INTERNATIONAL MONETARY FUND

The Energy Origins of the Global Inflation Surge

Jorge Alvarez, Thomas Kroen

WP/25/91

2025
MAY

WORKING PAPER

 WP/25/91

IMF Working Paper
Research Department

The Energy Origins of the Global Inflation Surge
Prepared by Jorge Alvarez and Thomas Kroen*

Authorized for distribution by Deniz Igan
May 2025

ABSTRACT: This paper investigates the relationship between energy prices and inflation dynamics in the context of the global inflation surge during the COVID-19 pandemic. Using a comprehensive sector-level dataset covering over 30 countries and a local projections empirical strategy, we extend previous studies that primarily focused on single-country analyses or aggregate inflation measures. Our findings indicate that while the energy shocks of 2021–2022 were remarkable, the degree of inflation passthrough of energy shocks appears to be relatively stable over time. Moreover, we show that energy price shocks significantly influence inflation through stable sectoral channels, with structural characteristics such as energy dependence and price flexibility playing critical roles in the passthrough mechanism. These results underscore the necessity of a sectoral perspective in understanding inflationary pressures and highlight the importance of detailed data on price-setting mechanisms and intersectoral connectivity in understanding the energy-inflation passthrough.

RECOMMENDED CITATION: Alvarez,Jorge, and Thomas Kroen (2025). "The Energy Origins of the Global Inflation Surge". IMF Working Paper No. 25/91 (Washington, DC: International Monetary Fund).

JEL Classification Numbers:	D57, E31, E37, Q43
Keywords:	Inflation Passthrough; Energy Prices; Production Networks; Price Rigidities; Local Projections.
Author's E-Mail Address:	jalvarez@imf.org, tkroen@imf.org

* The authors would like to thank Emine Boz, Alberto Musso, Jean-Marc Natal, Galip Kemal Ozhan, Nicholas Sander, Sebastian Wende, and Sihwan Yang for their collaboration and helpful comments on this work. The authors also thank Kazuhiro Hiraki and Deniz Igan for helpful comments, and Weili Lin and Canran Zhang for excellent research assistance. The views expressed herein are those of the author(s) and should not be attributed to the IMF, its Executive Board, or IMF management. Any errors or omissions are the responsibility of the author(s).

The Energy Origins of the Global Inflation Surge

Jorge A. Alvarez
International Monetary Fund

Thomas Kroen *
International Monetary Fund

Date: May 2, 2025

Abstract

This paper investigates the relationship between energy prices and inflation dynamics in the context of the global inflation surge during the COVID-19 pandemic. Using a comprehensive sector-level dataset covering over 30 countries and a local projections empirical strategy, we extend previous studies that primarily focused on single-country analyses or aggregate inflation measures. Our findings indicate that while the energy shocks of 2021–2022 were remarkable, the degree of inflation passthrough of energy shocks appears to be relatively stable over time. Moreover, we show that energy price shocks significantly influence inflation through stable sectoral channels, with structural characteristics such as energy dependence and price flexibility playing critical roles in the passthrough mechanism. These results underscore the necessity of a sectoral perspective in understanding inflationary pressures and highlight the importance of detailed data on price-setting mechanisms and intersectoral connectivity in understanding the energy-inflation passthrough.

JEL codes: D57, E31, E37, Q43

Keywords: Inflation Passthrough, Energy Prices, Production Networks, Price Rigidities, Local Projections.

*Email: jalvarez@imf.org and tkroen@imf.org
The authors thank Emine Boz, Alberto Musso, Jean-Marc Natal, Galip Kemal Ozhan, Nicholas Sander, Sebastian Wende, and Sihwan Yang for their collaboration and helpful comments on this work. The authors also thank Kazuhiro Hiraki and Deniz Igan for helpful comments and Weili Lin and Canran Zhang for excellent research assistance. The views expressed herein are those of the author(s) and should not be attributed to the IMF, its Executive Board, or IMF management. Any errors or omissions are the responsibility of the author(s).

1 Introduction

The global inflation surge of 2021-2022 during a period of large energy price shocks brought questions about the passthrough of energy shocks into consumer prices to the spotlight. The energy shocks were large by historical standards, with variation across geographies based on the composition of energy inputs, the adaptability of energy generation systems, and the elasticity of energy inputs with respect to the underlying supply shocks. The case of Europe is a case in point, with the war in Ukraine disrupting gas supply lines and "the prices of oil, coal and gas [increasing] by around 40%, 130% and 180% respectively" (Adolfsen et al., 2022). Effects were more moderate but still sharp in other regions. This paper uses this variation to document the magnitude of the passthrough of energy price surges during 2020-2024 into overall inflation, determine the structural determinants behind the cross-country and cross-sector variation, and assess how the passthrough of energy prices into inflation during the recent inflation episode compares to historical episodes.

Ex-ante it is unclear how energy price passthrough during the Covid period should compare to prior periods of inflation surges. While models with price adjustment frictions (Alvarez and Neumeyer (2020), Caballero and Engel (2007), Cavallo et al. (2023), Golosov and Lucas Jr (2007), Karadi and Reiff (2019)) would predict unchanged passthrough conditional on the size of the shock, Bernanke and Blanchard (2023) show that the strength of energy price passthrough will depend on the strength of wage-price feedbacks. If those were stronger during the pandemic than before, stronger passthrough would be expected. Our paper provides an empirical test to distinguish between these competing hypotheses.

Our analysis documents three facts on the passthrough of energy shocks into inflation. First, while the magnitude of the 2021-2022 energy shock was remarkable, the extent of its passthrough into headline inflation at the country-level was generally comparable to previous episodes. Using a panel of more than 30 countries, we show in a local projections framework that the passthrough coefficient remained stable on average, contradicting the hypothesis of a potentially stronger-than-usual transmission. This was true both in advanced economies and in emerging markets in our sample. The finding suggests a certain structural rigidity in the inflationary response, even in the face of large energy shocks. These findings are robust to using the Känzig (2021) oil supply news shocks as an instrument for energy prices.

Second, the paper provides evidence of non-linear effects in the passthrough of energy prices. The country-level passthrough from energy prices into headline inflation is stronger when the change in energy prices is larger, consistent with models where firms are more responsive to larger shocks due to price adjustment frictions (Alvarez and Neumeyer (2020), Cavallo et al. (2023), Karadi and Reiff (2019)). Yet, the paper finds no significant change in these non-linearities post-2020. This lack of a broad-based strengthening in the passthrough implies that while energy prices impact inflation, the size of the passthrough conditional on the size of the shock remains relatively predictable in its non-linearity, a notable insight given the scale of recent price changes and the variety of energy inputs. This suggests that stable structural characteristics shape the passthrough of energy prices into headline inflation.

Third, for a better understanding of these structural characteristics, we delve into sector-level data and highlight the critical role of sectoral attributes, in particular energy input dependence and price flexibility, in influencing how energy shocks transmit through production networks and into aggregate inflation measures. These findings underscore the importance of sectoral heterogeneity, suggesting that energy-intensive sectors with more flexible pricing structures may propagate shocks faster and more strongly compared to more rigid, less energy-dependent sectors. The results are consistent with input-output linkages between heterogeneous sectors playing a role in shaping the stable, non-linear, aggregate energy passthrough.

The literature on the passthrough of energy price shocks to inflation has explored various theoretical and empirical dimensions, shedding light on the mechanisms through which energy price fluctuations influence aggregate inflation. Our paper makes two primary contributions to the literature.

