INTERNATIONAL MONETARY FUND

Firms' Resilience to Energy Shocks and Response to Fiscal Incentives

Assessing the Impact of 2022 Energy Crisis

David Amaglobeli, Joaquim Guilhoto, Samir Jahan, Salma Khalid, Raphael Lam, Gregory Legoff, Brent Meyer, Xuguang Simon Sheng, Pawel Smietanka, Sonya Waddell, and Daniel Weitz

WP/24/27

IMF Working Papers **describe research in progress by the author(s) and are published to elicit comments and to encourage debate.**
The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

2024
FEB

WORKING PAPER

© 2024 International Monetary Fund WP/24/27

IMF Working Paper
Fiscal Affairs Department

Firms' Resilience to Energy Shocks and Response to Fiscal Incentives: Assessing the Impact of 2022 Energy Crisis

Prepared by David Amaglobeli, Joaquim Guilhoto, Samir Jahan, Salma Khalid, Raphael Lam, Gregory Legoff, Brent Meyer, Xuguang Simon Sheng, Pawel Smietanka, Sonya Waddell, and Daniel Weitz

Authorized for distribution by Rodrigo Cerda and Era Dabla-Norris
February 2024

***IMF Working Papers* describe research in progress by the author(s) and are published to elicit comments and to encourage debate.** The views expressed in IMF Working Papers are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

ABSTRACT: The energy price shock in 2022 led to government support for firms in some countries, sparking debate about the rationale and the nature of such support. The results from nationally representative firm surveys in the United States and Germany indicate that firms in these countries were generally resilient. Coping strategies adopted by firms included the pass-through of higher costs to consumers, adjustment of profit margins (United States) and investments in energy saving and efficiency (Germany). Firms in energy-intensive industries would have been significantly more affected if international energy prices were fully passed through to domestic prices in Europe. Survey responses further reveal that most firms are uncertain about the impact of recent policy announcements on green subsidies. Firms take advantage of fiscal incentives to accelerate their climate-related investment plans are often those that have previous plans to do so. These findings suggest better targeting and enhancing policy certainty will be important when facilitate the green transition among firms.

RECOMMENDED CITATION: Amaglobeli, David, Joaquim Guilhoto, Samir Jahan, Salma Khalid, Raphael Lam, Gregory Legoff, Brent Meyer, Xuguang Simon Sheng, Pawel Smietanka, Sonya Waddell, Daniel Weitz, 2024, "Firms' Resilience to Energy Shocks and Response to Fiscal Incentives: Evaluating the Impact of 2022 Energy Crisis", IMF Working Paper 24/27.

JEL Classification Numbers:	H20, H32, E31, D57
Keywords:	Energy prices; Subsidies; Survey, Cost-Push Model, Input Output Table; Firm Behavior
Author's E-Mail Address:	damaglobeli@imf.org, jguilhoto@imf.org, sjahan2@imf.org, skhalid@imf.org, wlam@imf.org, glegoff@imf.org, Brent.Meyer@atl.frb.org, sheng@american.edu, pawel.smietanka@bundesbank.de, Sonya.Waddell@richmondfed.org, Daniel.Weitz@atl.frb.org

WORKING PAPERS

Firms' Resilience to Energy Shocks and Response to Fiscal Incentives

Assessing the Impact of 2022 Energy Crisis

Prepared by Prepared by David Amaglobeli, Joaquim Guilhoto, Samir Jahan, Salma Khalid, Raphael Lam, Gregory Legoff, Brent Meyer, Xuguang Simon Sheng, Pawel Smietanka, Sonya Waddell, and Daniel Weitz[1]

[1] The authors would like to thank Saioa Armendariz, Bryn Battersby, Jiro Honda, Jorge Miranda Pinto, Aiko Mineshima, Galen Sher, Martin Stuermer, and Nate Vernon for their helpful comments. Mengfei Gu provided excellent research assistance.

Contents

I. Introduction

The energy crisis of 2022 ignited debate about the need to support firms in the face of a major shock. In the run-up to Russia's invasion of Ukraine, global energy prices were rising as the economic recovery after COVID-19 started to take hold. Increases in energy prices and the resulting high levels of inflation were expected to moderate over the coming year with the resolution of supply bottlenecks and responsive monetary policy (IMF, 2022). In this context, fiscal support to cope with high energy prices was limited and policy debate largely concerned with the exit from extraordinary measures implemented during the pandemic. However, Russia's invasion of Ukraine triggered a significant spike in energy prices, particularly in Europe. Within Europe, the magnitude of the shocks varied across countries, depending on their energy mix and reliance of imports of energy sources from Russia. To protect households and viable firms during the energy price spikes, many governments announced broad-based measures aimed at suppressing the pass-through from higher international prices to domestic prices. While most support measures were targeted at households, a significant number of measures were directed at firms and production.

Governments rationalized the fiscal support to firms by the need to cushion the impact of a systemic shock, which could have otherwise led to widespread bankruptcies and disruption of production (Bialek, Schaffranka and Schnitzer, 2023). These considerations presumed that firms were less capable to pass through higher production costs to final consumers, who could then be targeted with support, or that using other margins of adjustment would jeopardize societal welfare through job losses, lost output, or constrained investment. The energy price spike also provided an opportunity for governments to address long-term energy security concerns and to expedite the green transition—transforming industries to become more energy-efficient and to curb emissions. As a result, governments introduced fiscal incentives, such as green subsidies, to facilitate the green transition, such as the Inflation Reduction Act in The United States and the Green Industrial Policies in European Union (IMF 2023).

How firms responded to the energy price spike in 2022 is an important research question given the extensive support for firms in many policy packages (Amaglobeli and others, 2023; Ari and others, 2022) and in the context of the green transition where price signals are often key to incentivizing green behavior (Arregui and others, 2022). In this paper, we leverage the results of two representative surveys of businesses in the United States and Germany to gain insight into how firms responded to the energy spike and to consider how fiscal incentives can better faiclitate the transition.[1] In the surveys, firms were specifically asked about their experience with energy price changes and the associated behavioral responses. The analysis of firm surveys also allows us to understand the main obstacles firms face when shifting to investments in low-carbon technologies and the announcement effect of incentives provided by the Inflation Reduction Act in the United States and the Green Deal Industrial Plan in the EU, with both packages designed to accelerate those investments. We complement findings from the surveys with a cost-push analysis of the energy price shock to gauge the heterogenous impact across firms and sectors.

Our novel findings show that while most firms in the United States and Germany faced rising energy costs in 2022, they proved to be quite resilient on average. Amid the uncertainties from the energy price spike, firms

[1] The choice of these two countries—the United States and Germany—is predicated on the fact that these two largest advanced economies were both affected by the 2022 energy price spike, but the extent of the shock differed. Moreover, these two countries have a well-developed infrastructure for surveying individual firms.

were able to adjust multiple margins to mitigate the impact of an adverse shock. Survey responses suggest that in both countries, firms responded to higher energy costs by reducing their profits and passing price increases on to their consumers. In Germany, where the energy shock was more acute and perceived to be more persistent, firms have responded by increasing investments in energy efficiency and changing their behavior to generate energy savings.[2] An analysis based on input-output tables further suggests, in the absence of government interventions and with the full pass-through of higher international energy prices to domestic prices, some industries would have been more heavily affected than others among European firms.[3] Finally, the survey responses also indicate that the majority of firms were uncertain about the impact of the recently announced policy packages on their climate-related investment plans. While our results focus on the announcement effect of policies, these findings could help governments refine their policy packages and point to the need to maintain price signals when considering policy interventions. Targeting support and enhancing policy certainty are two design features that help balance maintaining price signals with providing support.

Our paper contributes to the literature investigating the influence of energy prices on the macroeconomy, particularly in terms of actual and expected inflation (Milani, 2009; Choi et al., 2018; Nasir, Balsalobre-Lorente, and Huynh, 2020; Kilian and Zhou, 2022; Dao and others, 2023; Wehrhöfer, 2023), the effects of crises, disasters, or wars on oil price expectations (An, Binder, and Sheng, 2023), and output growth and unemployment expectations (Baker, McElroy, and Sheng, 2020; Binder, 2020). Our paper also builds upon a broader body of literature that utilizes firm-level surveys to examine the characteristics of agent perceptions and expectations. Noteworthy examples include Altig and others (2022), Coibion, Gorodnichenko, and Kumar (2018), Enders, Hunnekes, and Muller (2019), Barrero (2022). Our paper is the first to report the effect of 2022 energy crisis and the plans to reduce carbon emissions across two countries based on firm-level survey responses using a well-establish central banks survey infrastructure.

The rest of the paper is organized as follows: Section II assesses the initial impact of higher international energy prices on domestic prices and the real sector, and the governments' policy responses to mitigate the adverse impact; section III provides information on the firm surveys conducted in the United States and Germany; section IV discusses firms' coping strategies in the wake of a major energy crisis; section V concludes.

[2] See also Deutsche Bundesbank, 2023.

[3] There is some evidence that even firms in energy intensive industries were able to absorb the energy price shock (see, for example, Stiewe, Ruhnau and Hirth, 2022).

