In Germany, electricity contracts are struck between the households and the provider which ensures that households are informed about them. In contrast, natural gas contracts are usually struck between the provider and the building owner, which leaves renters, more than half of the German population uninformed.

Figure 2: Inflation expectations of households and firms over time



Notes: This figure plots the average one-year inflation expectation of households and firms at the monthly frequency in the sample.

provided in Appendix C.1. The outcomes used are all part of the core questionnaire. The main outcome variable is households' 1-year inflation expectation, which is elicited as a point estimate in every wave from all respondents. The question asks specifically about inflation (or deflation) over the next 12 months instead of prices following the New York Fed Survey of Consumer Expectations to avoid priming individuals to think about specific prices they can easily recall. As Figure 2a shows, individuals' 1-year inflation expectations rose from 4.5% to over 7% during the sample period. The BOP-HH data also contain other quantitative expectation variables that are less frequently asked. These include quantitative 5-year and 10-year inflation expectations, interest rate expectations, house price expectations, and income expectations. Furthermore, I use qualitative expectations for the unemployment rate, economic growth rate, the stock market, rents, and taxes. All outcomes measured on categorical scales are transformed into z-scores using the respective sample mean and standard deviation.

Furthermore, I proxy how informed households are about inflation by taking the absolute deviation between their perception of inflation in the last year and the inflation rate for the same period. Households are classified as uninformed if their average deviation is above the sample median. Similarly, I define a dummy for households having below-median trust in the ECB. Importantly, I only use data on inflation perceptions and trust in the ECB before households are treated because both are potentially endoge-

nous variables. Finally, the BOP-HH also collects demographic and economic variables that include households' gender, age, household size, marital status, education level, employment status, local labor market, net household income, and liquid wealth. I only keep households that I observe for more than one wave in my final sample, which yields about 4300 unique households. In Appendix Table A.1, the source and construction of all household-level variables are presented in more detail. Summary statistics for all variables at the household level can be found in Appendix Table A.3.

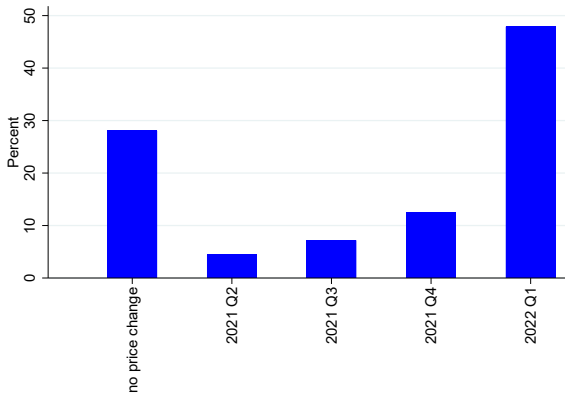
2.2 Bundesbank Online Panel: Firms

The BOP-F is a quarterly firm survey, which is representative of German firms along sectoral, size, and regional characteristics.[3] The median (average) firm has 11 (101) employees and a turnover of €0.40 million (€53.86 million). The survey covers firms from all sectors. About 17% are manufacturing firms, 13% are construction firms, 13% are retail firms, 51% are other service firms, and 6% are located in the remaining sectors (agriculture, forestry, mining, sewerage). A vast majority of the respondents, about 89%, are either the owner, executive director, or a board member and thus have significant decision-making power within the firm. Each quarterly sample contains almost 9000 firms and is split into three monthly waves, in which one-third of the firms are surveyed. The BOP-F follows a panel structure, such that each firm is surveyed every three months. I added several supplementary questions to the second quarter of 2022, which mirror the questions added to the BOP-HH. I ask whether and in which quarter the firm first experienced a significant change, defined as greater than 5%, in its energy input prices since the first quarter of 2021. Slightly less than 30% of the firms report no price changes during the sample period. The share of firms experiencing a price change increases over time and peaks in the first quarter of 2022, coinciding with the price shocks related to the Russian invasion of Ukraine (see Figure 3a). This pattern tracks the development of market prices for natural gas, electricity, coal, and oil depicted in Figure 3b. The heterogeneity in the increase in the different energy inputs constitutes another source of

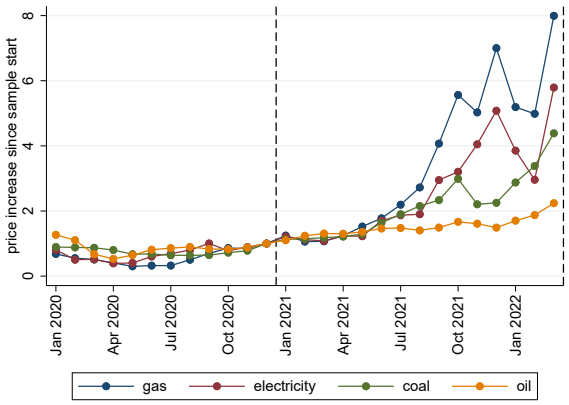
[3] See Boddin et al. (2022) for more details on the sampling and structure of the survey.

Figure 3: Price increases of firms

(a) timing of price changes



(b) energy prices



Source: BOP-F, ICE, SMARD, FRED Notes: The prices in panel (b) are all normalized to January 2021.

variation. I also ask firms for their energy mix, meaning the share of energy expenditures for each of these inputs. Next, firms are asked about the sign and magnitude of the price change. Again, I drop all firms that experienced a price decrease (4% of the sample). The average price increase experienced by the firms during the sample period is 36%. The exact wording of these questions and a translation are provided in Appendix C.2.

The main firm outcomes are firms' quantitative inflation and own-price expectations for the next twelve months. Both expectations are elicited as a point estimate in every wave from all firms. The text of the question is analogous to the BOP-HH question on inflation expectations, ensuring their comparability. As Figure 2b shows, firms' 1-year inflation expectations doubled from 3% to 6% during the sample period. Firms' own-price expectations allow me to test how much of the energy price increase firms expect to shift onto their own prices. I also test whether firms were hit with a different confounding shock at the same time. To that end, I use a battery of qualitative questions regarding potential problems firms report to face. In particular, they are asked about the following issues: production costs, availability of personnel, regulations, Covid-19 restrictions, customer demand, competitive pressures, credit supply, or supply chain disruptions. All outcomes measured on categorical scales are transformed into z-scores using the respective sample mean and standard deviation.

Similar to households, I also divide firms into being informed and uninformed. Firms

are classified as informed if they either explicitly monitor or target their energy use. Firms with 50 or fewer employees are classified as small firms. Finally, I only keep firms that I observe for more than one wave in my final sample, which yields about 5900 unique firms. In Appendix Table A.2, the source and construction of all firm-level variables are detailed. Summary statistics for all variables at the firm level can be found in Appendix Table A.4.

3 Empirical strategy

In this section, I describe my empirical strategy to identify the effect of experiencing an increase in energy prices. I employ analogous strategies for households and firms, which I describe in turn. For both strategies, the identification comes from a comparison over time of households (firms) that have already experienced a price increase to households (firms) that have not experienced a price increase yet. Importantly, I control for aggregate time trends so that I only compare households (firms) at the same time. This ensures that both the macroeconomic environment, such as, for example, aggregate inflation and growth, are the same for units in the treatment and control group. Therefore, the only differential change over time between treatment and control units is having experienced an actual energy price increase. For households, the following equation is estimated:

$$y_{it} = \alpha_i + \gamma_t + \beta Treat_i \cdot Post_{it} + \varepsilon_{it} \tag{1}$$

where y_{it} is the outcome of household i in month t, α_i represent household fixed effects, controlling for all time-invariant household characteristics, γ_t are month fixed effects, and ε_{it} is the error term clustered at the household level. $Treat_i$ is a dummy taking the value one if household i experienced a price increase over my sample period and $Post_{it}$ is a dummy taking the value one after the price increase of household i. The coefficient β identifies the causal effect of an increase in electricity prices for households.

The estimation equation on the firm level is displayed below:

$$y_{it} = \alpha_i + \gamma_{st} + \delta_{et} + \beta Treat_i \cdot Post_{it} + \varepsilon_{it} \tag{2}$$

where y_{it} is the outcome of firm i in month t, α_i are firm fixed effects, which control for all time-invariant firm characteristics, γ_{st} are 1-digit NACE sector-month fixed effects, which control for all sector-specific shocks, and ε_{it} is the error term which I cluster at the firm level. δ_{et} are the energy expenditure shares of all energy inputs $e \in E =$ {oil, natural gas, coal, electricity} separately interacted with month fixed effects. These fixed effects ensure that only firms with a similar energy input mix are compared to each other. $Treat_i$ and $Post_{it}$ are defined analogously to the household specification.