First, the paper contributes to the literature on inflation dynamics during the COVID-19 pandemic by incorporating a sectoral dimension. This sectoral approach, enhanced by recent data from the Covid-19 period, provides a timely and detailed perspective on how structural sectoral characteristics — notably energy dependence and price flexibility—shape inflationary outcomes across economies. Several recent studies explore inflation dynamics during the COVID-19 pandemic, including Ball et al. (2022), Cavallo et al. (2024), and Dao et al. (2024) examining how pandemic-related supply chain disruptions and policy responses drove aggregate inflation dynamics in the US and globally. These studies suggest that the post-pandemic period exhibited increased sectoral heterogeneity, reinforcing the importance of analyzing sector-specific inflation responses. Chen et al. (2024) document the contribution of labor markets to the Covid inflation surge while Ocampo et al. (2022) discuss alternative inflation measures that strip out volatile inflation components beyond food and energy. Bobasu et al. (2024) show how energy price shocks affect the transmission of monetary policy while Boeck et al. (2025) and Patzelt and Reis (2024) study the impact of energy price shocks on inflation expectations. Lafrogne-Joussier et al. (2023) provide firm-level evidence on the passthrough from input price surges. Additionally, Miyamoto et al. (2024) provide evidence on energy price passthrough at the ZLB relative to non-ZLB times while Aruoba and Drechsel (2024) analyze the impact of monetary policy shocks on sectoral inflation outcomes. The role of global and common factors in inflation has also been examined by Auer et al. (2024), who document that energy price shocks contribute to synchronized inflation movements across countries. Euro-area-specific studies, such as Adolfsen et al. (2024), Alessandri and Gazzani (2025), Baba and Lee (2022), Casoli et al. (2024), Corsello and Tagliabracci (2023), and Hansen et al. (2023) investigate regional variations in energy passthrough and monetary policy.

Second, our paper extends previous studies on the energy-inflation passthrough, which often focus on single-country analyses or cross-country studies using aggregate inflation measures.

By leveraging a dataset that covers over 30 countries with sectoral granularity, our paper offers a broader and more nuanced view of how energy prices transmit across different sectors. Earlier contributions, including Abdallah and Kpodar (2023), Choi et al. (2018), Clark and Terry (2010), and De Gregorio (2012), provide evidence on the strength and persistence of energy price passthrough during the pre-Covid period. Silva et al. (2024) highlight differences between the passthrough of energy shocks and shocks to other commodity prices. Relative to this literature, our contribution shows that passthrough during the Covid period was comparable to prior episodes but the underlying energy price shocks were extraordinarily large. Moreover, we provide novel evidence on the key importance of sectoral heterogeneity.

Third the paper provides reduced-form evidence on energy price passthrough from a cross-country panel, documenting empirical regularities that can be used as inputs to discipline structural modelling work. Recent studies on the passthrough of energy price shocks using a structural modeling approach complemented with empirical evidence for the United States include (Afrouzi and Bhattarai (2023), Afrouzi et al. (2024), Gagliardone and Gertler (2023), and Minton and Wheaton (2023)). Afrouzi et al. (2024) develop a theoretical framework and present empirical evidence that oil price shocks act akin to negative supply shocks. Similarly, Minton and Wheaton (2023) examine the speed of downstream transmission of energy shocks using Producer Price Index (PPI) data, emphasizing the role of supply chain frictions and input-output linkages. Gagliardone and Gertler (2023) analyze the propagation of upstream energy shocks, finding that sectoral characteristics and monetary policy responses are crucial in determining the extent of inflationary spillovers. Relative to these papers we take a global perspective and focus on overall energy price passthrough, rather than more narrowly defined oil price passthrough.

Finally, further research has analyzed the role of sectoral characteristics in shaping inflation transmission. Alvarez-Blaser et al. (2024) highlight how firms' pricing strategies and input cost structures influence the magnitude and speed of passthrough from sectoral shocks. Several papers discuss monetary policy in models with production networks and sectoral input-output linkages (La'O and Tahbaz-Salehi (2022), Rubbo (2023), Silva (2023)). Our paper does not make a structural contribution but provides empirical estimates that can be used as an input to discipline structural model estimation.

The rest of the paper proceeds as follows. Section A describes the aggregate cross-country and sector-level datasets used. Section 3 provides descriptive evidence on aggregate energy price dynamics and the heterogeneity in sectoral energy price passthrough. Section 4 outlines the empirical local projections framework and presents the key findings, while section 5 concludes.

2 Data

The paper uses aggregate data to assess the passthrough of energy inflation into overall inflation at the country-level and sectoral data to assess sectoral passthrough dynamics. We describe each group of datasets below. Additional details are provided in annex A.

2.1 Aggregate Data

At the macro level, we use quarterly data on CPI inflation and GDP growth from the IMF WEO database. Output gaps are estimated using a univariate HP-filter. Oil, gas, and, coal prices are from the IMF's Primary Commodities database. For global oil and gas prices, we use the respective global indices in the database that aggregate the underlying oil (Brent, Dubai Fateh, WTI) and gas (American, European, Japanese) price indices into a global index. Nominal effective exchange rates and energy inflation are from Haver Analytics. Country-level energy inflation is measured using Haver Analytics' quarterly seasonally adjusted energy HICP index.

2.2 Sectoral Data

At the sectoral level, we primarily rely on two types of data: sectoral inflation data and data on sectoral input-output linkages to construct energy dependence measures at the sectoral level.

First, we source sectoral nominal and real value added for 11 sectors per country from the OECD Value Added by Activity database. We supplement this data with sectoral BEA data for the US and Haver Analytics data for Brazil. Sectoral value added deflators are constructed as the difference between quarterly nominal and real value-added growth rates.

Second, the paper relies on annual international input-output linkages from the OECD's ICIO data. The data provides detailed input-output linkages for 45 sectors across 76 individual countries from 1995 to 2020. The remainder of countries is summarized as the "rest of the world" so the input-output tables cover the entire global economy. Using international input-output tables is critical for our analysis of energy price passthrough since a significant share of energy inputs are imported for many countries. Thus, national input-output tables may understate sectoral energy dependence.

We denote the international input-output matrix by Ω, where elements are indexed by $\Omega_{i,j}$ and indicate the amount of input sector j sources from sector i. Let I denote the total number of sectors in the international input-output table and N the number of countries. Then, Ω has size INxIN. For the calculations, we will focus on the "technical matrix" (see Bartelme and Gorodnichenko (2015)), $\tilde{\Omega}$, which we obtain by dividing each column of Ω by sectoral gross output Y_i [1].

We construct two measures of energy dependence. Direct energy dependence is the total input share of energy in sectoral gross output. Total energy dependence is the sum of direct energy dependence and indirect energy dependence, measured by the Leontief-inverse

[1]Sectoral gross output Y_i can be computed as the sum of all intermediates that sector i uses plus sectoral value-added plus taxes less subsidies from the ICIO tables. Formally $\tilde{\Omega} = (\mathbf{Y}_1^{-1}, ..., \mathbf{Y}_i^{-1}, ..., \mathbf{Y}_I^{-1})'\Omega$. where $\mathbf{Y}_i^{-1}$ is a column vector with each entry equal to Y_i^{-1}

weighted energy dependence of suppliers. This captures all indirect input-output linkages across the production network.

Let e_i denote a INx1 vector of zeros with a one for sector i among the IN sector-country pairs and let e_{energy} denote a INx1 vector of zeros with ones for all sector-country pairs that include the energy sector.