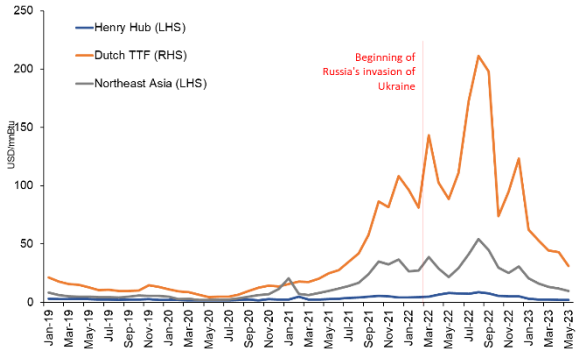
II. The Initial Impact of the Energy Crisis and Government Responses

A. Surge in International and Domestic Prices

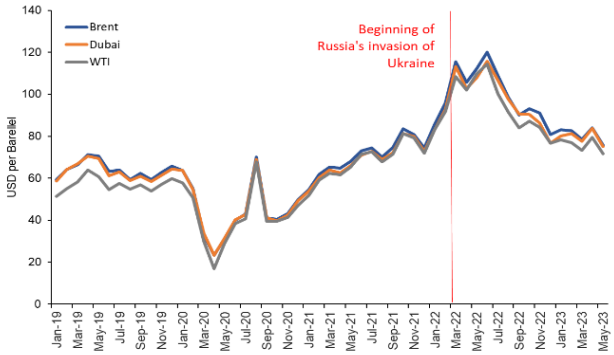
Soaring global energy prices in 2022, amplified by Russia's invasion of Ukraine, were a major shock to the global economy, especially in Europe. The disruption to natural gas and oil markets, which reflected Europe's dependence on Russian supplies and historically low levels of hydro- and nuclear electric output, resulted in the price of Dutch gas futures increasing by almost 300 percent by early-March 2022 (Figure 1.a). While prices exhibited marked volatility throughout 2022, the average price of Dutch gas futures from the war's onset to the end of the year exceeded pre-pandemic averages by over six-fold. Moreover, the energy price spike was not restricted to Europe only, with the average price of Northeast Asian gas futures following the onset of the war exceeding pre-pandemic averages by almost four-fold. North American futures also exhibited price responses to the war, though these were muted relative to other trading hubs.[4] Crude oil prices (Brent, Dubai, and WTI) also rose by 70 percent relative to the pre-pandemic average (Figure 1.b).

Figure 1. Global Energy Prices

a. Natural Gas



b. Crude Oil



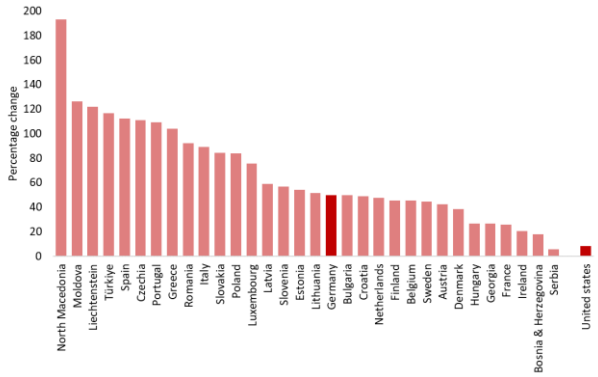
Sources: Bloomberg, Argus, IMF Staff calculations.
Note 1: The average reference lines are for 2016-2019. Note 2: Prices used in the graph are Dutch TTF Natural Gas Forward Day Ahead, Natural Gas spot price at the Henry Hub terminal in Louisiana, and LNG in Northeast Asia.

Rising global and regional energy prices drove domestic energy costs up. Among European countries, between the second half of 2021 and the first half of 2022 the average domestic prices (before taxes and fees) of natural gas and electricity increased by about 70 and 40 percent for non-residential consumers, respectively. These averages mask wide variations across European countries. Germany, where prices for non-residential customers for natural gas and electricity increased by about 50 percent between first half of 2022 and the second half of 2021, was closer to the median price increase for the European countries (Figure 2). By contrast in the United States, over the same period, prices for non-residential customers for natural gas and electricity rose by less than 10 percent.

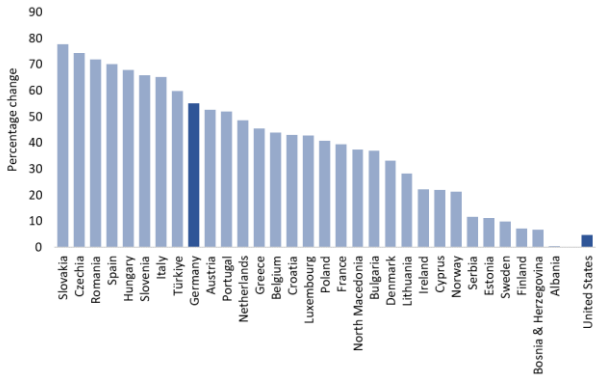
[4] The limited impact on gas prices in the United States reflects partially fragmented global market for natural gas because of the complex network of infrastructure needed to transport it (Brasier, Pescatori, and Stuermer, 2023).

Figure 2. Changes in Energy Prices for Final Consumers, 2021H2-2022H1

a. Natural Gas



b. Electricity



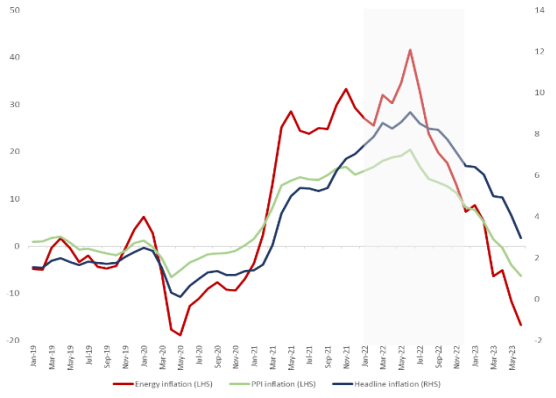
Sources: Eurostat, US Energy Information Administration, and IMF Staff calculations.
Note. Data for Europe is for non-household consumers and excludes taxes and levies.

B. Impact on Inflation

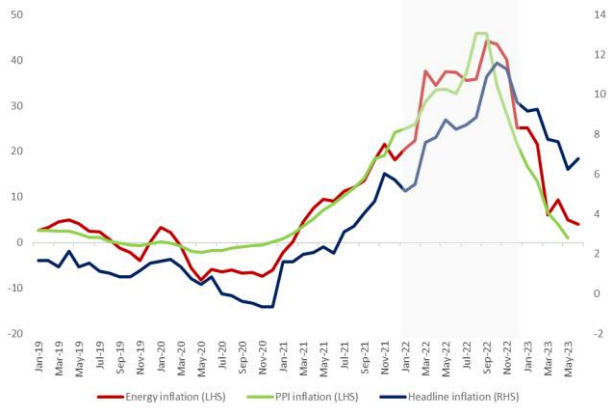
In the United States and Germany, changes in energy prices were a key driver of headline consumer and producer price indices (Figure 3.a and 3.b). In both countries, prices were on the rise well before the outbreak of the war. While the immediate spike in international prices pushed domestic prices up, prices started to decline from the third quarter of 2022. On the other hand, the surge in energy costs of households and firms had an insignificant impact on real output in both countries, particularly in the United States (Figure 3.c. and 3.d.).

Figure 3. Immediate Impact of the Energy Price Shock on Macroeconomy

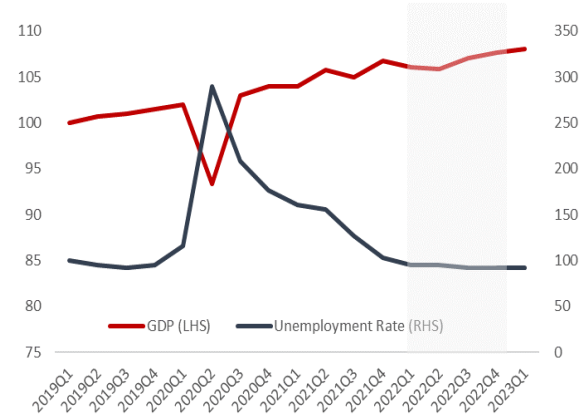
a. United States: CPI, PPI, and Energy inflation



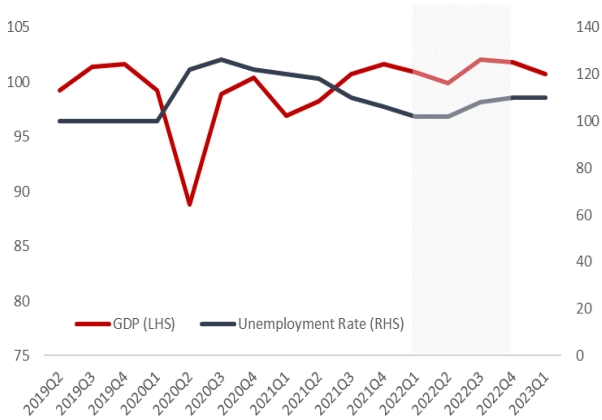
b. Germany: CPI, PPI, and Energy inflation



c. United States: Growth and Unemployment (2019Q1=100)



d. Germany: Growth and Unemployment (2019Q1=100)



Sources: US Bureau of Labor Statistics, US Bureau of Economic Analysis, Deutsche Bundesbank, Eurostat, and IMF staff calculations.
Note: For Germany: headline and energy inflation are year-on-year changes in the harmonized index of consumer prices, and PPI inflation is the year-on-year change in the index of producer prices of industrial products sold on the domestic market; unemployment data is the index of registered unemployment pursuant to section 16 Social Security Code III and is seasonally adjusted; GDP data is seasonally and calendar adjusted. For the United States: headline and energy inflation are year-on-year changes in the consumer price index for all urban consumers, and PPI inflation is the year-on-year change in the producer prices for industry group; GDP and unemployment rate date are seasonally adjusted.