There is a recent literature showing that difference-in-difference setups that exploit differential treatment timing can be biased by treatment effect heterogeneity (Goodman-Bacon, 2021; Borusyak et al., 2023). Therefore, I employ the imputation estimator developed of Borusyak et al. (2023) which consistently identifies the treatment effect even in the presence of treatment effect heterogeneity. The estimation follows a three-step procedure. First, one estimates all fixed effects, i.e. $\{\alpha_i, \gamma_t\}$ for households and $\{\alpha_i, \gamma_{st}, \delta_{et}\}$ for firms, on the sample of untreated and not-yet-treated units. Second, I impute the estimated fixed effects for the treated units. Third, I compute the difference between the actual outcomes for the treated units and their implied counterfactual obtained through the imputation procedure and take the overall average to get the average treatment effect. Taking the average at different points in time relative to treatment then identifies dynamic effects.[4] I also show the results of a standard two-way fixed effect estimation and scale with the increase in the price to estimate the continuous effect.

The identification assumption of my empirical strategy is that the treatment and control units would have been on parallel trends absent the price increase. That is, if a household had not experienced a price increase, its inflation expectation would have changed similarly to a household that has not experienced a price increase yet. I test

[4] Since each firm is sampled every three months, I identify the effects for firms at the quarterly frequency.

Table 1: Effect of electricity price increase on households' inflation expectations

	(1) 1-year inflation expectation	(2) 1-year inflation expectation	(3) 1-year inflation expectation	(4) 1-year inflation expectation
price increase x post	0.186***	0.186***		
	(0.072)	(0.069)		
100% price increase x post			1.438***	
			(0.438)	
below-median price increase x post				0.013
				(0.084)
above-median price increase x post				0.379***
				(0.107)
estimator	BJS	TWFE	TWFE	BJS
household FE	yes	yes	yes	yes
month FE	yes	yes	yes	yes
mean	5.532	5.518	5.485	5.532
N	13575	14382	14116	13565
# cluster	3860	4192	4112	3860

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on the estimation of equation (1) using the imputation method of Borusyak et al. (2023) (BJS) or a standard two-way fixed model (TWFE).

this assumption with the placebo test suggested by Borusyak et al. (2023), which is run on the sample of not-(yet)-treated units and estimates a placebo trend before treatment. The pre-trend coefficients are normalized to the period directly preceding treatment.

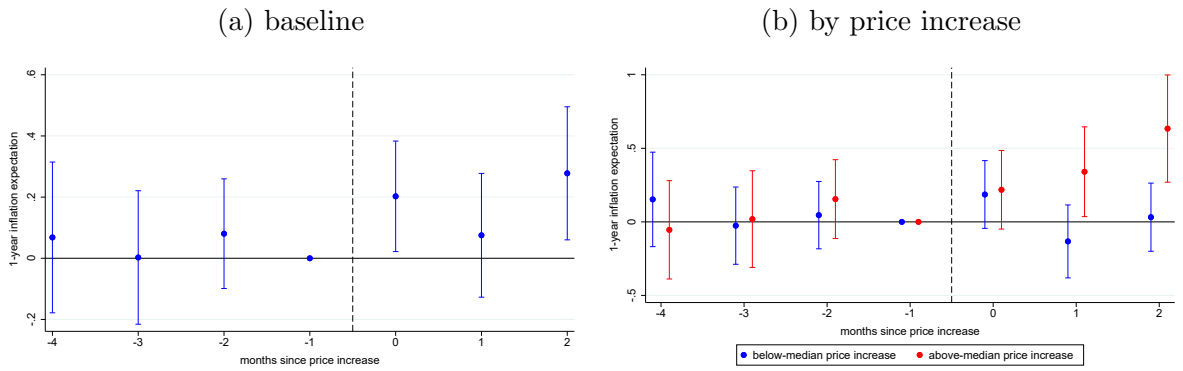
4 Results

This section presents the results for both households and firms, in turn. Furthermore, I discuss possible threats to identification and present several robustness tests. Finally, I compare the results for households and firms and discuss their implications.

4.1 Household Expectations

Table 1 presents the baseline results of estimating equation (1). Households increase their inflation expectations by 0.186 percentage points ($p < 0.01$) after they have experienced a price increase compared to other households that have not yet experienced a price increase. The point estimate is virtually the same when using a standard difference-in-difference estimator (see column (2) of Table 1). To put this estimate into perspective, when scaling the treatment dummy with the price increase, a 100% price increase causes inflation expectations to increase by 1.438 percentage points. In column (4), the effect is estimated for below- or above-median price increases separately. The results are clearly

Figure 4: Event study of electricity price increases on households' inflation expectations

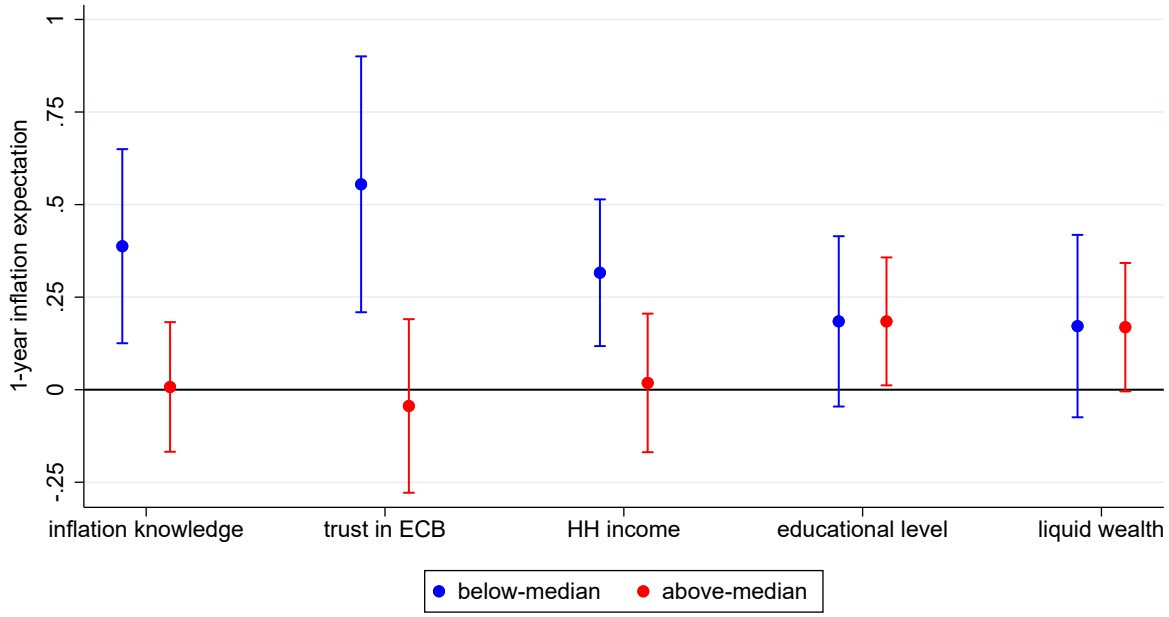


Notes: Panel (a) of this figure plots point estimates and 95% confidence bands from estimating a dynamic version of equation (1) using the imputation method of Borusyak et al. (2023). Panel (b) of this figure plots point estimates and 95% confidence bands from estimating a dynamic version of equation (1), keeping only below or above median price increases in the sample, using the imputation method of Borusyak et al. (2023). The pre-trends are re-normalized to the month before treatment happens.

driven by large price increases, which lead to a statistically significant increase in inflation expectations of 0.371. On the contrary, small price increases do not have a statistically significant effect. These results are inconsistent with models of full-information rational expectations since both households that are subject to the price increase and those who are not should have the same information set in case of perfect information. Thus, it constitutes evidence that households extrapolate their personal experience to macroeconomic variables.

Next, I inspect the dynamics of inflation expectations before and after a price increase to test the parallel trends assumption. Figure 4a shows that in the months preceding a price increase, the treatment and control group exhibited similar trends in inflation expectations. In the month of the price increase, there is an immediate increase in inflation expectations, which is muted one month after and becomes larger and significant three months afterward. The somewhat surprising pattern can be explained if one considers small and large price increases separately. As Figure 4b shows, it is driven by small price increases that only have an effect in the month of the price increase and then revert back to zero. In contrast, large price increases lead to a persistent increase in inflation expectations. This temporal pattern strongly suggests that large increases in electricity prices cause households' inflation expectations to increase. However, one potential threat to this interpretation arises from the possibility of reverse causality as households are asked to recall whether and when the price increase happened. This could potentially cause

Figure 5: Effect of electricity price increase on households' inflation expectations: heterogeneous effects



Notes: This figure plots point estimates and 95% confidence bands from the estimation of equation (1) using the imputation method of Borusyak et al. (2023) in different subsamples. The groups are always divided at the median value. For education, respondents with a higher education entrance qualification (*Fachhochschule* or *Abitur*) are classified as above the median. Inflation knowledge and trust in the ECB are measured only before treatment occurs. Point estimates are displayed in Appendix Table B.3.

only households with high inflation expectations to recall the price increase causing a selection effect. I test for this possibility by regressing the eventual treatment status, i.e. a dummy for eventually experiencing a price increase, on ex-ante inflation expectations. If households with high inflation expectations select into treatment, their ex-ante inflation expectations should predict the treatment status. As Appendix Table B.1 shows, ex-ante inflation expectations, as well as other ex-ante expectations, such as house price, interest rate or income expectations, and a host of demographic variables, cannot predict the treatment status.