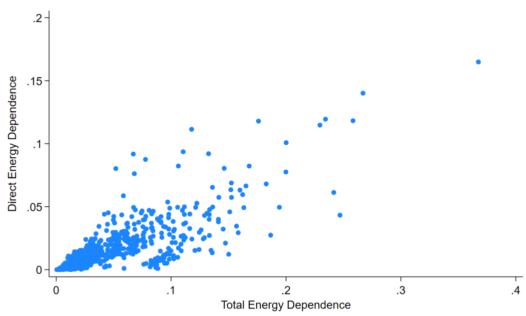
Direct and total sectoral energy dependence γ_i^{direct} and γ_i^{total} are then computed as:

$$\gamma_i^{direct} = e'_{energy}\tilde{\Omega}e_i \quad (1)$$

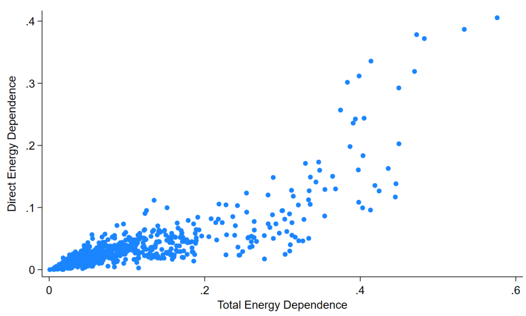
$$\gamma_i^{total} = e'_{energy}(I-\tilde{\Omega})^{-1}e_i \quad (2)$$

In the paper, we use two definitions for the energy sector: A narrow definition that only captures coke and refined petroleum products (ICIO sector C19) and a broader definition that also includes utilities (ICIO sector D)[2]. The sectoral energy dependence measures are aggregated from the 45 OECD ICIO sectors that follow the NACE classification to the 11 sectors for which we have sectoral price data using the average across sectors in the sectoral mapping. Finally, we impute missing sectoral energy dependence in recent years with the most recent available value.

Overall, the different definitions of sectoral energy dependence yield highly correlated measures at the country-sector level. Figure 1 shows that the correlations are .8 for the narrow energy definition (Panel a) and .83 for the broad energy definition (Panel b) in 2019. Moreover, as shown in Appendix Figure B.1, these correlations remain very high when including all years with available data from 1995-2020 and residualizing sectoral energy dependence on a country and a time fixed effect. These measures also correlate intuitively across sectors. For example, for "manufacturing, utilities and water supply", the average total energy dependence is .34 (.05 using the narrow definition), while for finance and insurance, the average total energy dependence is .03 (.01 using the narrow definition).



(a) Narrow Energy Definition



(b) Broad Energy Definition

Panels show 2019 correlation of sectoral energy dependence measures computed from OECD ICIO data for direct and total energy dependence. Energy sector is defined as ICIO sector C19 (Panel a) and as ICIO sectors C19 and D (Panel b).

Figure 1: Correlation of sectoral direct and total energy dependence in 2019

[2]Technically, sector D includes "electricity, gas, steam, and air conditioning supply."

Since the different measures are highly correlated, we will primarily rely on total energy dependence under the broad definition of the energy sector, unless otherwise noted.

Finally, to measure sectoral price flexibility we use data from Rubbo (2023). Building on firm-level BLS data that feeds into the US PPI, she constructs sectoral price adjustment probabilities δ_i. For the remainder, we assume that the sectoral price stickiness for US sectors captures the sectoral price stickiness of the same sectors in other countries.

The final sample is an unbalanced panel of 33 countries with country-level and sectoral price data as well as sectoral energy dependence data. The panel includes 25 advanced economies and 8 emerging markets (Brazil, Bulgaria, Chile, Colombia, Costa Rica, Hungary, Poland, Romania) with data starting in 1981. For most regressions, we use data starting in 2010 to focus on the recent time period. Both for the aggregate and for the sectoral regressions, we winsorize outcomes at the 2 and 98 percentile period-by-period to mitigate the impact of large outliers.

Table 1 provides an overview of the sectoral data for the sample since 2010. There is rich sectoral dispersion in sectoral inflation rates both when using more widely available sectoral value-added deflators and for sectoral PPIs, which are only available for a subset of sectors and for European economies.

	N	Mean	Std
Gross Value Added (in million USD)	19,790	17247.77	34569.61
Sectoral Value-Added Deflator (yoy)	20,468	3.72	14.60
Sectoral PPI Inflation (yoy)	8,533	3.27	13.22
Direct Energy Dependence	21,830	.0346	.0532
Indirect Energy Dependence	21,830	.0927	.0971
Sectoral Price Flexibility	21,830	.2566	.1492

Table summarizes sectoral data for sample from 2010-2024. Sectoral gross-value added is nominal (converted to USD). Sectoral value added deflators and PPI inflation rates are reported as yearly inflation rates in percent. Energy dependence is computed from OECD-ICIO data. Sectoral price flexibility is based on data from Rubbo (2023). Remaining data is from Eurostat and OECD.

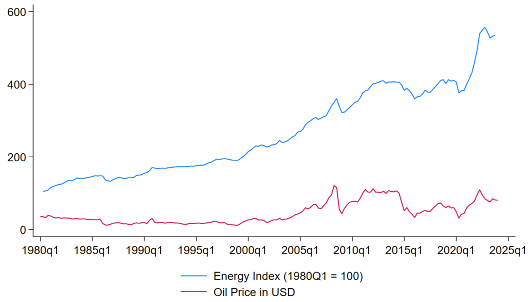
Table 1: Sectoral Summary Statistics

3 Descriptive Statistics and Stylized Facts of the 2021-2023 Inflation Episode

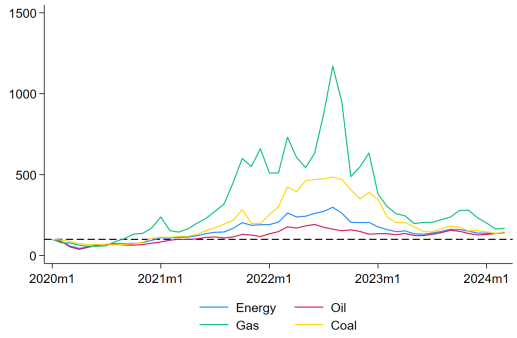
This section briefly describes the context of the 2021-2023 inflationary episode, and shows stylized facts on the behavior of energy input prices and the relationship between sectoral energy dependence and sectoral inflation.

3.1 Macro-level Developments

During 2021 and 2022, the world witnessed a large energy shock across countries and across energy sources. Global energy prices doubled relative to 2019 (Figure 2 Panel B), with a median price increase of more than 50 percent (Figure 2 Panel A).



(a) Energy and oil prices

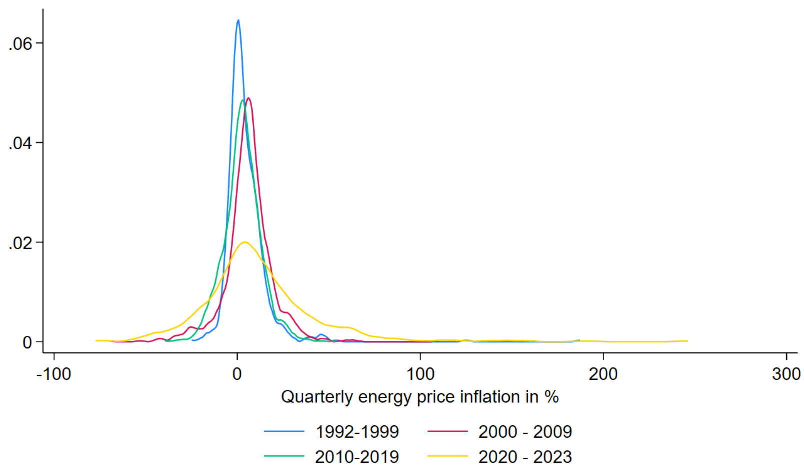


(b) Prices of energy commodities

Panel a) shows quarterly evolution of global oil prices (in USD) and global energy prices indexed to 100 in 1980Q1. Panel b) plots evoluation of quarterly energy prices across different energy sources using data from the IMF Primary Commodities Prices Database. Data are reported as indices normalized to 100 in January 2020 for Panel b). Gas, oil, and coal prices capture global averages of major blends.