C. Modelling the Counterfactual Shock

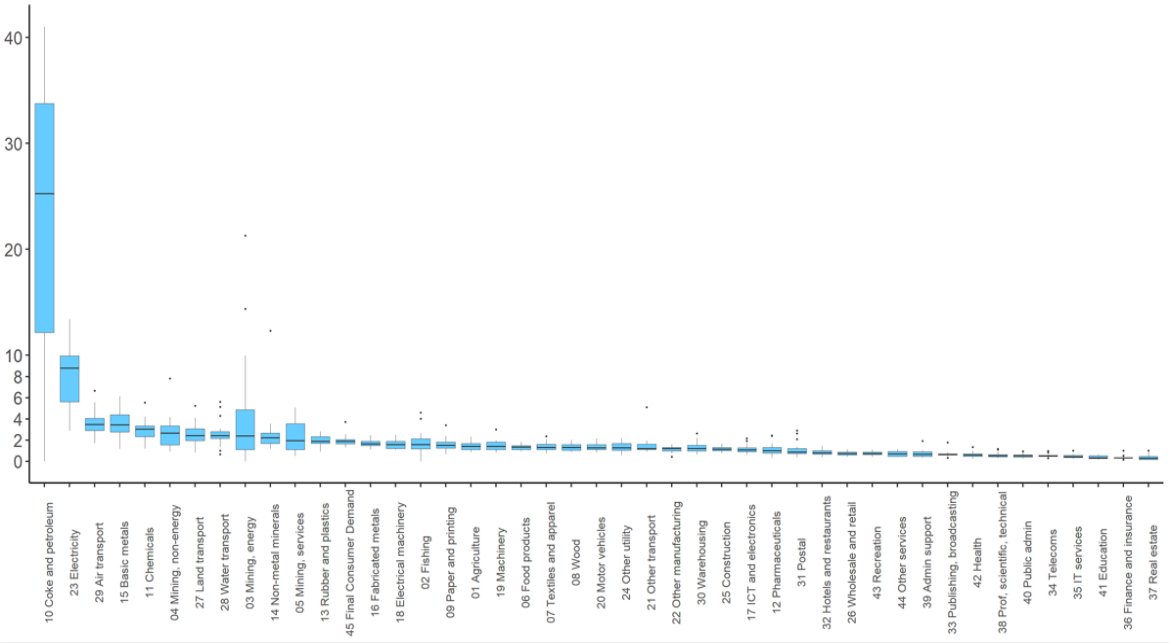
But the impact on domestic economies could have been larger, particularly for some industries, in the absence of government interventions. Indeed, concerns around vulnerability and a loss of competitiveness in some sectors were key to spurring policymakers to provide support. As domestic production of high energy-intensive goods weakened from the second quarter of 2022, imports of the same goods picked up before stabilizing only at the end of the year (Chiacchio and others, 2023). To better understand the sectoral problem presented to policymakers in early-2022, we developed an illustrative counterfactual scenario with the full (unmitigated) propagation of the energy price shock and simulated this in a cost-push model using OECD's 2021 edition of inter-country Input-Output (IO) tables. The analysis considers 66 economies plus the rest of the world using 2018 data.[5] In this analysis we consider both the first-round direct and indirect effects of more costly energy imports as well as the impact of more costly non-energy imports on the price of production, where we take into account the effect of rising global energy prices on countries' trade partners. This provides an estimate of Mechanical effect (i.e., discounting any behavioral responses by firms or consumers) of rising global energy prices for the prices of final consumer demand and producer prices in the Euro Area, while abstracting from other inflation dynamics (such as inflation expectations). As expected, we find that a modeled 50 percent shock to global energy prices affects some sectors of the economy much more than others (Figure 4).[6] In particular, the impact would have been larger on average in the production of petroleum, electricity, air transport, basic metals, and chemicals. Meanwhile, the real estate, finance and insurance, education, IT, and

[5] 2021 edition of Inter-Country Input-Output Tables provides most comprehensive country coverage and is based on most recent data. See Annex III for a description of the cost-push methodology.

[6] We calibrate the size of counterfactual energy price shock based on relevant international energy prices and energy consumption for Germany—a country that was significantly hit by the energy crisis—and estimate it to be 50 percent. This estimate is derived by comparing the weighted average price changes in international natural gas (Dutch TTF) and in crude oil (the average of three major benchmark prices – WTI, Brent, and Dubai) with a set of counterfactual price changes excluding the price shock prompted by Russia's invasion of Ukraine. We apply the same magnitude of the energy price shock (50 percent) to all countries in the Euro Area.

telecommunication services are the least affected. However, although the mechanical effect of a shock to energy prices appears small for many sectors, the failure of one or more systemically important energy intensive firms could have triggered a chain reaction, which our simple model is not able to capture. Therefore, it is hard to conclude whether input price pressure would have translated into more systemic issues of the type that policymakers feared.

Figure 4. Impact of a Simulated Counterfactual Energy Price Shock on Industry Prices in Euro Area



Sources: OECD, and IMF staff calculations.
Note: each bar presents medians and an interquartile range (25-75th percentiles).

D. Government Interventions to Support Firms

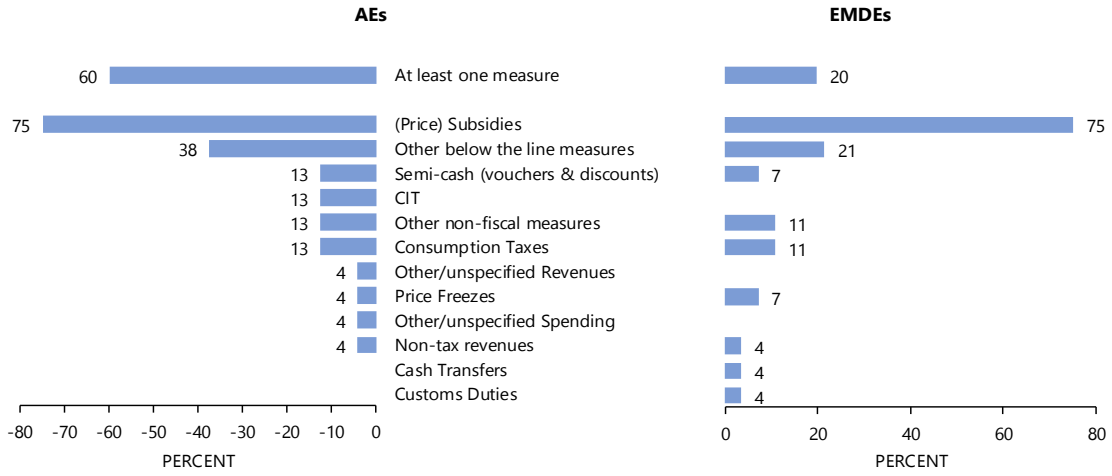
The surge in energy costs prompted many governments to announce support measures (Figure 5). Around three-quarters of advanced and emerging economies that implemented firm-support measures introduced price subsidies. Just over one-third of advanced economies with firm-support packages implemented other subsidies (below-the-line measures) while this figure was lower at 21 percent for emerging economies. Other measures took various forms of spending, tax, regulatory, and below-the-line fiscal support. For example, the German government introduced a temporary electricity and gas price brake for companies, temporary and targeted subsidy program for energy-intensive companies, and subsidies to energy companies to cover the cost of short-term procurement, storage, and transport of additional gas reserves.[7] These measures were on top of broad-based measures that reduced consumption taxes on energy products and several measures targeted at German households. [8] In the United States, given the more moderate price increase and pre-existing policies

[7] Under the temporary electricity and gas price brake German firms were provided with monthly rebate based on (i) the difference between market and reference prices and (ii) 80 percent of consumption volume in September 2022.

[8] Sgaravatti and others (2021) estimate total allocated support for households and firms in Germany between September 2021-June 2023 to have been EUR265 billion (6.8 percent of 2022 GDP). See https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices.

designed to ease the post-pandemic supply-demand mismatch, there was no major fiscal support package to mitigate the price shock.[9]

Figure 5. Breakdown of Policy Measures in Support of Firms



Source: Updated results of the IMF Database of Energy and Food Price Actions (DEFPA) Country Desk Survey from Amaglobeli and others (2023) (182 country teams' responses with 40 advanced economies and 142 emerging market and developing economies). AEs stand for Advanced Economies, and EMDEs for Emerging and Developing Economies.
Note: Policy measures announced in 2022.

III. Surveys of Firms in the United States and Germany

To gain insights into the impact of the energy price shock on firms, we designed thematic survey modules for integration into three existing firm surveys conducted by the Federal Reserve Bank and the Deutsche Bundesbank. These included the Atlanta Fed's survey of Business Inflation Expectations (BIE), the CFO survey by Duke University, Richmond Fed, and Atlanta Fed, and the Bundesbank's Online Panel—Firms (BOP-F) Survey. The BIE survey, which began in 2011, is a short survey of business decision-makers that draws from a panel of firms across all firm sizes and in all private nonagricultural sectors.[10] The CFO Survey is one of the longest-standing (nearly 30 years) and most comprehensive surveys of financial decision-makers in the United States. The CFO Survey is a nationally representative survey of financial decision-makers with US-wide coverage of firms ranging from small firms to Fortune 500 companies and features around 350 responses per quarter. The core survey questionnaire elicits own-firm and United States economic optimism, own-firm

[9] In response to rising energy prices caused by increased demand after the acute phase of the COVID-19 pandemic, the US government instituted sales of crude oil from the country's Strategic Petroleum Reserve (SPR), beginning in November 2021. Following usage throughout 2022, it was announced in December 2022 that the US Department of Energy would begin replenishing the SPR from March 2023.