I conduct several additional robustness checks to ensure the validity of the baseline results. First, I drop all households that stated that their price increase was due to them switching their provider. Second, I use Huber regressions as an alternative way to control for outliers. Third, I drop households that interrupted the survey to account for them potentially not paying sufficient attention to the survey. Fourth, I include fine-grained local labor market times month fixed effects to account for differential regional trends

in electricity prices as well as other economic variables.[5] Finally, I account for several potentially time-varying demographic control variables, including dummies for marital status, household size, age, and several time-varying employment and income control variables. As Appendix Table B.2 shows, none of these tests change the results discussed above.

To investigate the mechanism of the baseline result, I perform heterogeneity analysis along several dimensions. The extrapolation behavior of households could be the result of incomplete information which leads households to rely on personal experience as an alternative source of information. To test this hypothesis, I classify households as uninformed when their perception error of past inflation before treatment is above the sample median. As Figure 5 shows, the effect is almost entirely driven by uninformed households. One possible reason for households being less informed is a lack of trust in the central bank that is responsible for keeping inflation under control. Indeed, households that have below-median trust in the ECB before treatment exhibit significantly larger extrapolation behavior. Furthermore, if households are extrapolating from electricity price increases, this effect should be concentrated among households that spend a large share of their income on electricity. As one can see in Appendix Figure B.1, there is indeed a positive relationship between the share of income spent on electricity and extrapolation behavior. Since low-income households tend to spend a larger share of their income on electricity, are less informed about inflation, and have lower trust in the ECB, the overall effect is almost exclusively driven by below-median income households (see Figure 5).[6] In contrast, there is no evidence that households with a higher level of education are driving the effect. Respondents with varying education levels, those with and without a higher education entrance qualification, show virtually the same response. The same holds for households with below- and above-median levels of liquid wealth. Overall, the heterogeneity analysis is consistent with information frictions playing an important role in explaining the extrapolation behavior.

[5] In the sample, 221 of the 223 local labor markets in Germany are represented.

[6] As one can see in Appendix Table B.3, the heterogeneous effects by income, trust in the ECB, and inflation knowledge are all significantly different at the 5% level.

Table 2: Effect of energy price increase on firms' own-price and inflation expectations

	(1) 1-year own-price expectation	(2) 1-year own-price expectation	(3) 1-year own-price expectation	(4) 1-year inflation expectation	(5) 1-year inflation expectation	(6) 1-year inflation expectation
price increase x post	0.585***	0.483***	0.410**	0.004	0.012	0.006
	(0.171)	(0.177)	(0.192)	(0.053)	(0.055)	(0.058)
firm FE	yes	yes	yes	yes	yes	yes
month FE	yes			yes		
sector x month FE		yes	yes		yes	yes
energy share x month FE			yes			yes
mean	5.662	5.620	5.708	4.324	4.314	4.327
N	10613	10169	9534	8402	8042	7530
# cluster	4619	4444	4148	4124	3959	3690

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the firm level are in parenthesis. The regression results are based on estimating equation (2) using the imputation method of Borusyak et al. (2023).

I also test whether an increase in electricity prices affects long-term inflation expectations and other economic expectations. Appendix Table B.4 shows that the coefficients for the 5-year and 10-year inflation expectations are positive and sizeable, but not statistically significant. Moreover, I do not find evidence of an effect on households' quantitative expectations of interest rates, house prices, or income. Finally, there is no effect on qualitative expectations of the aggregate growth rate, the stock market, the unemployment rate, rents, or tax rates (see Appendix Table B.4).

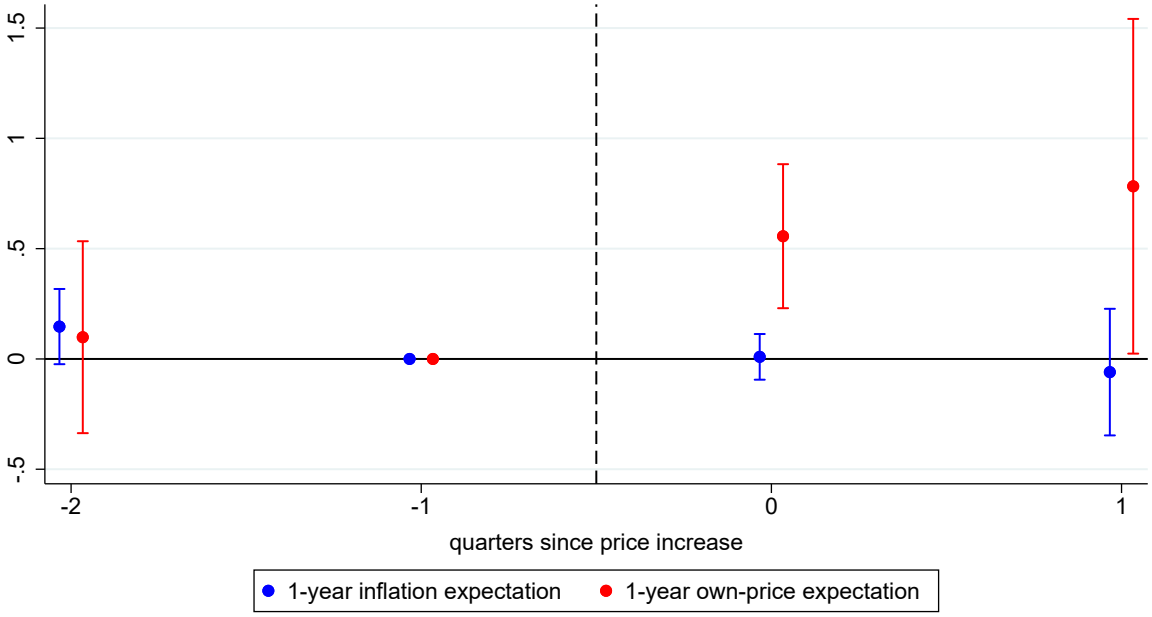
4.2 Firm Expectations

In this section, I turn to the firm-level results. First, I test whether firms expect to shift some of the increase in their energy input prices into their own prices. As Table 2 shows, firms expect to increase their own prices by 0.59 percentage points ($p < 0.01$) in response to a firm-specific energy price increase.[7] This holds even when including sector-month and energy expenditure share-month fixed effects such that the remaining identifying variation only stems from the differential timing of energy contracts running out. This result demonstrates the energy price increase constitutes a sizeable cost shock that is large enough to impact pricing decisions. Importantly, this is only a partial equilibrium result over the medium term and can not be easily used to quantify the pass-through of energy price shocks on price plans.[8] In contrast to their own prices, firms that experience an

[7] Relatedly, Dörrenberg et al. (2023) show that German firms also update their own price plans when they are informed about general energy price developments.

[8] For example, if all firms were price-takers and thus changed their prices simultaneously irrespective of their treatment status, the difference-in-difference approach would not pick this general equilibrium effect up. Also, it measures the price plans only for six months after the shock which means that firms that are not flexible price setters might react even later than that.