Figure 2: Evolution of global energy prices

These large energy shocks were unprecedented by global historical standards. Figure 3[3] shows that the distribution of cross-country quarterly energy price inflation displayed much thicker tails and a much lower kurtosis than during previous decades. This was to a large degree driven by global factors both on the upside and the downside. Across countries, energy price inflation surged in 2021 and 2022, driving the right tail of the energy price distribution in 2020-2023 (in yellow). Conversely, the widespread decline in inflation in 2023 contributed to the unusually thick left-tail.



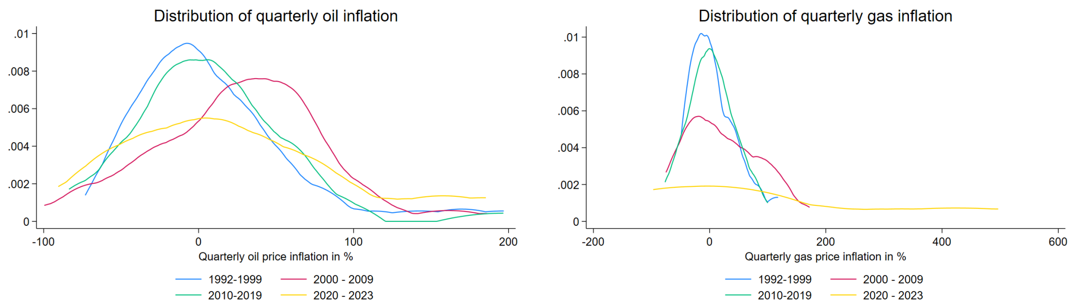
The figure reports the distribution of quarterly energy inflation using country-level data since 1992. Country-level energy inflation is measured using Haver's quarterly seasonally adjusted HICP energy inflation index. Quarterly price changes are reported in annualized rates.

Figure 3: Distribution of Energy Price Changes

Across energy sources, the 2020-2023 price movements were particularly large for gas

[3]This and the following chart use data since 1992, which is the earliest year with available gas price data.

prices in historical comparison. In contrast, the distribution of oil price changes was broadly in line with previous episodes, as shown in Figure 4. In particular, the 2020-2023 distribution of quarterly oil price changes was somewhat flatter but overall broadly comparable to the previous three decades. While 2020 and 2021 witnessed large oil price upswings, comparable large quarterly oil prices surges of more than 100 percent in annualized rates had occurred during each of the prior three decades. In contrast, the extremely low kurtosis of the gas price distribution and its thick tail were unprecedented. Quarterly gas price changes in excess of 200 percent (in annualized rates) as seen for example in 2022 after Russia's invasion of Ukraine (Albrizio et al. (2023)) had not occurred at least since the early 1990s. These gas price surges of 2022 came after a period of historically low gas price inflation from 2010-2019.



(a) Oil Prices **(b)** Gas Prices

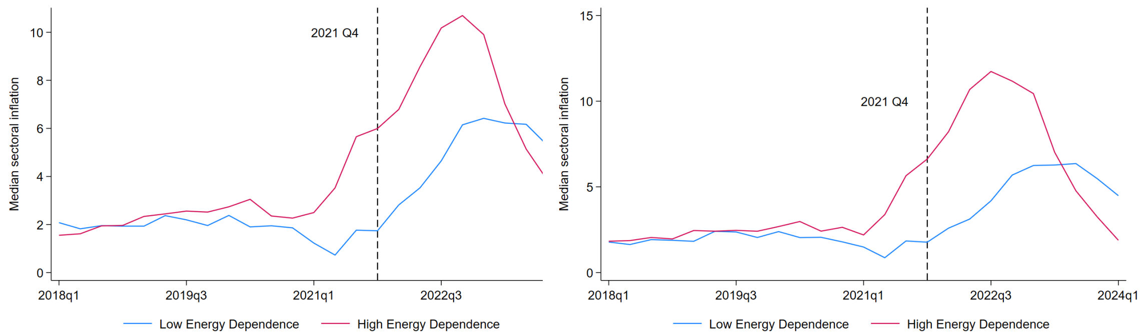
Figure reports distribution of quarterly changes of global oil and gas prices going back to 1992, the first year with available gas price data. Quarterly inflation rates are reported at annualized rates.

Figure 4: Distribution of quarterly oil and gas price changes

3.2 Sectoral Developments

The macro level developments had heterogeneous sectoral effects depending on sectoral energy dependence and price flexibility. Sectors with higher sectoral energy dependence witnessed a surge in sectoral inflation that began before Russia's invasion of Ukraine while inflation spread only gradually to less energy-intensive sectors. Figure 5 shows this pattern, using sectoral measures of energy dependence that are constructed country-by-country either using the input share of energy ("direct energy dependence" in Panel A) or using the input-output linkages weighted energy share ("total energy dependence" in Panel B), as outlined in Section 2.2. Across countries, energy-dependent sectors typically include agriculture, manufacturing, and construction while less energy-dependent sectors include several services sectors.

Inflation in energy-dependent sectors started surging over the course of 2021, mirroring the evolution of raw energy prices (Figure 2), and accelerated after Russia's invasion of Ukraine. Inflation in energy-dependent sectors subsequently peaked towards late 2022 before declining rapidly. In contrast, inflation in less-energy dependent sectors was affected much more gradually, but it remained more persistent and had a later peak. By early 2024, sectoral inflation in less-energy intensive sectors remained elevated, and on average 1-2 percentage points higher, than in more energy dependent sectors. Figure B.2 shows that these patterns are similar when using a broader definition of sectoral energy dependence that also includes the sectoral input reliance on utilities. These patterns are also robust after controlling for country-time variation and for country-sector time-invariant heterogeneity.[4]



(a) Direct Energy Dependence

(b) Total Energy Dependence

Figures report median quarterly inflation by sector, measured using sectoral value-added deflators in cross-country panel with 11 sectors per country. Sectoral energy dependence is computed as direct input share of energy (sector C19 - coke and refined petroleum products and sector D - utilities) in OECD ICIO Tables (panel a) or as direct + indirect share using the Leontief inverse (panel b).

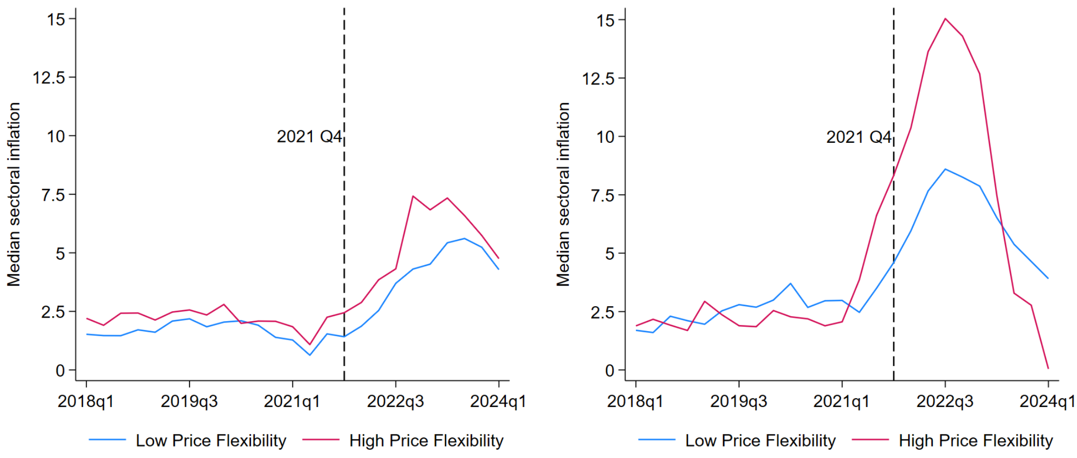
Figure 5: Evolution of Sectoral Inflation depending on energy dependence

The speed of propagation of higher energy input prices into higher sectoral inflation also depends on the speed of price adjustment. Figure 6 first splits sectors across countries along the median of sectoral energy dependence. Next, within each of these groups, we split sectors along the median of sectoral price flexibility relying on the sectoral price stickiness measures of Rubbo (2023). While sectoral price flexibility also played a role, the rapid surge in sectoral inflation was considerably driven by sectors with higher energy input reliance, irrespective of sectoral price flexibility. Although there are differences in inflation when contrasting the two price flexibility groups, the magnitude of the shocks induced contemporaneous increases in sectoral inflation in both groups with inflation surging faster in the more energy dependent sectors. As expected, inflation surged more moderately in the less price flexible sectors but persisted for longer.