[10] While the sampling frame only pulls from businesses in the states of Alabama, Florida, Georgia, Louisiana, Mississippi, and Tennessee (the 6th Federal Reserve District), its composition reflects the firm-size and industry makeup of the overall United States and typically features 300 respondents a month. See Meyer and Sheng (2022) for further details on the sampling frame, response rates, and other assurances of quality and representativeness of the panel.

expectations, and expectations for the aggregate United States economy.[11] The Bundesbank's BOP-F Survey includes both recurring questions on the economic situation of companies, their subjective probabilistic expectations, and thematic special modules. The survey covers all of Germany and, since July 2021, has been conducted on a quarterly basis with a net sample size of around 3,000 firms per month. Where possible, questions were kept identical in both the United States and German surveys to maximize comparability; however, where this was not possible, questions were designed to be as similar as possible (see Annex I for survey questions).

Surveys with the special modules were conducted in the first half of 2023 shortly after the end of the acute phase of the energy crisis. This allowed us to fully capture firms' immediate responses to the shock while giving business decision-makers time to formulate longer-term plans concerning their energy usage and production plans. In the United States, the survey module was deployed in the BIE during the first full week of March 2023 and in the CFO Survey during the first-quarter survey fielding period (February 27 – March 10, 2023). The Bundesbank's BOP-F survey's primary fielding period was during the first three weeks of May 2023 (May 2 – May 23, 2023), but questions on energy usage and intensity that had been asked in January 2023-March 2023 were also utilized. Nearly 2,500 responses from firms across the US and Germany were collected in this exercise, with approximately 2,000 of those responses coming from the Bundesbank's BOP-F survey. Response rates during the fielding periods that included our coordinated special question module did not differ meaningfully from historical averages for any of the three surveys.[12]

Analysis of the sample for each survey shows notable differences in the characteristics of firms in the United States and Germany. Firms in Germany are over one-and-a-half times more likely to have less than 100 employees and are almost twice as likely to be of high energy intensity, where this is taken to mean having energy costs greater than seven percent of total operating costs (Figure 6). A higher proportion of firms in Germany are in the 'other' services category, which includes education, finance, health, information, and leisure, with a share difference with the United States of 6 percentage points. This is followed by a higher share in the energy-intensive construction and natural resources sector, with a share difference of around 4 percentage points with the United States. Additionally, compared to the United States, high energy intensity firms are also far more likely to be small (91 percent of high energy intensity firms in Germany versus 53 percent in the United States).

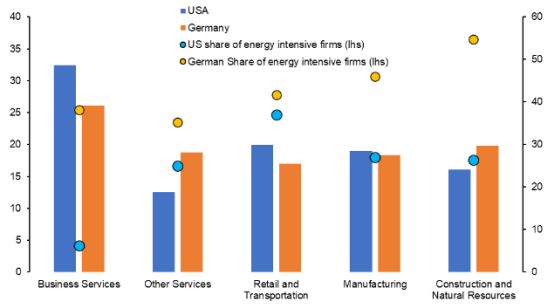
[11] For an in-depth background on the survey methodology, sampling frame, response rates, representativeness, and question design see: https://www.richmondfed.org/-/media/RichmondFedOrg/research/national_economy/cfo_survey/the_cfo_survey_methods.pdf

[12] While surveys provide useful way to learn about the behavior of firms, they have some shortcomings. For example, respondents may not provide honest or accurate information or provide answers that do not present their company's truthful state.

Figure 6. Characteristics of Firms in the Surveys in the United States and Germany.

a. Firm Size

b. Sectoral Composition and Energy Intensity



Sources: Federal Reserve Banks of Atlanta and Richmond, Bundesbank, and IMF Staff calculations.
Note: Firms are classed as having 'high energy intensity' if energy costs represent 7 percent or more of their total costs.

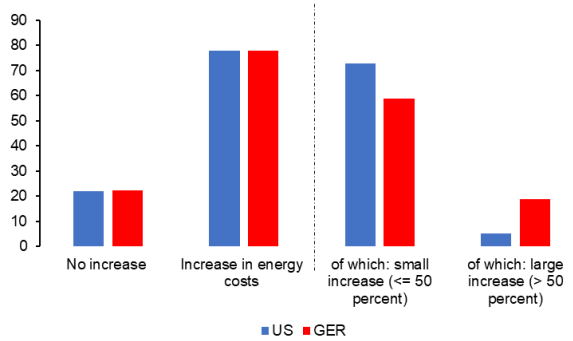
IV. Coping Strategies and Firms' Resilience

The results of the surveys conducted in the United States and Germany confirm that the majority of firms experienced an increase in energy costs in 2022 (Figure 7.a.). However, a higher share of firms in Germany experienced energy cost increase greater than 50 percent. Interestingly, for both the countries, there is limited within-country variation in the shares of firms experiencing energy cost increases or the share of firms experiencing a large increase in costs according to firm size or sectoral breakdown, emphasizing the systemic nature of the shock (Figure 7.b).

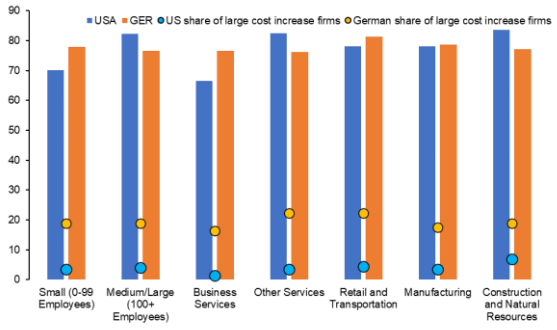
Figure 7. Rising Energy Costs in Germany and the United States

(Percent of firms)

a. Share of firms experiencing energy cost changes



b. Share of firms experiencing an increase in energy costs and share experiencing a large increase by firm size and sector



Sources: Federal Reserve Banks of Atlanta and Richmond, Bundesbank, and IMF Staff.
Note: A large (small) increase in energy costs is defined as an increase in energy costs greater (less) than 50 percent. The bars in panel b) report the share of total firms reporting a small or large increase in energy costs while the dots report the share of total firms reporting a large increase in energy costs.

Reflecting the differing magnitude of shocks experienced by each country, cross-country differences are stark when we consider how firms coped with rising energy costs. While close to one-third of firms in the United States and about a quarter of firms in Germany reported not to have passed higher energy costs on to

consumers, a quarter firms in Germany passed on more than half of the cost increase, with the corresponding share of US firms at 31 percent. To draw robust inferences on the factors determining passthrough of higher energy cost by firms to dowonstream firms or final consumers, we run logistic regressions with whether or not the firm passed through higher energy costs as the dependent variable (Table 1). We find that the passthrough is more likely amongst firms who report having high energy intensity. Morerover, while passthrough is more likely in the event of a higher cost shock, the relationship is not increasing in the size of the shock. These results are robust to using a dependent variable indicating passthrough of greater than 50 percent. The passthrough varies across sectors, in which the manufacturing, retail, and construction sectors in both countries exhibit a higher likelihood of passing costs on to consumers than in services sector. However, the differences are more stark in Germany, particularly in manufacturing.

Table 1. Passthrough and Firm Characteristics

	USA		Germany	
	Some Passthrough	High Passthrough (>50%)	Some Passthrough	High Passthrough (>50%)
Energy cost increase of 21-50%	4.45***	3.28***	1.56**	1.17
	(1.24)	(0.95)	(0.31)	(0.23)
Energy cost increase >50%	4.97**	3.32**	0.93	1.32
	(3.89)	(1.87)	(0.20)	(0.29)
High Energy Intensity	2.36***	0.78	2.23***	1.04
	(0.81)	(0.24)	(0.40)	(0.17)
Medium/Large Firm	1.74**	0.61*	1.63**	1.10
	(0.45)	(0.17)	(0.37)	(0.21)
Manufacturing	2.05**	0.55	2.87***	1.77***
	(0.71)	(0.21)	(0.70)	(0.36)
Retail	3.37***	1.30	1.68**	1.77**
	(1.29)	(0.48)	(0.44)	(0.48)
Construction	2.49**	0.78	1.68**	1.62**
	(0.93)	(0.31)	(0.42)	(0.38)
Constant	0.46	0.66	1.31	0.35
	(0.12)	(0.22)	(0.23)	(0.07)
Observations	*351*	*241*	*854*	*659*

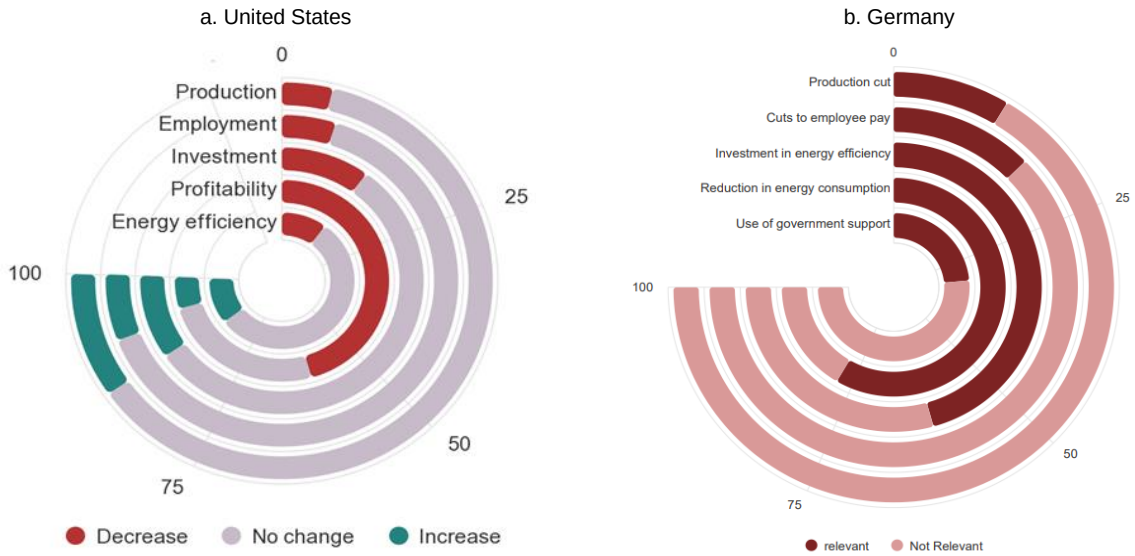
Standard errors in parenthesis; 0.10 > p *, 0.05 > p **, 0.01 > p ***
Note: coefficient greater than 1 indicates higher odds.