Figure 6: Effect of energy price increase on firm expectations

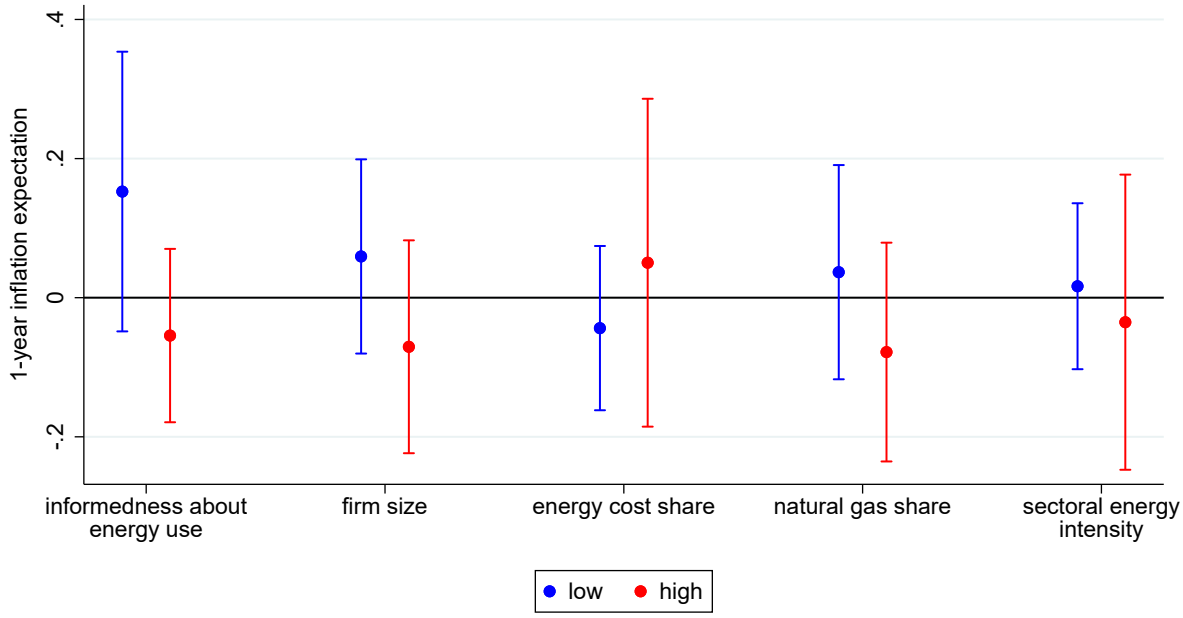


Notes: This figure plots point estimates and 95% confidence bands by estimating a dynamic version of equation (2) using the imputation method of Borusyak et al. (2023). The pre-trends are normalized to the quarter before treatment happens.

energy price shock do not differentially adjust their inflation expectations for the whole economy. The point estimate is close to zero and consistent across all specifications. Importantly, this result does not mean that firms do not adjust their inflation expectations to overall energy market prices. In contrast, both firms that experienced a price shock and those that did not change their expectations similarly. This result is in stark contrast to the average reaction of households. The fact that firms adjust their own and aggregate expectations differentially shows that they are not extrapolating firm-specific shocks to the overall economy. This result complements the findings of Andrade et al. (2022) showing that French firms extrapolate industry conditions to the aggregate level. The difference in these findings could be due Andrade et al. (2022) analyzing a low-inflation environment, whereas my sample period is characterized by high inflation. Consistent with this, Weber et al. (2023a) show that agents are more attentive during periods of high inflation.

As a robustness check, I test whether the increase in energy prices is confounded by other potential shocks at the firm level. In Appendix Table B.5, I show that firms affected by an increase in energy prices do not differently report having problems with the

Figure 7: Effect of energy price increase on firms' inflation expectations: heterogeneous effects



Notes: This figure plots point estimates and 95% confidence bands from estimating equation (2) using the imputation method of Borusyak et al. (2023) on different sub-samples. Firms are split at the sample media with respect to the energy cost share and natural gas expenditure share. Manufacturing & mining firms are classified as sectors with high energy intensity, and firms with 50 or fewer employees are classified as small firms. Respondents are classified as being informed about energy use if they indicate that their firm either monitors or explicitly targets their energy use. The point estimates are displayed in Appendix Table B.7.

availability of personnel, regulations, corona restrictions, customer demand, competitive pressures, credit supply, or supply chains. However, as expected, I find that there is a 0.061 standard deviation increase in firms reporting problems with production costs. This implies that there was no other firm-level shock correlated with the price shock. Furthermore, as Appendix Table B.6 shows, restricting the sample to either small or large price increases, using a standard two-way fixed effects estimator, or a continuous treatment variable does not yield significant results either. I test the parallel trends assumption underlying my difference-in-difference setup by conducting placebo tests and estimating dynamic effects. Figure 6 shows that treatment and control firms were on similar trends with respect to their own-price and inflation expectations before the price increase. Only after the price increase do own-price expectations jump upward and stay higher for two quarters afterward.

Similarly to households, decision-makers in firms can also be heterogeneously informed about their firm's energy consumption and aggregate energy prices. Firms that report

Table 3: Effect of energy price increase on households' forecast errors and deviations from professionals

	(1) absolute forecast error	(2) absolute forecast error: personal inflation	(3) absolute difference to professional forecasters
price increase x post	0.058**	0.060**	0.059**
	(0.029)	(0.027)	(0.025)
household FE	yes	yes	yes
month FE	yes	yes	yes
z-score	yes	yes	yes
mean	0.000	0.000	0.000
N	13575	13175	13575
# cluster	3860	3703	3860

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on the estimation of equation (1) using the imputation method of Borusyak et al. (2023). Z-scores are computed by subtracting the sample mean and dividing by the standard deviation.

explicitly monitoring or targeting their energy use are classified as informed, and all other firms are coded as uninformed. Analogously to households, Figure 7 shows that less informed firms react stronger to energy price shocks, but the difference is only significant at the 10% level (see Appendix Table B.7). This is likely due to the low number of uniformed firms, which make up only one-third of the sample. There is a similar but significantly smaller difference between small and large firms, with small firms acting more like households. In contrast, I do not find any systematic difference with respect to firms' energy intensity measured by their energy expenditure share, natural gas expenditure share, or sector. For all of these measures, I do not find a difference between more or less energy-intensive firms (see Figure 7).

4.3 Discussion

The results presented in Sections 4.1 and 4.2 show that households and firms form their inflation expectations differently when they face a similar real-world shock, namely an increase in the price of energy. Households adjust their inflation expectations upward, whereas firms do not extrapolate firm-specific shocks to the overall economy. One reason households would use their personal experience to form their expectations is that they lack other sources of information. This interpretation is consistent with the heterogeneity analyses presented in Figures 5 and 7. Informed households, proxied by their knowledge about past inflation, do not extrapolate their personal experience, whereas uninformed

households do extrapolate their personal experience. A similar result also holds for high-income households, who tend to be better informed than low-income households. Consistent with this, decision-makers in firms that are less informed, proxied by their monitoring of energy use, act more similarly to households (see Figure 7). These heterogeneity results explain the differential response of households and firms. Decision-makers within firms who respond to the survey are likely disproportionally rich and well-informed compared to the general public. Therefore, they respond similarly to households that have high incomes and are well-informed. This result is consistent with the findings of Link et al. (2023) who show that the expectations of well-informed households, proxied by cognitive skill, age, and financial wealth, are very similar to those of firms. Given that less-informed households seem to rely on their experience to form their expectations, the question remains whether their personal experience contains valuable information. Are households improving their expectation accuracy through the use of personal experience?

To answer this question, I compare households' expectations to both realized future outcomes and the expectations of professional forecasters at the same time. I compute both the absolute difference between the 1-year inflation expectations of households and realized CPI inflation over the same time period. To test whether households are misunderstanding aggregate inflation for their personal inflation experience, I also compute a personalized inflation measure (Weber et al., 2023b; Dietrich et al., 2022).[9] As a measure of professional forecasts, I rely on the consensus 1-year-inflation forecast for Germany from Consensus Economics, which is the mean of expert forecasts of banks, investment firms, and economic think tanks. I use the absolute difference between households' 1-year inflation expectations and the consensus forecast at the same time as a measure of distance to professional forecasters. As Table 3 shows, forecast errors increase significantly by 0.058 standard deviations after they were hit by an energy price shock. Given that energy price increases lead households to increase their inflation expectations, this implies that they become too pessimistic about future inflation. This is not driven by households confusing aggregate inflation with their personal inflation as forecast errors

[9] See Appendix Table A.1 for a detailed description of how personal inflation is constructed.

increase similarly when one compares households' expectations to their personal inflation. Finally, households are not only making significantly larger mistakes when compared to ex-post realized data but also when compared to ex-ante forecasts by professionals.[10]

Thus, households not only become less accurate in their forecasts compared to realized overall and personalized inflation but are also deviating more from the forecasts of professional forecasters. Therefore, it seems like households extrapolating their personal experience are not incorporating the new information in a way that improves their forecasts. In contrast, firms' forecast errors and forecast differences to professionals are unaffected by energy price increases, as one would expect since they did not adjust the expectations on average (see Appendix Table B.9).

5 Conclusion

I investigate how households and firms form their inflation expectations when experiencing an increase in their energy prices. Using a novel approach, I combine monthly survey data with a difference-in-difference setup to control for aggregate trends and only exploit the differential timing of energy price shocks. I show that households increase their inflation expectations significantly when they experience an increase in their electricity prices. This result is inconsistent with full-information rational expectations but can be rationalized by households extrapolating energy prices to the aggregate level. In line with models that feature information frictions, the effect is driven by households who are less informed about inflation. Moreover, due to extrapolation, households' expectations diverge more from realizations as well as expert forecasts.