4 Three Key Facts on the passthrough of Energy Shocks into Inflation

In this section, we present three central findings on how energy shocks translate into inflation. Each fact reflects unique aspects of the passthrough mechanism, helping to clarify the nature of inflationary responses to energy price increases observed during the 2021-2022

[4] Annex D provides a formal test using event study specifications that corroborate the patterns observed in Figure 5.



(a) Sectors with Low Energy Dependence **(b)** Sectors with High Energy Dependence

Figure reports median sectoral inflation splitting sectors first along the median of sectoral energy dependence and then within those sectors across the median of sectoral price flexibility. Sectoral energy dependence is measured using total (direct plus indirect) input reliance on sector C19 - coke and refined petroleum products - and sector D - utilities . Price flexibility is measured using the measure of Rubbo (2023). Dashed line indicates 2021Q4, the last quarter before the Russian invasion of Ukraine. Quarterly sectoral inflation is reported in annualized rates and collapsed using median across each group.

Figure 6: Role of Energy Dependence vs. Price Flexibility

inflation episode. For each fact, we outline our empirical strategy and methodological approach, using the cross-country, multi-sector, panel dataset that provides both aggregate and sectoral variation in inflation responses.

4.1 Fact 1: Stability of Passthrough Amid Historical Energy Shocks

First, we analyze the size of the inflation passthrough of energy prices and whether it has changed during the recent inflation episode, leveraging the country-level data set. We estimate coefficients on the passthrough of energy shocks into inflation using a local projections approach (Jordà, 2005) using the following specification:

$$\begin{aligned} \pi_{i,t+h} &= \alpha_i^h + \beta^h \pi_{energy,i,t} + \gamma^h \pi_{energy,i,t} Post_t + \nu^h Post_t + \theta^h X_{i,t-1} + \epsilon_{i,t+h} \\ \forall h &= 0, 1, 2, 3, ..., 12 \end{aligned} \tag{3}$$

Where i indexes countries and t indexes time. $\pi_{i,t+h}$ is a quarterly country-level measure of inflation (CPI inflation, median inflation, PPI inflation). $X_{i,t-1}$ is a vector of macroeconomic controls that includes two lags of inflation, the output gap, the change in the nominal effective exchange rate, and the policy rate. We estimate local projections for up to 12 quarters ahead with standard errors double-clustered by country and time.

Here, we do not include country-time fixed effects but rather rely on macroeconomic control variables to control for country-level macroeconomic conditions. If including time fixed effects, the impact of energy prices would effectively be identified relative to their global trend. Hence, we would only capture the passthrough of deviations of energy prices from their global level into inflation. Instead, we aim to capture the overall passthrough of energy price changes (both local and global). To facilitate comparison across time, we restrict our sample to the period since 2010. The series of coefficients β^h captures the baseline passthrough of energy inflation into inflation $\pi_{i,t+h}$ while the sequence of coefficients γ^h captures any post-Covid (2020-2024) differences.

Our estimation strategy takes the country-level increase in energy prices as given with energy price changes defined as changes in quarterly seasonally adjusted energy HICP indices. Thus, we estimate the passthrough of surges in energy inflation, taking as given any country-level policies to mitigate energy price surges.

Theoretically, it is unclear how the energy price passthrough during the Covid years should compare to prior episodes. On the one hand, New Keynesian models with price adjustment frictions, e.g. menu cost models (Alvarez and Neumeyer (2020), Cavallo et al. (2023), Golosov and Lucas Jr (2007)) would predict quantitatively comparable passthrough conditional on the size of the energy price shock. On the other hand, the strength of the energy price passthrough may depend on wage-price feedback loops and thus could be stronger or weaker than in previous periods as argued in Bernanke and Blanchard (2023). Hence, the strength of energy price passthrough during 2020-2023 and its comparison to prior episodes is ultimately an empirical question.

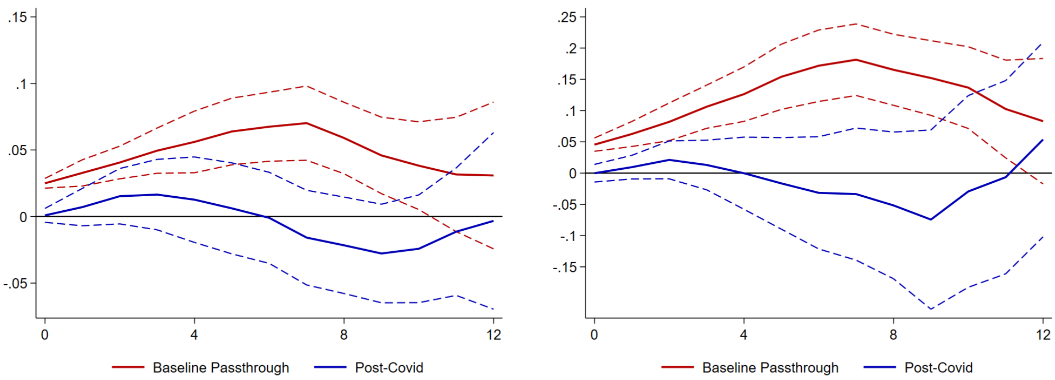
There are at least two identification concerns and one limitation related to regression (3).

First, while energy price surges during Covid were to a large degree unexpected (Adolfsen et al. (2024), Alessandri and Gazzani (2025)), the estimation in equation (3) could still be biased if energy prices and inflation are simultaneously determined, for example through aggregate demand shocks that feed into energy demand. To address these concerns, we additionally run a two-stage instrumental variables estimation using the Känzig (2021) oil supply news shock as an instrument. These exogenous oil supply shocks are identified from high-frequency oil futures price movements. Details are provided B.5.

Second, several countries implemented historically high levels of fiscal stimulus to stimulate the economy (De Soyres et al. (2023), Di Giovanni et al. (2023)) and, in the context of the shock of the energy price, to protect businesses and households from the impact of higher energy prices (Dao et al., 2023). This may create an omitted variable problem. However, the macroeconomic effects of fiscal stimulus should be captured by the output gap, for which we control. A remaining concern is that countries with higher energy price passthrough may systematically deploy more sectoral fiscal support, which would bias our passthrough estimates upward. The instrumental variables strategy mitigates these concerns by using an exogenous oil supply news shock.

Finally, one potential limitation of our paper is that it does not provide an in-depth assessment of energy support measures during the pandemic. While the IV approach provides a robustness check against potential heterogeneity, our paper does not provide an overall assessment of price support measures that were implemented in several countries. Those general equilibrium analyses are discussed in the macro literature (e.g.Erceg et al. (2024) and Guerrieri et al. (2022).