Passing higher prices to downstream firms or to final consumers is not the only coping strategy in responding to higher input costs. In the near-term, firms can reduce investment, production, worker wages or employment as energy prices rise. Firms may also be willing to absorb increased input costs in their profit margins by lowering mark-ups and running leaner operating surpluses. In the face of high energy price spikes, some firms may also accelerate the shift or transition to clean energy by increasing investments in energy efficiency or generally reduce energy consumption. This last margin of adjustment is particularly pertinent in the context of energy consumption and the Green Transition and, arguably, represents price mechanisms steering economies towards less consumption of fossil fuels.

The survey responses indicate that firms in both countries adjusted different non-price margins, possibly reflecting differences in the magnitude and perceived durability of the energy price shock (Figure 8). About 60

percent of German firms reported making or planning to make investments in improving energy efficiency and about three-quarters reported making or planning to make efforts to reduce their energy consumption. Aggregate energy balance indicators suggest that Germany significantly reduced consumption of natural gas and electricity in 2022 compared with 2021 (Figure 9).[13] A far smaller share of United States firms reported undertaking similar efforts and the majority reported adjusting their profit margin. However, these adjustments appear small in size with only 6 percent of firms reporting profits decreasing 'significantly' and a half of firms reporting their profits decreasing somewhat.[14] A relatively smaller share of firms in both countries reported having reduced or plan to reduce production (5.2 percent in the United States and 11.5 percent in Germany) or employment costs (6.5 percent in the United States and 16.9 percent in Germany). Finally, despite a severe energy price shock, only a small share of firms in Germany reported using or planning to use government support measures.

Figure 8. Firms' Strategies for Coping with Higher Energy Costs



Sources: Federal Reserve Banks of Atlanta and Richmond, Bundesbank, and IMF Staff.
Note: The chart in panel a) indicates the share of U.S. firms that reported a change in output, employment, investment, profitability, and energy efficiency as a result of the energy cost shock in 2022 (conditional on firms having experienced an increase in energy costs). The chart in panel b) indicates the proportion of German firms reporting price increases for products/services, cuts in production, cuts in employee pay, investments in energy efficiency, reduction in energy consumption, and the use of government support measures.

Possible differences in perceptions of the duration of the energy price spikes could affect firms' ongoing efforts to limit greenhouse gas emissions.[15] More than two-thirds of German firms reported undertaking or planning to undertake efforts to limit emissions. This contrasts with the United States, where only about one-third of

[13] In the European Union, the gas consumption by industry fell by 25 percent (25 bcm) in 2022, of which half is accounted by reduced output, 30 percent by fuel switching and 20 percent by efficiency gains (International Energy Agency, 2023).

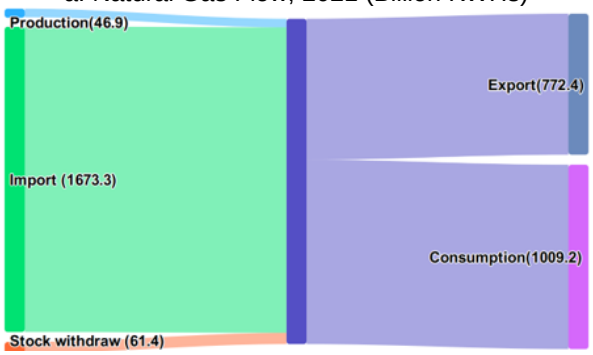
[14] In response to a hypothetical question how firms would respond under a scenario when the energy costs were to increase by 50 percent and remain 50 percent above the firm's expectations for the next three years, the firms in the United States would further decrease their profitability (by another 17 percentage points) compared to the response to questions under realized energy costs scenario. The findings in the United States that firms would absorb energy price shock through their profits is further corroborated by regression analysis discussed in Annex II.

[15] It was expected that the full suspension of the Russian gas supplies to Europe would result in very high prices and significant shortages in several of the most vulnerable countries in Europe, including Germany (see, for example, Di Bella and others, 2022). However, the availability of Liquified Natural Gas (LNG) was expected to significant dampen the adverse impact on EU economies from the supply disruption (Albrizio and others, 2022).

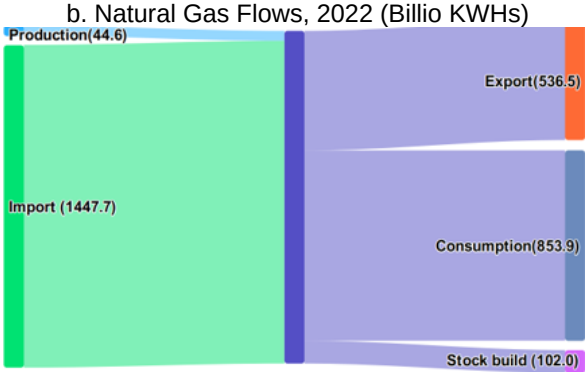
respondents reported some action or future plans (Figure 10.a.). Firms already having plans to reduce carbon emissions is stronlgy correlated with their investments in energy efficiency in both countries (Figure 10.b.&c.). Moroever, our results suggest that greener behaviors form a cluster of complementary actions, with a strong correlation between investing in energy efficiency, increasing renewable energy use, and decreasing energy consumption. The undertaking, or planning to undertake, efforts by firms to limit emissions is closely correlated with their positive responses touse the provisions of the fiscal incentive programs, such as the Inflation Reduction Act by the firms in the United States and the European Green Deal by the firms in Germany, respectively. In both countries, firms that currently undertake, or plan to undertake, efforts are more likely to report using the provisions of these fiscal incentive packages compared to other firms that had no plans to undertake efforts (Figure 10.d.).

Figure 9. Balance of Energy Flows in Germany

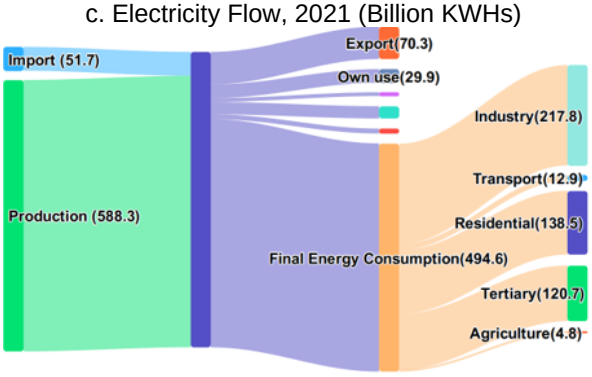
a. Natural Gas Flow, 2021 (Billion KWHs)



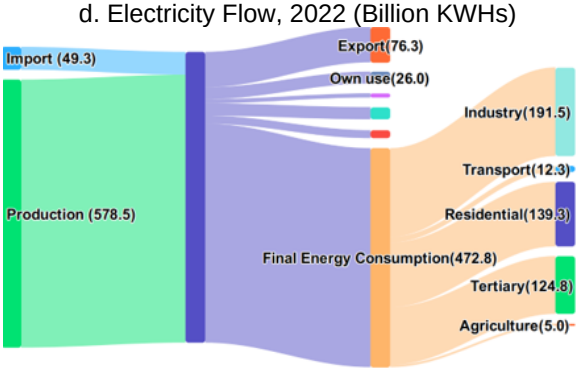
b. Natural Gas Flows, 2022 (Billio KWHs)



c. Electricity Flow, 2021 (Billion KWHs)



d. Electricity Flow, 2022 (Billion KWHs)



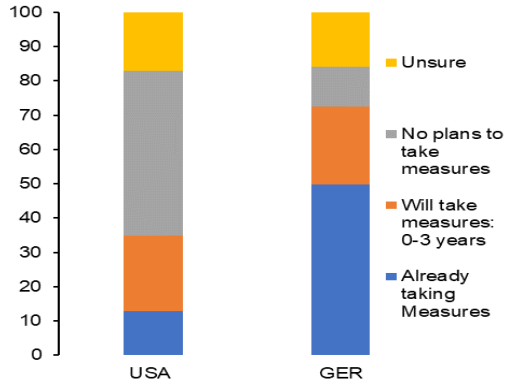
Sources: IEA for natural gas; and Enerdata for electricity.