Contrary to households, the average firm does not adjust its inflation expectations differentially when being hit by energy price increases. However, firms do increase their own-price expectations significantly implying that firms can differentiate between firm-level shocks and aggregate shocks and do not simply extrapolate idiosyncratic firm-specific shocks to the aggregate economy. The only group of firms that act similarly to house-

[10] All results are robust using to using the squared difference which puts more weight on large deviations than the absolute difference (see Appendix Table B.8).

holds are firms that are uninformed about their energy use. There are also groups of households that act quite similarly to firms. In particular, well-informed, high-income households also do not extrapolate their personal experience. Therefore, one potential reason for the differences between households and firms is that decision-makers in firms are more likely to be well-informed and have higher incomes than the general population. My results have important implications for modeling choices in macroeconomics. In particular, they suggest modeling varying degrees of information frictions with households facing more frictions than firms. This implies that households take longer to incorporate new information and adjust more slowly to macroeconomic or policy shocks.

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A Data, Sources, and Summary Statistics

Table A.1: Definition of variables and data sources: households

	description	source
1-year inflation expectation	Point estimate of the 1-year inflation rate expectation trimmed at the 2nd and 98th percentile to account for outliers. The question asks specifically about inflation (or deflation) over the next 12 months instead of prices following the New York Fed Survey of Consumer Expectations to avoid priming individuals to think about specific prices they can easily recall.	BOP-HH waves 21 - 28
5-year inflation expectation	Point estimate of the 5-year inflation rate expectation trimmed at the 2nd and 98th percentile to account for outliers. Every wave, only half of the sample is asked the question.	BOP-HH waves 21 - 28
10-year inflation expectation	Point estimate of the 10-year inflation rate expectation trimmed at the 2nd and 98th percentile to account for outliers. Every wave, only half of the sample is asked the question.	BOP-HH waves 21 - 28
1-year interest rate expectation	Point estimate of the 1-year expectation of the average interest rate on savings accounts trimmed at the second and 98th percentile to account for outliers.	BOP-HH waves 21 - 23; 26 - 28
1-year house price expectation	Point estimate of the 1-year expectation of the percent change in house prices trimmed at the second and 98th percentile to account for outliers.	BOP-HH waves 21 - 28
1-year house price expectation	Point estimate of the 1-year expectation of the percent change in house prices trimmed at the second and 98th percentile to account for outliers.	BOP-HH waves 21 - 28
1-year income expectation	Probabilistic forecast of households' own net income over the next year. The intervals are [< -2000€], (-2000€, -1500€], (-1500€, -1000€], (-1000€, -500€], (-500€, -250€], (-250€, 0€] (0€, 250€], (250€, 500€], (500€, 1000€], (1000€, 1500€], (1500€, 2000€], and [> 2000€]. To calculate the expected average change in income, the probability-weighted average is calculated by imputing the midpoint of each interval and assigning the endpoints for the open intervals.	BOP-HH waves 21 - 28
macroeconomic expectations	Households are asked for a qualitative forecast of the German unemployment rate, growth rate, stock market index (DAX), their local rents, or the level of taxation over the next year. Possible answers are 1 (strongly decrease), 2 (decrease), 3 (stay the same), 4 (increase), and 5 (strongly increase). The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-HH waves 21 - 28
absolute and squared forecast error	Absolute (squared) difference between households' 1-year inflation expectations and realized German CPI inflation over the same time period. The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-HH waves 21 - 28; Federal Statistical Office

continued

Table A.1 continued

	description	source
absolute and squared forecast error: personal inflation	Absolute (squared) difference between households' 1-year inflation expectations and personal realized CPI inflation over the same time period. Personal inflation is calculated as the weighted sum of spending shares and the corresponding CPI subcomponents. The spending shares are calculated as the average share of spending on durable goods, food & drinks, clothes & shoes, leisure, mobility, services, vacations, or housing in total spending over the sample period. The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation. The absolute production error of aggregate inflation explains about 78% of the variation in the absolute forecast error of personal inflation.	BOP-HH waves 21 - 28; Federal Statistical Office
absolute and squared difference to professional forecasters	Absolute (squared) difference between households' 1-year inflation expectations and professionals' consensus estimate of 1-year inflation expectations at the same point in time. The professional forecast is taken from the quarterly report of Consensus Economics, a private firm, which calculates the average expert forecast of large financial firms. In order to have monthly estimates, I interpolate the forecast for the missing months. The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-HH waves 21 - 28; Consensus Economics
inflation knowledge	Every quarter households are asked for a point estimate of their perception of inflation over the last 12 months. The variable is trimmed at the 2nd and 98th percentile and then the absolute deviation from the official inflation rate over the last 12 months is computed. Finally, households whose average deviation before treatment is below the sample median are classified as informed.	BOP-HH waves 21 - 28; Federal Statistical Office
trust in the ECB	In wave 22 of the BOP-HH, households were asked how much they trust that the ECB will fulfill its mandate of price stability. Answers range from 0 (no trust at all) to 10 (full trust). The variable is set missing for all households that were already treated in wave 22.	BOP-HH wave 22
household income	Net household income is elicited in the intervals [0, 500€), [500€, 1000€), [1000€, 1500€), [1500€, 2000€), [2000€, 2500€), [2500€, 3000€), [3000€, 3500€), [3500€, 4000€), [4000€, 5000€), [5000€, 6000€) and [$\geq$ 6000€]. Household income is determined by imputing the midpoint of each interval and assigning the endpoints to the open intervals.	BOP-HH waves 21 - 28
household liquid wealth	Household liquid wealth is calculated as the sum of bank deposits and securities. All asset values are elicited in the intervals [0, 2500€), [2500€, 5000€), [5000€, 10000€), [10000€, 25000€), [25000€, 50000€), [50000€, 100000€), [100000€, 250000€), [250000€, 500000€) and [$\geq$ 500000€]. Their value is determined by imputing the midpoint of each interval and assigning the endpoints to the open intervals. Asset values are only elicited when individuals join the sample and thus are not time-varying.	BOP-HH waves 23 - 28
share of electricity expenditures in net income	Estimate of average monthly expenditure on electricity divided by household net income trimmed at the 98th percentile to account for outliers.	BOP-HH wave 28
female	Dummy that equals one if the respondent is female	BOP-HH waves 21 - 28
age	Age of the respondent	BOP-HH waves 21 - 28
East Germany	Dummy that equals one if the respondent currently lives in East Germany	BOP-HH waves 21 - 28
household size	Number of household members	BOP-HH waves 21 - 28
married	Dummy that equals one if the respondent is either married or cohabiting.	BOP-HH waves 21 - 28

continued

Table A.1 continued

	description	source
educational level	Dummies that equal one if the respondent either has no degree, a secondary school degree (*Hauptschule*), an intermediate secondary school degree (*Realschule*), a technical school degree (*Fachhochschule*), or a high school degree (*Abitur*).	BOP-HH waves 21 - 28
employment status	Dummies that equal one if the respondent either is working full-time, is working part-time, is unemployed, is retired, or has some other employment status (mini-job, internship, federal voluntary service year, maternity/paternity leave, in education, out of the labor force).	BOP-HH waves 21 - 28

Notes: This table provides details on the definition and sources for all household variables used.

Table A.2: Definition of variables and data sources: firms

	description	source
1-year inflation expectation	Point estimate of the 1-year inflation rate expectation trimmed at the 2nd and 98th percentile to account for outliers.	BOP-F waves 6 - 14
1-year own-price expectation	Point estimate of the 1-year own-price expectation trimmed at the 2nd and 98th percentile to account for outliers.	BOP-F waves 6 - 14
1-year interest rate expectation	Probabilistic forecast of the ECB's policy rate over the next year. The intervals are [< -2%], [-2%, -1.5%), [-1.5%, -1%), [-1%, -0.5%), [-0.5%, -0.25%), [-0.25%, 0%) (0%, 0.25%], (0.25%, 0.5%], (0.5%, 1%], (1%, 1.5%], (1.5%, 2%], [> 2%]. To calculate the interest rate expectation, the probability-weighted average is calculated by imputing the midpoint of each interval and assigning the endpoints for the open intervals.	BOP-F waves 6 - 14
perceived problems	Qualitative expectations of firm-specific problems with customer demand, competitive pressure, credit supply, production costs, availability of personnel, Covid-19 restrictions, and other regulations over the next six months. The possible answers range from 1 (no problem at all) to 5 (very serious problem). The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-F waves 4 - 14
absolute and squared forecast error	Absolute (squared) difference between firms' 1-year inflation expectations and realized German CPI inflation over the same time period. The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-F waves 6 - 14; Federal Statistical Office
absolute and squared difference to professional forecasters	Absolute (squared) difference between firms' 1-year inflation expectations and professionals' consensus estimate of 1-year inflation expectations at the same time. The professional forecast is taken from the quarterly report of Consensus Economics, a private firm, which calculates the average expert forecast of large financial firms. In order to have monthly estimates, I interpolate the forecast for the missing months. The variables are transformed into a z-score by subtracting the mean and dividing them by their standard deviation.	BOP-F waves 6 - 14; Consensus Economics
number of employees	Number of employees currently employed at the firm.	BOP-F waves 4 - 8; 12 - 14
quarterly turnover	Firms' turnover in the last quarter. Every wave only half the sample is asked the question.	BOP-F waves 4 - 14
informedness about energy use	A dummy variable taking the value one if a firm reports to either monitor or target their energy use.	BOP-F waves 12 - 14
energy expenditure share for different energy inputs	Percent of energy expenditures spent on oil, coal, natural gas, electricity (both conventional and renewable), or other energy inputs in 2021	BOP-F waves 15 - 17