Figure 7 shows the baseline and post-COVID coefficients separately for the AEs and EMDEs in our sample, using the Consumer Price Index (CPI) as the inflation metric. The passthrough coefficients for AEs (red line in Panel A) of indicate that 1 percentage point increase in energy inflation has a passthrough of about .05 - .07 percentage point into CPI inflation over six quarters, which is broadly in line with similar findings in the literature. For different time periods, country samples, and energy definitions, empirical estimates oscillate between a passthrough of .02 and .08 (Afrouzi et al. (2024), Choi et al. (2018), Strauch et al. (2010)). Remarkably, differences in the passthrough over time (blue line) are not statistically significant. This is true for both advanced economies and emerging and developing economies.[5] Figure B.8 shows that these results are robust in an instrumental variable regression with the Känzig (2021) oil supply news shock as an instrument.



(a) AE

(b) EMDE

Figure reports local projections coefficients from country-level specification 3 estimated using sample from 2010 onward. Post-Covid dummy equals one for 2020 onward, and zero otherwise. Dependent variable is CPI inflation. Controls includes two lags of CPI inflation, output gap, change in nominal effective exchange rate, and policy rate. Standard errors are double clustered by time and country.

Figure 7: Passthrough into CPI inflation

Figure 8 confirms the previous finding using aggregate data on country-level producer prices inflation. The average passthrough into producer prices (red line) is larger than for CPI inflation. Importantly, the passthrough from energy price increases into producer prices inflation has not changed significantly during the pandemic period (blue line), implying that greater energy shocks rather than changes to energy price passthrough have been driving the recent inflation surge. Figure B.5 provides an additional robustness check using median CPI inflation as the measure of inflation.

Overall, these results are consistent with models that predict comparable energy price passthrough over time conditional on the size of the shock.[6] The findings of broadly unchanged

[5]The larger impact in EMDEs partly reflects the greater share of energy-intensive sectors in those countries (Fund, 2023)

[6]While some post-Covid coefficients are negative in Figures 7 and 8, many are only marginally or not significant

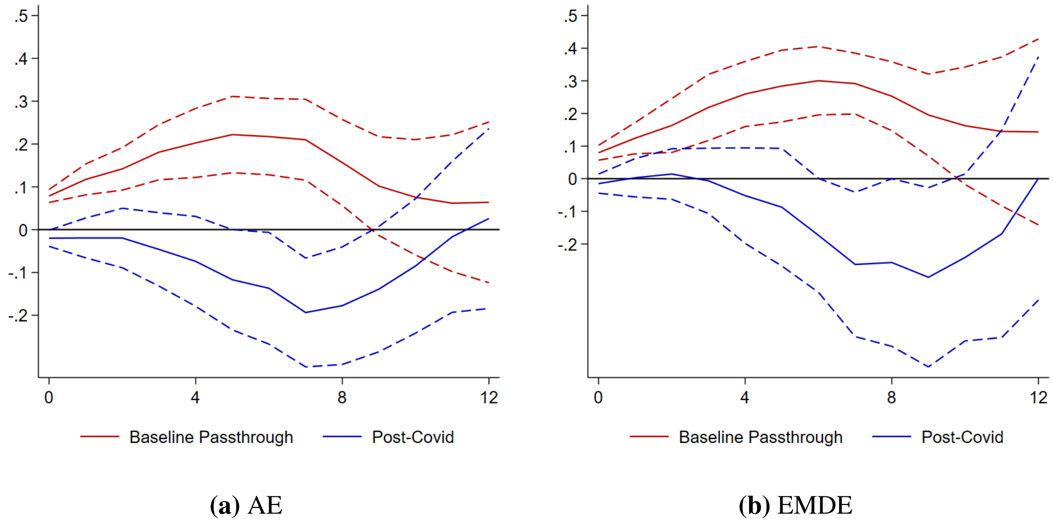


Figure reports local projections coefficients from country-level specification (3) estimated using sample from 2010 onward. Post-Covid dummy equals one for 2020 onward, and zero otherwise. Dependent variable is PPI inflation. Controls includes two lags of PPI inflation, output gap, change in nominal effective exchange rate, and policy rate. Standard errors are double clustered by time and country.

Figure 8: Passthrough into PPI inflation

passthrough over time also suggest that general equilibrium feedback loops, such as a potential wage-price spiral, were overall not stronger or weaker than during previous episodes. This is also consistent with other evidence that suggests the absence of a broad-based wage-price spiral during the Covid period (Alvarez et al. (2024)). While the passthrough of energy shocks was comparable, this does not imply that the passthrough from other supply shocks was also comparable. Several papers indicate that supply disruptions beyond food and energy played a key role in driving the Covid period inflation dynamics (e.g., Ball et al. (2022), Bai et al. (2024)).

4.2 Fact 2: Stable Non-linear Effects

Several papers in the literature highlight the importance of non-linearities during the recent inflationary episode (e.g. Cavallo et al. (2024), Dao et al. (2024), Gagliardone et al. (2023), Karadi et al. (2023)). Models incorporating costly price adjustment, such as (s,S) models (Alvarez and Neumeyer (2020), Caballero and Engel (2007), Cavallo et al. (2023), Karadi and Reiff (2019)), also imply potential non-linearities in the passthrough of energy shocks into inflation. Theoretically, firms may not ajdust prices in the presence of price adjustment frictions when shocks are small but they may adjust prices when larger socks occur. To assess global evidence on such non-linearities and changes over time in these, we estimate the following equation with quadratic and cubic terms for changes in energy prices:[7]

and the negative effects peter out after a few quarters.

[7]For simplicity of notation, we now use the notation $\pi_{e,i,t}$ to denote energy inflation in country i in period t.

$$\pi_{i,t+h}^{CPI} = \alpha_i^h + \beta_1^h \pi_{e,i,t-1} + \beta_2^h \pi_{e,i,t-1}^2 + \beta_3^h \pi_{e,i,t-1}^3 + \gamma_1 \pi_{e,i,t-1} \times \textbf{\textit{Post}}_t + \gamma_2 \pi_{e,i,t-1}^2 \times \textbf{\textit{Post}}_t + \gamma_3 \pi_{e,i,t-1}^3 \times \textbf{\textit{Post}}_t + \phi^h \textbf{\textit{Post}}_t + \theta^h X_{i,t-1} + \epsilon_{i,t+h} \quad \forall h = 0,1,2,...,12 \tag{4}$$

In this specification, the marginal effect of an energy price change onto CPI inflation now depends on the level of energy price inflation. Using estimates from equation (4), we compute marginal effects for three distinct levels of energy price inflation: i) a 1 percent level, ii) the pre-Covid standard deviation of 11 percent and iii) the 2020-2023 standard deviation of 20 percent. Results are reported in Figure 9.[8]

Consistent with Cavallo et al. (2024) and (s,S) models, there is evidence of non-linearities in the pre-COVID period in advanced economies (Panel A). When energy inflation is 1 percent, a marginal increase in energy inflation has a passthrough into CPI inflation of about 5 percent after 4-6 quarters. When energy inflation is 20 percent, a marginal increase in energy inflation is associated with a close to 10 percent passthrough in advanced economies. At higher levels of energy inflation, the inflationary effects onto CPI inflation are also more persistent. In the more limited EMDEs sample, there is no clear evidence for non-linearities. The marginal effect of higher energy inflation remains relatively constant when going from 1 to 20 percent energy inflation.

When comparing changes in these coefficients over time, we find little evidence for a systematic strengthening of these non-linear effects in the post-COVID period as evidenced by the statistically and economically insignificant coefficients on the change post-Covid (blue lines). While there are non-linearities in the passthrough from energy inflation into CPI inflation in AEs, these non-linearities were already present pre-Covid and did not strengthen significantly after 2020. For EMDEs, there is no clear evidence for non-linearities in the baseline nor in the post 2020 sample. The evidence suggests an absence of non-linearities both in the pre- post-Covid period for that group. Overall, as for Fact 1, this confirms stable inflation passthrough both in the pre and post Covid period.