In both countries, firms that have already invested in emission reductions indicate that they are more inclined to invest in additional emission reductions and take advantage of the fiscal incentives, especially if cost is considered a major hurdle for investment. Among these firms, the financial incentives of the policies appear to be the most important aspect. However, more generally, firms in the United States are more likely to report other constraints including potential disruption of processes, lack of specialty knowledge, and lack of workforce skills. It is interesting to note the difference, given that the workforce development has been a key pillar of the strategies in the EU Green Deal but the IRA does not. Nevertheless, our results only measure the effects of the announcements of both policies and not necessarily their implementation, given some details of the fiscal packages are being finalized and the short period of time that elapsed between the announcement of the IRA and Green Deal and our survey. In this vein, it should also be noted that close to half of German firms were

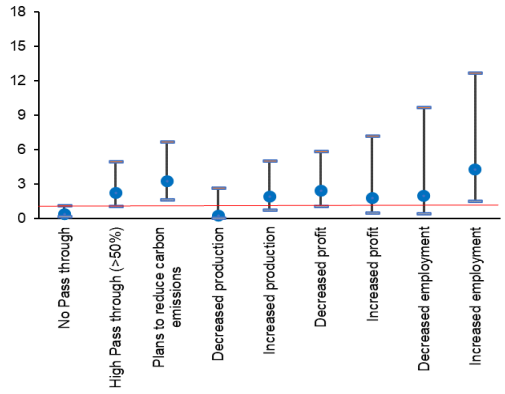
unsure about whether they would utilize the provisions of the Green Deal, perhaps reflecting the short interval between the package's announcement and the survey.

Figure 10. Plans to Reduce Greenhouse Gas Emissions, Investment in Energy Efficiency, and Utilization Provisions of the Inflation Reduction Act (United States) and the Green Industrial Deal (Germany)

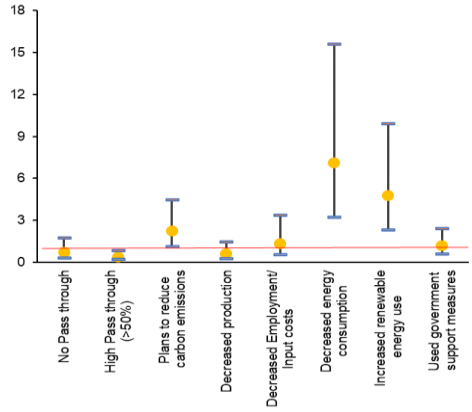
a. Plans to Reduce GHG Emissions
(Percent)



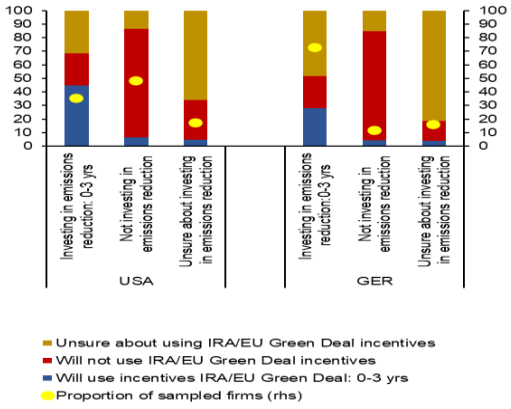
b. Key Correlates with Investment in Energy Efficiency, United States
(Likelihood Odds Ratio)



c. Key Correlates with Investment in Energy Efficiency, Germany
(Likelihood Odds Ratio)



d. Plans to Utilize IRA/GND Conditional on Existing Plans
(Percent)



Sources: Federal Reserve Banks of Atlanta and Richmond, Bundesbank, and IMF Staff.
Note: Chart in panel a. reports the proportion of sample firms that report plans to meaningfully reduce their Greenhouse Gas emissions. Charts in panels b. and c. report the results of logistic regressions with whether or not the firms invested in energy efficiency in response to rising energy costs as the dependent variable. Coefficients represent likelihood odds ratios, with estimates greater than one (red line) indicating higher odds. Chart in panel d. reports the proportion of firms that indicate the intention to use provisions of the Inflation Reduction Act (United States) and the European Green Deal (Germany) according to their pre-existing plans for investment in emissions reduction (x-axis categories).

V. Conclusion

The experience of the 2022 energy crisis suggests that firms can—and do—deploy multiple coping strategies in response to large-scale shocks. In Germany, where the magnitude and the perceived persistence of the shock was more pronounced, firms passed through higher energy costs to consumers, invested or made plans to invest in energy efficiency or reduced or made efforts to reduce consumption of energy while also having access to broad-based policy support. In the United States, where the shock was milder, policy intervention was limited, and the perception of its persistence was likely shorter, firms absorbed higher energy costs by lowering profitability. Our econometric investigation indicates that the passthrough is more likely amongst firms reporting to have high energy intensity. Pass-through was also found to be higher in manufacturing, retail and construction sectors but not in services sector.

The firm surveys reveal an inclination to reduce carbon emissions particularly where the impact of the energy shock is bigger while the take-up of fiscal incentives is strongly correlated with firms' current plans to reduce emissions. A higher share of firms in Germany than in the United States are undertaking or planning to undertake efforts to limit carbon emissions. This may reflect the different perceptions about the severity of the energy crisis. In both countries, firms committed to emission reduction are more inclined to leverage fiscal incentive packages, such as the Inflation Reduction Act in the U.S. and the European Green Deal in Germany. Financial incentives emerge as pivotal, yet U.S. firms frequently cite additional challenges, including potential disruption of processes, lack of specialty knowledge, and lack of workforce skills.

Findings in this paper highlight the importance of maintaining price signals incentivize energy saving and investments in energy efficiency. Moreover, support measures should be temporary and balance several key considerations, including the need to accelerate the Green Transition.[16] The goal of policy should be to provide sufficient stabilization in the event of an acute shock to give firms time to adjust their energy consumption – a key behavioral change for which we find some evidence in Germany. Moreover, support should be targeted towards firms that are most affected and whose failure poses the greatest short-term systemic risk, which must be balanced against long-term viability, including in the context of a greener economy. However, identifying most affected but viable firms may require non-trivial administrative costs. Government support through loans or guarantees should be tracked and published as part of fiscal risk statements (Battersby and others, 2022). Looking forward, policy efforts to support the take-up of greener technology through lowering the costs of adoption represent a better usage of public funds than supporting the consumption of fossil fuels.

[16] For more comprehensive discussion on best practice considerations in designing government support for firms, refer to Ari and others (2023).

Annex I. Survey Questions

BIE and CFO Surveys

1. Approximately what percentage of your operating costs are attributable to energy usage?

a) Realized over the last 12 months?
b) Anticipated in the next 12 months?

- 0-3 percent.
- 4-6 percent.
- 7-10 percent.
- Greater than 20 percent.

2a. On average, since the start of 2022, did your company experience an increase in its total costs associated with energy usage?

- Yes.
- No.

2b. By how much did your firm's total costs associated with energy usage increase since the start of 2022?

- Less than 25 percent.
- 25-50 percent.
- 51-75 percent.
- More than 75 percent.

2c. How much of the increase in total costs associated with your firm's energy usage since the start of 2022 was passed onto consumers through an increase in the price of goods and services?

- None.
- Less than 25 percent.
- 25-50 percent.
- 51-75 percent.
- More than 75 percent.

3a. Please indicate how increases in your firm's total energy costs since the start of 2022 have impacted (decreased significantly, decreased somewhat, no change, increased somewhat, or increased significantly) the following for your firm:

- Production.
- Employment.
- Overall investment.
- Profitability.
- Energy efficiency (consumption per unit of output).

3b. If your firm's total energy costs increased by unexpectedly by 50 percent today and remained 50 percent above your expectations for the next 3 years, how would this impact (would decrease significantly, would decrease somewhat, no change, would increase somewhat, or would increase significantly) each of the following for your firm:

- Production.
- Employment.
- Overall investment.
- Profitability.
- Energy efficiency (consumption per unit of output).

BOP-F Survey

1. In 2022, what proportion of your total production costs was accounted for by energy costs?

2. Please consider the period from end-March 2022 to end-March 2023. How did expenditure on energy and fuels develop in your enterprise during this period?

- Decreased significantly.
- Decreased.
- Stayed roughly the same.
- Increased.
- Increased significantly.

3. What proportion of your increased expenditure on energy and fuel have you passed on to your customers via the prices of your products and services?

- No pass through.
- Less than 25 percent.
- Between 25 and 50 percent.
- Between 51 and 75 percent.
- More than 75 percent.
- Does not apply.

4. What measures have been taken since 2021 or are planned for the near future as a result of the increased energy costs in your enterprise? (1=taken in 2021, 2=taken in 2022, 3=planned for the near future, 4=neither taken recently nor planned)

- Price increases for products and/or services.
- Cutbacks to production and/or product/service offerings.
- Relocation of production abroad.
- Increased imports of energy-intensive intermediate products.
- Purchases of cheaper intermediate products or adjustments to employees' remuneration.
- Investments to improve energy efficiency.
- Changes in behavior to reduce energy consumption.
- Replacement of natural gas with other fossil fuels.
- Increased use of renewable energy.
- Use of government support measures (including gas and electricity price brake).
- Other measures.

4a. Has your firm already, ore does it plan to, meaningfully reduce its carbon emissions (for example, by increasing energy efficiency, switching to renewable energy, or other measures)? For the purposes of this and subsequent questions, please exclude carbon offsets from consideration as a reduction in carbon emissions.

- Yes, already doing so.
- Yes, over the next 12 months.
- Yes: between 1 and 3 years from now.
- Not planning on doing so over the next 3 years.
- Unsure.

4b. Which barriers, if any, is your firm encountering or has it already encountered in its efforts/plans to meaningfully reduce its carbon emissions (for example, by increasing energy efficiency, switching to renewable energy, or other measures)? Please rank up to 3 options.

- Measures are costly/prohibitive.
- Meaningfully reducing carbon emissions results in downtime/disruption of existing business processes.
- Lack of consultancy resources/knowledge of how to reduce carbon emissions.
- Lack of skills in workforce/resistance of workforce.
- Other.