continued

Table A.2 continued

	description	source
share of energy in total costs	Share of energy cost in total costs elicited in intervals 0%, (0%, 10%), [10%, 20%), [20%, 30%), [30%, 40%), [40%, 50%), [50%, 60%), [60%, 70%), [70%, 80%), [80%, 90%), [90%, 100%) and 100%. To calculate the share of energy costs in total costs is calculated by imputing the midpoint of each interval.	BOP-F waves 12 - 14
rank within the firm	A dummy that equals one when the respondent is either the owner, executive director, or a member of the board.	BOP-F waves 4 - 14
sector	1-digit NACE sector (20 sectors) of the firm.	BOP-F waves 4 - 14

Notes: This table provides details on the definition and sources for all firm-level variables used.

Table A.3: Descriptive statistics: households

	mean	median	sd	N
1-year inflation expectation	5.53	5.00	3.01	14447
5-year inflation expectation	5.08	4.00	3.63	4843
10-year inflation expectation	5.31	4.00	4.62	4860
1-year interest rate expectation	0.37	0.10	0.65	8272
1-year house price expectation	9.49	8.00	8.22	14345
1-year income expectation	49.61	125.00	485.28	7201
unemployment rate expectation	3.29	3.00	0.92	14864
growth rate expectation	2.85	3.00	1.07	14864
stock market expectation	3.08	3.00	0.98	14806
rent expectation	4.13	4.00	0.70	14860
taxation expectation	4.00	4.00	0.83	14863
absolute forecast error	3.63	3.70	2.15	14447
squared forecast error	17.80	13.69	19.62	14447
absolute forecast error: personal inflation	4.46	4.60	2.46	14031
squared forecast error: personal inflation	25.99	21.20	23.72	14031
absolute difference to professional forecasters	3.41	2.90	2.78	14447
squared difference to professional forecasters	19.34	8.41	39.90	14447
inflation perception error	1.93	1.80	1.07	13407
trust in the ECB	4.41	5.00	2.60	7159
household income (in 1000€)	3.53	3.25	1.91	14306
household liquid wealth (in 1000€)	64.09	18.75	109.78	12170
monthly electricity expenditures (in 100€)	1.26	0.86	2.32	14524
female	0.50	1.00	0.50	14882
age	50.90	54.00	17.52	14882
East Germany	0.19	0.00	0.39	14882
household size	2.24	2.00	1.10	14835
married	0.60	1.00	0.49	13455
education: no degree	0.03	0.00	0.18	14876
education: secondary school	0.30	0.00	0.46	14876
education: intermediate secondary school	0.31	0.00	0.46	14876
education: technical school	0.06	0.00	0.24	14876
education: high school	0.30	0.00	0.46	14876
employment status: full-time	0.43	0.00	0.49	14868
employment status: part-time	0.12	0.00	0.33	14868
employment status: unemployed	0.02	0.00	0.13	14868
employment status: retired	0.31	0.00	0.46	14868
employment status: other	0.12	0.00	0.32	14868

Table A.4: Descriptive statistics: firms

	mean	median	sd	N
1-year own-price expectation	5.83	5.00	5.78	12247
1-year inflation expectation	4.39	4.00	1.85	10342
1-year interest rate expectation	-0.00	0.00	0.68	12310
problems with customer demand	2.57	2.00	1.26	19914
problems with competitive pressure	2.88	3.00	1.13	19719
problems with credit supply	2.31	2.00	1.18	15838
problems with supply chains	3.03	3.00	1.23	16897
problems with production costs	3.22	3.00	1.13	19154
problems with availability of personnel	3.63	4.00	1.22	19503
problems with regulations	3.29	3.00	1.26	19486
problems with Covid-19 restrictions	2.92	3.00	1.32	19537
absolute forecast error	4.05	4.20	1.55	10342
squared forecast error	18.80	17.64	11.61	10342
absolute difference to professional forecasters	2.46	2.10	1.75	10342
squared difference to professional forecasters	9.11	4.41	16.64	10342
energy cost share: oil	0.20	0.00	0.31	23754
energy cost share: coal	0.00	0.00	0.03	23754
energy cost share: natural gas	0.23	0.05	0.30	23754
energy cost share: electricity	0.45	0.45	0.33	23754
energy cost share: other	0.11	0.00	0.25	23754
share energy in total costs	0.10	0.05	0.10	19981
owner, executive director, member of board	0.89	1.00	0.31	25294
number of employees	101.11	11.00	689.59	10437
turnover (in million €)	53.86	0.40	1245.59	6497
sector: manufacturing	0.17	0.00	0.38	24893
sector: construction	0.13	0.00	0.33	24893
sector: retail	0.13	0.00	0.34	24893
sector: other services	0.51	1.00	0.50	24893
sector: other	0.06	0.00	0.24	24893

B Additional Tables and Figures

Table B.1: Predicting the treatment status of households

	(1) experiences price change	(2) experiences price change	(3) experiences price change
ex-ante inflation expectation	-0.001	0.000	0.001
	(0.003)	(0.004)	(0.004)
ex-ante interest rate expectation		-0.002	-0.005
		(0.014)	(0.014)
ex-ante house price expectation		-0.000	0.000
		(0.001)	(0.001)
ex-ante income expectation (in 100€)		0.002	0.002
		(0.002)	(0.002)
female			0.006
			(0.019)
age			-0.000
			(0.001)
East Germany			-0.029
			(0.023)
household size			-0.007
			(0.011)
married			0.001
			(0.022)
education: secondary school			0.102
			(0.092)
education: intermediate secondary school			0.077
			(0.090)
education: technical school			0.067
			(0.091)
education: high school			0.048
			(0.089)
employment: full-time			-0.003
			(0.041)
employment: part-time			-0.009
			(0.045)
employment: unemployed			0.054
			(0.075)
employment: retired			0.034
			(0.046)
household income: 1000 - 1999€			-0.028
			(0.060)
household income: 2000 - 2999€			-0.025
			(0.059)
household income: 3000 - 3999€			0.021
			(0.060)
household income: 4000 - 4999€			0.043
			(0.062)
household income: 5000 - 5999€			0.017
			(0.064)
household income: > 6000€			0.051
			(0.064)
mean	0.544	0.551	0.554
N	14479	13966	12199
# cluster	4177	3994	3920

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The results are based on a regression of a dummy, which takes the value one if the household experiences a price increase in the sample period, on prior expectations and observable household characteristics.