[8]The individual coefficient estimates on the quadratic and cubic terms are reported in Figure B.4.

4.3 Fact 3: Structural Sectoral Characteristics Shape the Aggregate Passthrough

Since the aggregate passthrough of energy price changes into inflation was comparable in the pre- and post-Covid periods, this suggests that structural relationships at the sectoral level shape the passthrough of energy price changes into CPI inflation. For the remaining analysis, we turn to the multi-country sectoral data set that covers 11 granular sectors consistently across 33 countries. We then document drivers of heterogeneity in passthrough coefficients across sectors by estimating the following specifications that exploit cross-sectoral variation in inflation responses.

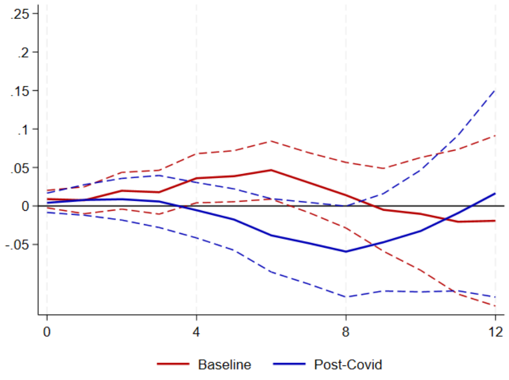
$$\pi_{i,j,t+h} = \alpha^h_{i,j} + \alpha^h_{i,t} + \beta^h \pi_{\text{energy},i,t} \text{ x } s^{energy}_{i,j} + \epsilon_{i,j,t+h} \quad \forall h = 0, 1, 2, \ldots, 12 \tag{5}$$

$$\pi_{i,j,t+h} = \alpha^h_{i,j} + \alpha^h_{i,t} + \beta^h \pi_{\text{energy},i,t} \text{ x } \delta_i + \epsilon_{i,j,t+h} \quad \forall h \tag{6}$$

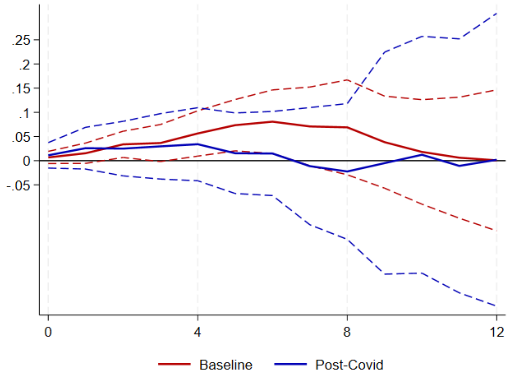
$$\pi_{i,j,t+h} = \alpha^h_{i,j} + \alpha^h_{i,t} + \beta^h \pi_{\text{energy},i,t} \text{ x } \delta_i \text{ x} s^{energy}_{i,j} + \epsilon_{i,j,t+h} \quad \forall h \tag{7}$$

Here, $s^{energy}_{i,j}$ is the input share of energy in sector j in country i, δ_j is a sectoral price rigidity measure from Rubbo (2023), and other variables are defined as before. The interaction coefficients, β^h, reflect how the passthrough of energy price variation into sectoral inflation is shaped by differences in price rigidity and energy dependence across sectors. Here we include country-sector fixed effects $\alpha^h_{i,j}$ and country-time fixed effects $\alpha^h_{i,t}$ to absorb any time-invariant variation specific to sectors in a given country and any time-varying country characteristics. For the main specifications, we use continuous interaction terms for $s^{energy}_{i,j}$ and δ_i. Robustness checks yield similar results when constructing discrete interactions terms.

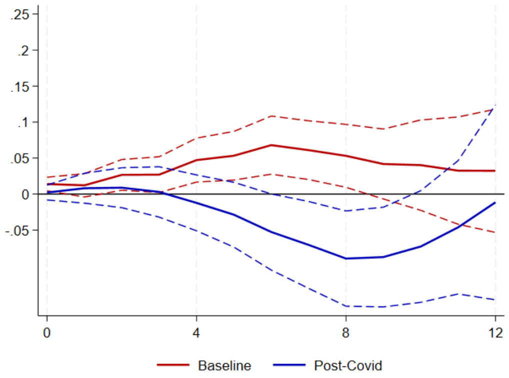
As before, fiscal policy stimulus could generate an omitted variable bias. However, any country-level fiscal stimulus is absorbed by the country-time fixed effects. The average propensity of countries to direct fiscal support towards specific sectors is controlled for through the country-sector fixed effects. The remaining concern are time-varying fiscal policies that specifically target the energy sector. To address this, we estimate sector-level instrumental variables regressions as a robustness check. Under the assumption that no fiscal measures relating to the energy sector are announced during the high-frequency time window for which the oil supply news shocks are identified, the instrument is orthogonal to sector-specific fiscal stimulus.



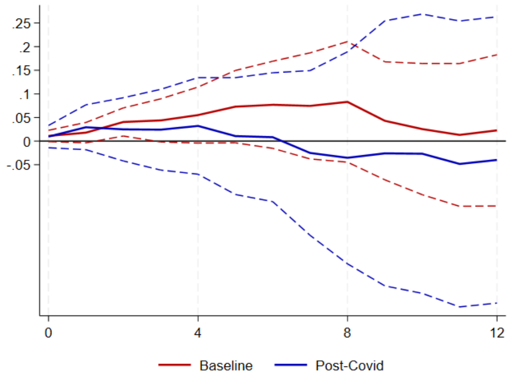
(a) AE - 1%



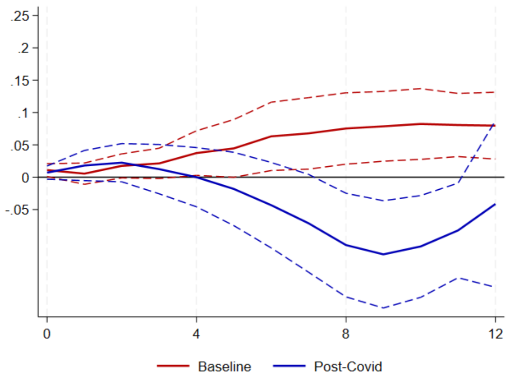
(b) EMDE - 1%



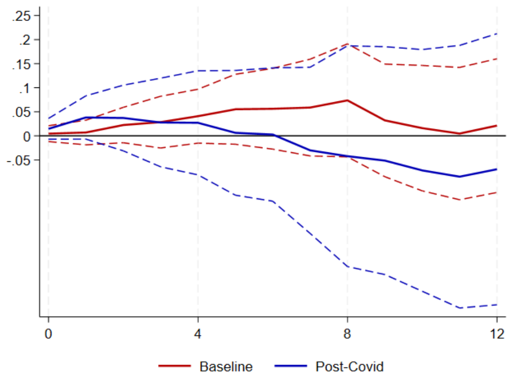
(c) AE - 11%



(d) EMDE - 11%



(e) AE - 20%



(f) EMDE - 20%

Figures report marginal effects of increase in energy inflation estimated from equation (4) for three different levels of energy inflation - 1%, 11%, and 20% - along with 95 % confidence bands. Red line reports baseline effect, blue line reports post-Covid change in passthrough. Sample starts in 2010. Post-Covid period is 2020 onward. AE = Advanced Economies. EMDE = Emerging and Developing Economies. Standard errors are double clustered by country and time.