5a. The Inflation Reduction Act (IRA) of 2022, signed into law in August 2022, has committed over $350 billion in tax credits, grants, loans, and other incentives to assist firms and households with the transition to green energy. Has your firm already, or does it plan to, utilize the incentives provided by the IRA to meaningfully reduce its carbon emissions (for example, by increasing energy efficiency, switching to renewable energy, or other measures)?

- Yes, already doing so.
- Yes, over the next 12 months.
- Yes: between 1 and 3 years from now.
- Not planning on doing so over the next 3 years.
- Unsure.

5b. How will each of the following provisions in the IRA bill impact (directly or indirectly) your firm's adoption/likelihood (increase, decrease, no change, or unsure) of meaningfully reducing its carbon emissions (for example, by increasing energy efficiency, switching to renewable energy, or other measures)?

- Availability of financing/tax incentives for investing in energy efficiency/clean energy.
- Availability of energy infrastructure/new technology to ease transition to clean energy.
- Cost of energy efficiency/clean energy investments.
- Other.

5. Has your enterprise already significantly reduced its CO2 emissions or is it planning to do so (e.g., by increasing energy efficiency, switching to renewable energy, or other measures)?

- Yes, we have already reduced our CO_2 emissions.
- Yes, we plan to reduce our CO_2 emissions within the next twelve months.
- Yes, we plan to reduce CO_2 emissions within the next one to three years.
- No, and we are not planning to reduce our CO_2 emissions within the next three years.
- We have not yet taken any decisions.
- Does not apply.

6. What constraints did your enterprise encounter in its efforts to significantly reduce its CO2 emissions? (e.g., by increasing energy efficiency, switching to renewable energy, or other measures)? Please select one answer for each row and rank up to three answer options according to their relevance.

- Measures are costly or unaffordable.
- Significant reduction in emissions would lead to disruptions or failures in existing business processes.
- Lack of consultation or expertise in reducing CO2 emissions.
- Lack of qualifications or support on the part of employees.
- Other constraints.

7. In 2023, the European Commission presented its European Green Deal. The aim of this industrial plan is to accelerate the transition to clean energy, for example by facilitating the granting of state aid to firms, simplifying the regulatory framework, improving staff expertise, and increasing funding for research and development. Has your enterprise already used the incentives created by the European Green Deal to significantly reduce its CO2 emissions (e.g., by increasing its energy efficiency, switching to renewable energy, or other measures) or is it planning to do so?

- Yes, we have already used the incentives created by the industrial plan.
- Yes, we plan to use the incentives created by the industrial plan within the next twelve months.
- Yes, we plan to use the incentives created by the industrial plan within the next one to three years.
- No, and we are not planning to use the incentives created by the industrial plan within the next three years.
- We have not yet taken any decisions.
- Does not apply.

8. How will the following measures planned under the European Green Deal (directly or in-directly) affect whether your enterprise significantly reduces its CO2 emissions (e.g., by increasing energy efficiency, switching to renewable energy, or other measures)? Please select one answer for each row, with 1 indicating that the measure would make a CO2 reduction more likely, 2 a CO2 reduction less likely, 3 a CO2 reduction neither more or less likely, or 4 that the impact of the measure is unclear.

- Availability of funding/tax incentives or subsidies/state aid for investment in energy efficiency/clean energy.
- Availability of energy infrastructure/new technologies to facilitate the transition to clean energy.
- Measures to reduce the cost of investing in energy efficiency/clean energy.
- Employee training measures.
- Regulatory reform.

Annex II. Regression Analysis of Firm Responses in the United States

As discussed in section IV, the majority of US firms reported absorbing the shock from higher energy costs by lowering profitability. While the impact of realized energy cost increases on US firms' business decisions had limited effect on their production, employment, investment, and energy efficiency (with more than 70 percent of firms reporting no impact) more than 60 percent reported that the higher energy costs have decreased their profitability, particularly for those with high energy intensity and experiencing substantial energy cost increases. Reduced profitability was also the response of most US firms to a hypothetical scenario when an energy cost increases by 50 percent and remain 50 percent above the firm's expectations for the next three years.

These findings are further confirmed by the regression analysis. In Table A.II.1, the results demonstrate the response of US firms to increases in energy costs since the beginning of 2022. Firms that faced high energy costs were three times more likely (3.215, obtained from the odds ratio of 4.215-1) to pass on these costs. However, they were nearly 50 percent less likely to expand profitability compared to firms that experienced low energy costs. Firms with high energy intensity were approximately 46 percent less likely to expand their profitability but more likely to expand employment. Compared to the retail and wholesale trade sector, firms in the construction sector were about 50 percent less likely to experience profitability growth. Furthermore, firms in the manufacturing and service sectors were less likely to pass on energy costs.

Table 1. Impact of energy cost realizations on US firms' decisions

	(1)	(2)	(3)	(4)	(5)	(6)
	Pass-Through	Production	Employment	Investment	Profit	Efficiency
High energy intensity	1.097	1.324	2.377**	1.098	0.539**	0.694
	(0.260)	(0.456)	(0.924)	(0.341)	(0.142)	(0.212)
High energy cost realization	4.215***	0.576	0.630	0.825	0.493**	1.234
	(1.182)	(0.228)	(0.268)	(0.263)	(0.139)	(0.395)
Small firm	0.816	0.971	0.644	0.837	1.325	0.865
	(0.168)	(0.287)	(0.211)	(0.213)	(0.288)	(0.217)
Construction	0.780	0.551	1.842	1.319	0.480**	0.832
	(0.251)	(0.269)	(0.916)	(0.532)	(0.170)	(0.340)
Manufacturing	0.500**	1.420	0.463	0.806	0.609	1.053
	(0.159)	(0.625)	(0.243)	(0.332)	(0.213)	(0.421)
Services	0.337***	0.624	0.683	0.578	0.677	0.852
	(0.0916)	(0.242)	(0.295)	(0.196)	(0.195)	(0.283)
Observations	333	325	327	326	331	325

Note: This table shows the impact of energy cost increases since the start of 2022 on firms' passthrough of energy cost increase to increase in prices of goods and service (column 1), production (column 2), employment (column 3), overall investment (column 4), profitability (column 5), and energy efficiency (column 6). The dependent variable takes the value of 0, 1, 2, 3 and 4 corresponding to the five responses – "none," "less than 25%," "25-50%," "51-75%," and "more than 75%" in column (1). For columns (2) – (6), the dependent variable takes the value of -1, 0 and +1, corresponding to the responses of "decrease significantly and somewhat," "no change," and "increase significantly and somewhat." High energy cost realization is a dummy variable, equal to 1 for energy cost increase of 25% or more, and 0 otherwise. High energy intensity is a dummy variable, equal to 1 for energy intensity of 4% or more, and 0 otherwise. Small firm is a dummy variable, equal to 1 for small firms, and 0 for medium and large firms. We divide the firms into four super-sectors as defined in Meyer and Sheng (2022): (i) Construction, mining and utilities, and real estate, rental and leasing; (ii) Durable and non-durable goods manufacturing; (iii) Retail and wholesale trade and transportation and warehousing; and (iv) Educational services, finance and insurance,

healthcare and social assistance, information, leisure and hospitality, other services except government, and professional and business services. In the regression, the retail and wholesale trade sector is the omitted category. The odds ratios from the ordered logit model are reported, with standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

In the survey, we incorporated a hypothetical question that reads as follows: "If your firm's total energy costs were to unexpectedly increase by 50 percent today and remain 50 percent above your expectations for the next three years, how would this impact each of the following areas for your firm?" The aim of this question is to examine the potentially causal impact of significant energy shocks on firms' intended decisions. The dependent variable is the disparity between firms' planned decisions in response to this hypothetical large shock and the actual decisions they made in response to realized energy cost increases.

Following this hypothetically large energy shock, firms with high energy intensity would be approximately 40% less likely to expand their employment (column 2), and roughly 50% less likely to increase their profitability (column 4). Furthermore, small firms, firms in the manufacturing sector, and the service sector would be approximately 40%-50% less likely to improve energy efficiency (column 5).

Table 2. Impact of hypothetically large energy cost increases on US firms' planned decisions (relative to their actual decisions in response to realized energy cost increases)

	(1)	(2)	(3)	(4)	(5)
	Production	Employment	Investment	Profit	Efficiency
High energy cost realization	1.163	1.089	0.823	1.021	1.234
	(0.301)	(0.276)	(0.187)	(0.246)	(0.273)
High energy intensity	0.703	0.580**	0.817	0.522***	0.690
	(0.183)	(0.148)	(0.192)	(0.130)	(0.157)
Small firm	0.948	1.097	0.860	0.742	0.586**
	(0.245)	(0.279)	(0.195)	(0.176)	(0.131)
Construction	1.084	1.203	0.849	1.123	0.678
	(0.439)	(0.505)	(0.307)	(0.432)	(0.239)
Manufacturing	1.524	0.742	1.215	0.860	0.491**
	(0.619)	(0.294)	(0.447)	(0.332)	(0.173)
Services	1.206	0.688	0.694	1.090	0.550**
	(0.407)	(0.229)	(0.208)	(0.349)	(0.162)
Observations	318	322	321	326	322

Note: This table shows the impact of hypothetically large energy cost increases on the difference between firms' planned decision and actual decision in production (column 1), employment (column 2), overall investment (column 3), profitability (column 4), and energy efficiency (column 5). The dependent variable takes the value of -1, 0 and +1, corresponding to the responses of "negative differences," "zero difference," and "positive differences." This regression includes firms' actual decisions they made in response to realized energy cost increases as the control variables. (To save space, the coefficients on these control variables are not shown, but available upon request.) For explanations on other independent variables, see the notes in Table 1. The odds ratios from the ordered logit model are reported, with standard errors in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Annex III. Cost-Push Methodology

In the Leontief Price Model (Miller and Blair, 2022), also known as the cost-push input-output price model (Oosterhaven, 1996; Dietzenbacher, 1997), quantities are fixed, and the prices change, as opposed to the traditional Leontief demand-pull input-output quantity model where prices are fixed, and the quantities change.