Table B.2: Effect of electricity price increase on households' inflation expectations: robustness

	(1) 1-year inflation expectation	(2) 1-year inflation expectation	(3) 1-year inflation expectation	(4) 1-year inflation expectation	(5) 1-year inflation expectation	(6) 1-year inflation expectation
price increase x post	0.113**	0.182**	0.213***	0.176**	0.175**	0.192**
	(0.051)	(0.072)	(0.082)	(0.083)	(0.076)	(0.078)
household FE	yes	yes	yes	yes	yes	yes
month FE	yes	yes	yes		yes	yes
Huber robust estimation	yes					
drop HHs that switch provider		yes				
drop HHs that interrupted the survey			yes			
local labor market x month FE				yes		
demographic controls					yes	yes
income controls						yes
mean	5.374	5.537	5.566	5.540	5.573	5.538
N	13481	13301	10680	11690	12127	11703
# cluster	3855	3770	3644	3316	3817	3723

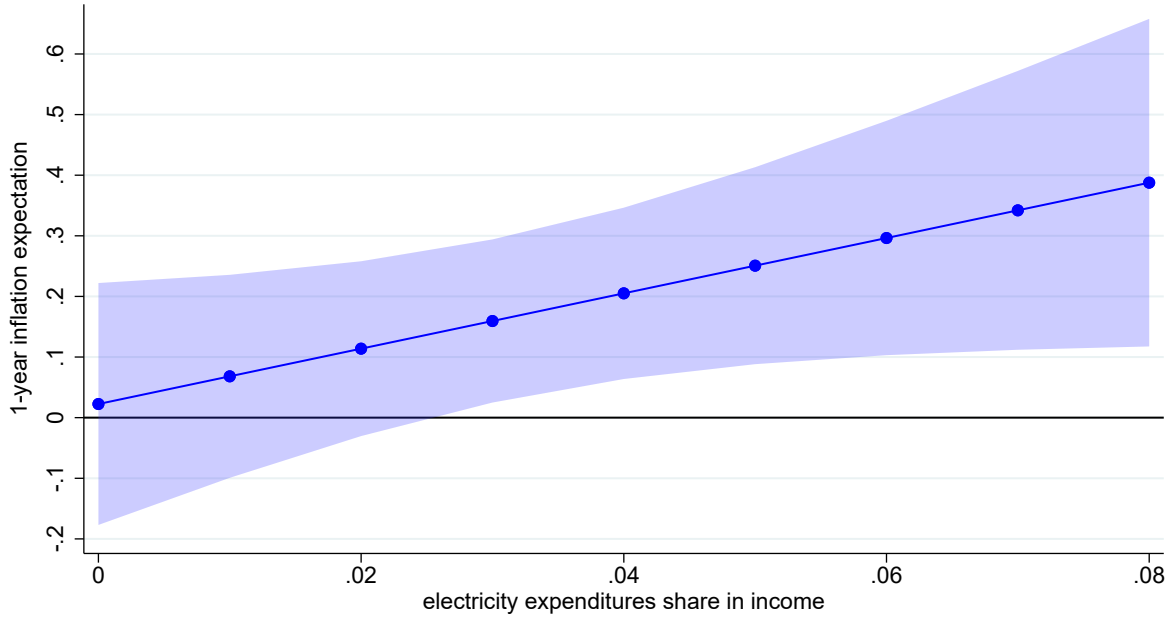
Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on estimating equation (1) as described in Section 3. The demographic control variables include dummies for marital status as well as household size, and age. The income control variables include dummies for full-time employment, part-time employment, unemployment, and retirement, as well as six household income dummies.

Table B.3: Effect of electricity price increase on households' inflation expectations: heterogeneous effects

	(1) 1-year inflation expectation	(2) 1-year inflation expectation	(3) 1-year inflation expectation	(4) 1-year inflation expectation	(5) 1-year inflation expectation
price increase x post x uninformed about inflation	0.388***				
	(0.134)				
price increase x post x informed about inflation	0.007				
	(0.089)				
price increase x post x low trust in ECB		0.555***			
		(0.176)			
price increase x post x high trust in ECB		-0.044			
		(0.120)			
price increase x post x low-income HH			0.316***		
			(0.101)		
price increase x post x high-income HH			0.018		
			(0.095)		
price increase x post x low education level				0.185	
				(0.117)	
price increase x post x high education level				0.185**	
				(0.088)	
price increase x post x low liquid wealth					0.172
					(0.126)
price increase x post x high liquid wealth					0.169*
					(0.088)
household FE	yes	yes	yes	yes	yes
group x month FE	yes	yes	yes	yes	yes
p-value of group difference	0.018**	0.005***	0.030**	1.000	0.985
mean	5.463	5.840	5.504	5.533	5.491
N	13166	6042	13092	13571	11114
# cluster	3704	2346	3773	3859	3088

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on estimating equation (1) as described in Section 3 for different sub-samples.

Figure B.1: Effect of electricity price increase on households' inflation expectations by spending on electricity



Notes: This figure plots point estimates and 95% confidence bands from estimating equation (1) interacted with the share of income spent on electricity.

Table B.4: Effect of electricity price increase on households' other expectations

	(1) 5-year inflation expectation	(2) 10-year inflation expectation	(3) 1-year interest rate expectation	(4) 1-year house price expectation	(5) 1-year income expectation
price increase x post	0.296	0.322	0.020	-0.207	-36.931
	(0.180)	(0.285)	(0.031)	(0.193)	(25.386)
household FE	yes	yes	yes	yes	yes
month FE	yes	yes	yes	yes	yes
mean	5.024	5.225	0.370	9.240	52.64
N	4268	4238	7738	13479	6632
# cluster	2557	2533	3782	3854	3684
	(6) unemployment rate expectation	(7) growth rate expectation	(8) stock market expectation	(9) rent expectation	(10) taxation expectation
price increase x post	0.003	-0.015	0.003	0.017	-0.021
	(0.031)	(0.029)	(0.031)	(0.030)	(0.029)
household FE	yes	yes	yes	yes	yes
month FE	yes	yes	yes	yes	yes
z-score	yes	yes	yes	yes	yes
mean	0.000	0.000	0.000	0.000	0.000
N	13971	13972	13914	13966	13970
# cluster	3906	3906	3902	3905	3906

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on estimating equation (1) as described in Section 3. Z-scores are computed by subtracting the sample mean and dividing by the standard deviation.

Table B.5: Effect of energy price increase on firms' reported problems

problems with	(1) production costs	(2) availability of personnel	(3) regulations	(4) Covid-19 restrictions
price increase x post	0.060**	-0.033	0.025	0.009
	(0.029)	(0.029)	(0.027)	(0.029)
firm FE	yes	yes	yes	yes
month FE	yes	yes	yes	yes
z-score	yes	yes	yes	yes
mean	0.000	0.000	0.000	0.000
N	18770	19146	19129	19180
# cluster	5478	5490	5527	5539
problems with	(5) customer demand	(6) competitive pressure	(7) credit supply	(8) supply chains
price increase x post	-0.012	-0.023	0.012	0.043
	(0.029)	(0.028)	(0.031)	(0.033)
firm FE	yes	yes	yes	yes
month FE	yes	yes	yes	yes
z-score	yes	yes	yes	yes
mean	0.000	0.000	0.000	0.000
N	19563	19368	15478	16522
# cluster	5576	5550	5089	5160

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the firm level are in parenthesis. The regression results are based on estimating equation (2) as described in Section 3. Z-scores are computed by subtracting the sample mean and dividing by the standard deviation.

Table B.6: Effect of energy price increase on firms' inflation expectations

	(1) 1-year inflation expectation	(2) 1-year inflation expectation	(3) 1-year inflation expectation	(4) 1-year inflation expectation
price increase x post	0.004	0.048		
	(0.053)	(0.047)		
100% price increase x post			0.166	
			(0.121)	
below-median price increase x post				-0.044
				(0.059)
above-median price increase x post				0.059
				(0.069)
estimator	BJS	TWFE	TWFE	BJS
household FE	yes	yes	yes	yes
month FE	yes	yes	yes	yes
mean	4.324	4.384	4.382	4.322
N	8402	8960	8946	8399
# cluster	4124	3882	3877	4124

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on estimating equation (2) using either the imputation method of Borusyak et al. (2023) (BJS) or a standard two-way fixed model (TWFE).

Table B.7: Effect of energy price increase on firms' inflation expectations: heterogeneous effects

	(1) 1-year inflation expectation	(2) 1-year inflation expectation	(3) 1-year inflation expectation	(4) 1-year inflation expectation	(5) 1-year inflation expectation
price increase x post x not informed about energy use	0.153				
	(0.103)				
price increase x post x informed about energy use	-0.054				
	(0.064)				
price increase x post x small firm		0.059			
		(0.071)			
price increase x post x large firm		-0.071			
		(0.078)			
price increase x post x low energy cost share			-0.044		
			(0.060)		
price increase x post x high energy cost share			0.050		
			(0.120)		
price increase x post x low natural gas share				0.037	
				(0.079)	
price increase x post x high natural gas share				-0.078	
				(0.080)	
price increase x post x non-energy-intensive sector					0.016
					(0.061)
price increase x post x energy-intensive sector					-0.035
					(0.108)
firm FE	yes	yes	yes	yes	yes
group x month FE	yes	yes	yes	yes	yes
p-value of group difference	0.086*	0.218	0.484	0.306	0.677
mean	4.324	4.348	4.358	4.336	4.324
N	8402	8217	7301	7881	8402
# cluster	4124	4061	3281	3849	4124

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the firm level are in parenthesis. The regression results are based on estimating equation (2) as described in Section 3 for different sub-samples.