The cost-push model works with the principle that prices of all industries are normalized to 1 to reflect the shares of the source industries valued added (VA) in the composition of the industries prices, this normalization is given by the equation below, where **P** is the matrix with the price normalization, **v** is the coefficients of value-added vector, and **A** is the matrix of technical coefficients.

$$P = diag(v)(I - A)^{-1}$$

As such, in the base year, the sum over a column of **P** will be 1, expressing equilibrium in the system.

The cost-push price model then can be used to measure the impact on prices throughout the economy given changes in primary inputs-prices (value added) or changes in prices of intermediate inputs (**A** matrix).

In the simulation conducted in this paper, it was assumed an increase of 50 percent in the prices of the products originating from the Mining of Energy industry, in all countries. As such, a new matrix of technical coefficients, $\mathbf{A_1}$ were obtained. Applying this new structure of production costs to the above equation, it was possible to obtain a new matrix of industries prices composition, $\mathbf{P_1}$, reflecting the price effects of this change over the economies. Using the information from $\mathbf{P_1}$ and **P** it is then possible to estimate how the prices of intermediated inputs changed for each industry in each country, and by summing over a column of $\mathbf{P_1}$ it is possible to obtain the price change for a given industry.

For a given economy, the producer prices index is estimated by using as weight the industries shares in the economy total output, and the final demand prices index is estimated by using as weight the industries products shares in the household's total consumption.

The simulation in this paper was done using the OECD Inter-Country Input-Output (ICIO)[17] tables, which considers 67 economies and 45 industries.[18]

[17] https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm

[18] The countries included in the model are: Argentina, Australia, Austria, Belgium, Bulgaria, Brazil, Brunei, Canada, Switzerland, Chile, China, Colombia, Costa Rica, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, Great Britain, Greece, Hong Kong, Croatia, Hungary, Indonesia, India, Ireland, Iceland, Israel, Italy, Japan, Kazakhstan, Cambodia, Republic of Korea, Laos, Lithuania, Luxembourg, Latvia, Morocco, Mexico, Malta, Myanmar, Malaysia, Netherlands, Norway, New Zealand, Peru, Philippines, Poland, Portugal, Romania, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, Sweden, Thailand, Tunisia, Türkiye, Taiwan, USA, Vietnam, and South Africa. Results are presented for Euro Area countries only.

References

Albrizio, Silvia, John Bluedorn, Christoffer Koch, Andrea Pescatori, and Martin Stuermer (2022), "Market Size and Supply Disruptions: Sharing the Pain of a Potential Russian Gas Shut-off to the European Union", IMF Working Paper No. 22/143.

Altig, David, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Brent Meyer, and Nicholas Parker (2022) Surveying business uncertainty. Journal of Econometrics 231, 282-303.

Amaglobeli, David, Mengfei Gu, Emine Hanedar, Gee Hee Hong, and Céline Thévenot (2023), "Policy Responses to High Energy and Food Prices", IMF working paper 23/74.

An, Zidong, Carola Binder, and Xuguang Simon Sheng (2023), "Gas price expectations of Chinese households", Energy Economics 120, 106622.

Ari, Anil, Nicolas Arregui, Simon Black, Oya Celasun, Dora Iakova, Aiko Mineshima, Victor Mylonas, Ian Parry, Iulia Teodoru, and Karlygash Zhunussova (2022), "Surging Energy Prices in Europe in the Aftermath of the War: How to Support the Vulnerable and Speed up the Transition Away from Fossil Fuels", IMF Working Paper No. 22/152.

Ari, Anil, Philipp Engler, Gloria Li, Manasa Patnam, Laura Valderrama (2023), "Energy Support for Firms in Europe – Best Practice Considerations and Recent Experience", IMF working paper 23/xx.

Arregui, Nicolas, Oya Celasun, Dora Iakova, Aiko Mineshima, Victor Mylonas, Frederik Toscani, Yu Ching Zong, Li Zeng, and Jing Zhou (2022), "Targeted, Implementable, and Practical Energy Relief Measures for Households in Europe", IMF Working Paper No. 22/262.

Baker, Scott, Tucker S. McElroy, and Xuguang S. Sheng (2020). Expectation formation following large, unexpected shocks. Review of Economics and Statistics 102 (2), 287-303.

Barrero, Jose Maria (2022) "The micro and macro of managerial beliefs". Journal of Financial Economics 143, 640-667.

Battersby, Bryn, Espinoza, Raphael, and others (2022), "The State as Financier of Last Resort", Staff Discussion Note SDN2022/003. International Monetary Fund, Washington, DC.

Bialek Sylwia, Claudia Schaffranka and Monika Schnitzer (2023), "The energy crisis and the German manufacturing sector: Structural change but no broad deindustrialisation to be expected", *VoxEU*

Binder, Carola (2020). "Coronavirus fears and macroeconomic expectations". Review of Economics and Statistics 102 (4), 721-730.

Brasier, Rachel, Andrea Pescatori, and Martin Stuermer (2023), "How Natural Gas Market Integration Can Help Increase Energy Security", IMF Blog.

Chiacchio, Francesco, Roberto A. De Santis, Vanessa Gunnella and Laura Lebastard (2023) "How have higher energy prices affected industrial production and imports?" ECB Economic Bulletin Issue 1/2023, European Central Bank

Choi, Sangyup, Davide Furceri, Prakash Loungani, Saurabh Mishra, and Marcos Poplawski-Ribeiro (2018), "Oil prices and inflation dynamics: Evidence from advanced and developing economies", Journal of International Money and Finance, 71-96.

Coibion, Olivier, Yuriy Gorodnichenko, and Saten Kumar (2018). How do firms form their expectations? new survey evidence. American Economic Review 108, 2671-2713.

Dao, Mai Chi, Allan Dizioli, Chris Jackson, Pierre-Olivier Gourinchas, and Daniel Leigh (2023), "Unconventional Fiscal Policy in Times of High Inflation", ECB Forum on Central Banking (June 26-28, 2023).

Deutsche Bundesbank. 2023. "Germany as a Location of Business: Selected Aspects of Current Dependencies and Medium-Term Challenges." Monthly Report, September 2023, Frankfurt

Di Bella, Gabriel, Mark Flanagan, Karim Foda, Svitlana Maslova, Alex Pienkowski, Martin Stuermer, and Frederik Toscani (2022), "Natural Gas in Europe: The Potential Impact of Disruptions to Supply", IMF Working Paper No. 22/145

Dietzenbacher, Erik. (1997) "In Vindication of the Ghosh Model: A Reinterpretation as a Price Model," Journal of Regional Science, 37, 629–651.

Enders, Zeno, Franziska Hunnekes, and Gernot Muller (2019) Monetary policy announcements and expectations: Evidence from German firms. Journal of Monetary Economics 108, 45-63.

International Energy Agency (2023), "Natural Gas Supply-Demand Balance of the European Union in 2023".

International Monetary Fund (2022), "World Economic Outlook – Update, Rising Caseloads, a Disrupted Recovery, and Higher Inflation", January 2022.

International Monetary Fund (2023), Fiscal Monitor: Climate Crossroads: Fiscal Policies in a Warming World. Washington, DC: IMF, October.

Kilian, Lutz, and Xiaoqing Zhou (2022), "Oil prices, gasoline prices, and inflation expectations", Journal of Applied Econometrics 37, 867-881.

Meyer, Brent, and Xuguang S. Sheng (2022). Unit Cost Expectations and Uncertainty: Firms' Perspectives on Inflation. Atlanta Fed working paper.

Milani, Fabio (2009), "Expectations, learning, and the changing relationship between oil prices and the macroeconomy", Energy Economics 31, 827-837.

Miller, Roland and Peter Blair (2022) Input-Output Analysis: Foundations and Extensions. Third Edition. Cambridge University Press.

Nasir Muhammad Ali, Daniel Balsalobre-Lorente, and Toan Luu Duc Huynh (2020), "Anchoring inflation expectations in the face of oil shocks and in the proximity of ZLB: A tale of two targeters", Energy Economics 86 104662.

Oosterhaven, Jan. 1996. "Leontief versus Ghoshian Price and Quantity Models," Southern Economic Journal, 62, 750–759.

Sgaravatti, Giovanni, Simone Tagliapietra, Cecilia Trasi, and Georg Zachmann (2021), "National fiscal policy responses to the energy crisis", Bruegel Datasets, first published 4 November 2021, available at https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices

Stiewe, Clemens, Ruhnau, Oliver; Hirth, Lion (2022): European industry responds to high energy prices: The case of German ammonia production, ZBW – Leibniz Information Centre for Economics, Kiel, Hamburg

Wehrhöfer, Nils (2023), "Energy Prices and Inflation Expectations: Evidence from Households and Firms", mimeo.

PUBLICATIONS

Firms' Resilience to Energy Shocks and Response to Fiscal Incentives: Assessing the Impact of 2022 Energy Crisis

Working Paper No. WP/2024/027