Table B.8: Effect of energy price increase on households' squared forecast errors and deviations from professionals

	(1) squared forecast error	(2) squared forecast error: personal inflation	(3) squared difference to professional forecasters
price increase x post	0.067**	0.065**	0.058**
	(0.031)	(0.029)	(0.026)
household FE	yes	yes	yes
month FE	yes	yes	yes
z-score	yes	yes	yes
mean	0.000	0.000	0.000
N	13575	13175	13575
# cluster	3860	3703	3860

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the household level are in parenthesis. The regression results are based on estimating equation (1) using the imputation method of Borusyak et al. (2023). Z-scores are computed by subtracting the sample mean and dividing by the standard deviation.

Table B.9: Effect of energy price increase on firms' forecast errors and deviations from professionals

	(1) absolute forecast error	(2) squared forecast error	(3) absolute difference to professional forecasters	(4) squared difference to professional forecasters
price increase x post	-0.017	-0.000	0.004	-0.007
	(0.030)	(0.031)	(0.031)	(0.032)
firm FE	yes	yes	yes	yes
month FE	yes	yes	yes	yes
z-score	yes	yes	yes	yes
mean	0.000	0.000	0.000	0.000
N	8402	8402	8402	8402
# cluster	4124	4124	4124	4124

Notes: Statistical significance denoted as: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors clustered on the firm level are in parenthesis. The regression results are based on estimating equation on (2) using the imputation method of Borusyak et al. (2023). Z-scores are computed by subtracting the sample mean and dividing by the standard deviation.

C Questionnaire

C.1 Bundesbank Online Panel - Households

The full questionnaire of the BOP-HH wave 28 including the regular questions is available online in both German and English. The special questions added to wave 28 are presented below.

Month price change: Hat sich der Preis, den Ihr Haushalt für Strom bezahlt, seit September 2021 geändert? Falls ja, in welchem Monat fand erstmalig eine Preisänderung statt? (*Did the your household's electricity price change since September 2021? If yes, in what month did the price change take place?*)

- Nein, keine Preisänderung seit September 2021 (*No, my price did not change since September 2021*)
- Ja, im September 2021. (*Yes, in September 2021*)
- Ja, im Oktober 2021. (*Yes, in October 2021*)
- Ja, im November 2021. (*Yes, in November 2021*)
- Ja, im Dezember 2021. (*Yes, in December 2021*)
- Ja, im Januar 2022. (*Yes, in January 2022*)
- Ja, im Februar 2022. (*Yes, in February 2022*)
- Ja, im März 2022. (*Yes, in March 2022*)
- Ja, im April 2022. (*Yes, in April 2022*)

Reason for change of electricity price: Aus welchem Grund hat sich Ihr Strompreis geändert? (*Why did your electricity price change?*)

- Mein derzeitiger Anbieter hat den Strompreis angepasst (*My current provider has changed the price*)
- Ich habe den Anbieter gewechselt, weil mein vorheriger Anbieter meinen Vertrag gekündigt hat (*I changed my provider because my prior provider terminated my contract*)

– Ich habe den Anbieter gewechselt, weil mein vorheriger Anbieter den Preis erhöht hat (*I changed by provider because my prior provider increased prices*)

– Aus anderen Gründen (*For other reasons*)

Electricity price change: Wie stark hat sich Ihr Strompreis in etwa seit September 2021 verändert? (*How much did your electricity price change since September 2021?*)

– Um mehr als 10% gesunken (*Reduction of more than 10%*)

– Zwischen 1 und 10% gesunken (*Reduction between 1 und 10%*)

– Zwischen 1 und 10% gestiegen (*Increase between 1 und 10%*)

– Zwischen 11 und 20% gestiegen (*Increase between 11 und 20%*)

– Zwischen 21 und 30% gestiegen (*Increase between 21 und 30%*)

– Zwischen 31 und 40% gestiegen (*Increase between 31 und 40%*)

– Zwischen 41 und 50% gestiegen (*Increase between 41 und 50%*)

– Um mehr als 50% gestiegen (*Increase of more than 50%*)

Spending on electricity: Wie hoch sind derzeit in etwa die monatlichen Ausgaben Ihres Haushalts für Strom? (*How high is your household's monthly spending on electricity?*)

Hinweis: Falls Sie es nicht genau wissen, geben Sie bitte eine Schätzung an. (*If you do not know the exact number, please give your best estimate.*)

_____ Euro

C.2 Bundesbank Online Panel - Firms

The full questionnaires of the BOP-F waves 15, 16, and 17 including the regular questions are available online in both German and English. The special questions added to wave 15, 16, and 17 are presented below.

Energy price change: Um wie viel Prozent haben sich die durchschnittlichen Energieeinkaufspreise Ihres Unternehmens seit 2020 verändert? (*How much have the average energy prices your firm faces changed since 2020?*)

Hinweis: Bitte berücksichtigen Sie nur den Preis der eingekauften Energie, nicht die eingekaufte Energiemenge. (*Please only take the energy price and not the quantity of energy into account.*)

a = im Jahr 2021 im Vergleich zum Jahr 2020 (*in 2021 relative to 2020*)

b = im 1. Quartal 2022 im Vergleich zum 4. Quartal 2021 (*in the first quarter of 2022 relative to the fourth quarter of 2021*)

- Rückgang um 20% (*Reduction of more than 20%*)
- Rückgang zwischen 11 und 20% (*Reduction between 11 und 20%*)
- Rückgang zwischen 5 und 10% (*Reduction between 5 und 10%*)
- Geringfügige Änderung zwischen -5% und 5% (*Little change between -5% and 5%*)
- Zwischen 5 und 10% gestiegen (*Increase between 5 und 10%*)
- Zwischen 11 und 20% gestiegen (*Increase between 11 und 20%*)
- Zwischen 21 und 30% gestiegen (*Increase between 21 und 30%*)
- Zwischen 31 und 40% gestiegen (*Increase between 31 und 40%*)
- Zwischen 41 und 50% gestiegen (*Increase between 41 und 50%*)
- Zwischen 51 und 60% gestiegen (*Increase between 51 und 60%*)
- Zwischen 61 und 70% gestiegen (*Increase between 61 und 70%*)
- Um mehr als 70% gestiegen (*Increase of more than 70%*)

Quarter of change in energy prices: In welchem Quartal seit dem Anfang des Jahres 2021 haben sich die Energieeinkaufspreise Ihres Unternehmens zum ersten Mal deutlich verändert? (*In which quarter since the beginning of 2021 have the energy prices of your firm changed significantly?*)

Hinweis: Bitte beachten Sie, dass sich die Frage nach der erstmaligen deutlichen Änderung der Preise richtet, auch wenn dieser weitere deutliche Änderungen gefolgt sind. (*Note that this question refers to the first significant change in prices even when there were subsequent price changes.*)

- erstmalig im 1. Quartal 2021: Januar bis März 2021 (*first change in the first quarter of 2021: January - March 2021*)
- erstmalig im 2. Quartal 2021: April bis Juni 2021 (*first change in the second quarter of 2021: April - June 2021*)
- erstmalig im 3. Quartal 2021: Juli bis September 2021 (*first change in the third quarter of 2021: July - September 2021*)
- erstmalig im 4. Quartal 2021: Oktober bis Dezember 2021 (*first change in the fourth quarter of 2021: October - December 2021*)
- erstmalig im 1. Quartal 2022: Januar bis März 2022 (*first change in the first quarter of 2022: January - March 2022*)

Share energy type: Welchen Anteil an den Jahresenergiekosten Ihres Unternehmens nahmen im Jahr 2021 die folgenden Energiequellen jeweils ein? (*What share of your firm's energy cost did the following energy sources take in 2021?*)

Hinweis: Bitte beachten Sie, dass sich die Angaben über alle Energiequellen auf 100 summieren müssen. Sie können auch Eingabefelder leer lassen, wenn eine Energiequelle in Ihrem Unternehmen nicht genutzt wird. Leere Felder werden automatisch mit dem Wert 0 abgespeichert. (*Note that the shares of all energy sources have to sum up to 100. You can leave a field empty if your firm does not use the energy source at all, which will be interpreted as a value of zero.*)

- Erdöl (inkl. Kraftstoffe/Heizöl): _____ (*Oil*)
- Fernwärme aus erneuerbaren Quellen: _____ (*District heating from renewable sources*)

- Fernwärme aus konventionellen Quellen: _____ (*District heating from conventional sources*)
- Braun-/Steinkohle: _____ (*Brown and hard coal*)
- Erdgas oder Flüssiggas: _____ (*Natural gas or liquified natural gas*)
- Strom aus erneuerbaren Quellen: _____ (*Electricity from renewable sources*)
- Strom aus konventionellen Quellen: _____ (*Electricity from conventional sources*)
- Sonstige Energiequellen: _____ (*Other energy sources*)