Figure 9: Non-linearities in passthrough

Using the specification from equation (5), Figure 10 shows the differential impact of energy inflation onto sectors with higher relative to sectors with lower energy dependence using a continuous interaction term. Both when using direct sectoral energy dependence (Panel a) and when using our measure of total sectoral energy dependence (Panel b), effects are statistically and economically significant.[9]

These results are indicative of imperfect energy price passthrough at the industry-level. Using the estimates from Figure 10 Panel a), the passthrough from a 1 percent energy price increase is about 70 percent in the medium-run and lower in the short-run. For the first seven quarters, our confidence bands allow us to rule out full passthrough at the 95% level of significance. While this evidence is broadly consistent with the firm-level evidence[10], a caveat applies. Our measure of energy prices is a country-wide variable while the best measure would be at the industry-level to account for cross-industry heterogeneity in the energy input mix.

To provide a sense of magnitude for these effects, one may consider a sector in the US in 2022 Q1, when energy prices increased by 33.4 percent at annualized rates.[11] A one standard deviation (.072) more energy-dependent sector had .96 percentage points higher inflation at the peak using the estimates from Panel b). Going from the least to the most connected sector (difference of .245) implies 3.27 percentage points higher sectoral inflation at the peak.[12] Annex C shows that these effects are substantially larger than the passthrough of oil price change alone. This shows that the amplification of energy price changes is higher than for oil alone.[13] Overall, network amplification for oil price shocks is substantially weaker, revealing that energy shocks beyond oil inflation are critical, consistent with the descriptive evidence presented in Figure 2.

The specification from equation (6) allows us to assess the role of a key sectoral characteristic present in multi-sector New Keynesian models with nominal price rigidities[14]: sectoral price flexibility. Figure 11 shows how the response of sectoral inflation is stronger and faster in sectors with more flexible prices. As expected, sectoral inflation rises faster in sectors with higher price flexibility both in response to energy and oil price changes. Over time, sectoral inflation also rises in more sticky price sectors before subsiding and the double interaction point estimates are close to zero after 12 quarters. Once gain, energy price changes beyond oil are important. For a similar sized change in energy and oil inflation, the double interaction coefficient is about five times larger for the interaction with energy prices, again highlighting

[9] Figure B.9 shows that results are robust in an IV specification.

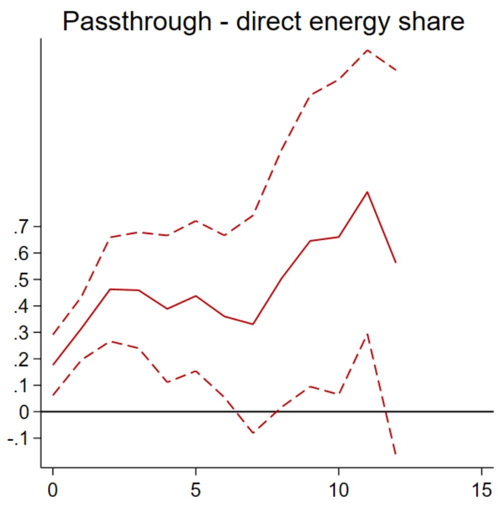
[10] Ganapati et al. (2020) estimate a passthrough rate of around 70% while Lafrogne-Joussier et al. (2023) find passthrough above 100%. In both studies, passthrough increases over time consistent with the presence of price rigidities that prevent full immediate adjustment.

[11] While the annualized change in US energy inflation was sizable, other countries notably in Europe witnessed much larger energy inflation surges in 2022.

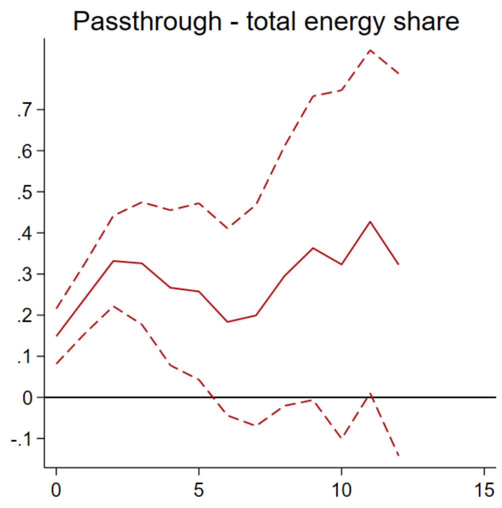
[12] The least energy-dependent sector is "Professional and Scientific Services". The most connected sector is "Agriculture".

[13] To illustrate this point, appendix figure C.12 reports the estimates from a similar regression specification to that of equation 7 that uses the double interaction with oil inflation rather than energy inflation.

[14] Such as Pasten et al. (2024) and Rubbo (2023).



(a) Direct Impact



(b) Total Impact

Figure reports estimated local projection double interaction coefficients on interaction of energy inflation with sectoral oil input share along with 95% confidence bands. Panel a) uses direct energy input share. Panel b) uses total energy input share. Energy sector is defined as ICIO sectors "C19" and "BDE". Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

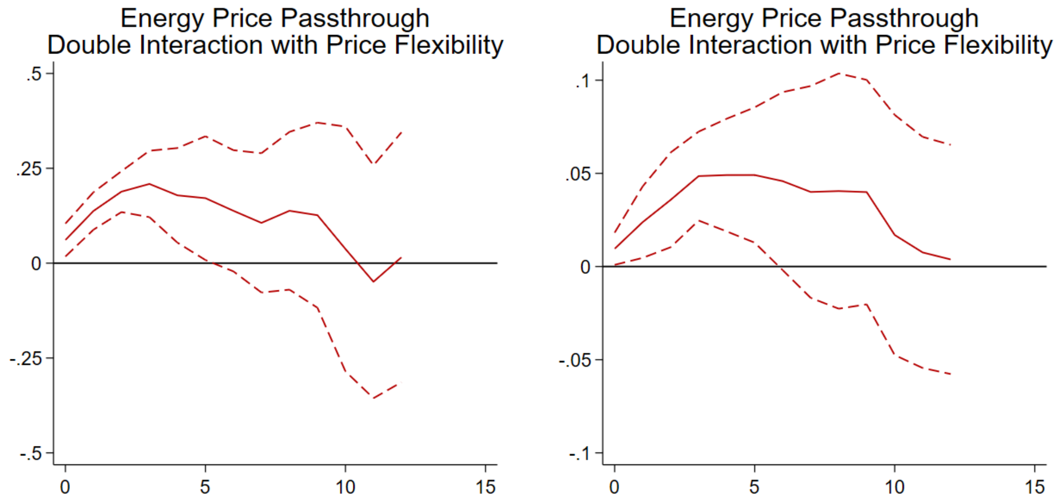
Figure 10: Passthrough depending on energy dependence

that energy prices beyond oil are important and that they have stronger network amplification than oil price changes alone. Figure B.10 shows that these results are robust to instrumenting energy price changes with an external instrument.

To get a sense of the economic meaning behind the coefficient magnitudes, marginal effects are computed as before. For a 33.4 percent price change in energy inflation (equivalent to US in 2022 Q1), a sector with one standard deviation (.156) higher price flexibility had 1.04 percentage point higher inflation relative to a less price flexible sector. Going from the least to the most price flexible sector (.509 difference) implies 3.4 percentage points higher inflation. These differences are quantitatively sizable relative to the peak in aggregate US CPI inflation, which reached 9.9 percent during the recent inflation surge.

Finally, using the triple interaction specification in equation (7), we test whether among more energy dependent sectors, passthrough is on average higher if those sectors have more flexible prices.[15] This provides a formal test for the pattern outlined in Figure 6. Figure 12 reports the estimated triple interaction coefficient and confidence intervals. The positive, marginally significant, triple interaction coefficients indicate that for a given level of sectoral price flexibility, sectoral inflation reacts more strongly to energy price changes for sectors with higher sectoral energy dependence. Hence, both sectoral price flexibility and sectoral energy dependence determine the response of sectoral inflation to energy prices and there is independent variation in the two sectoral measures. At the peak, a sector with average sectoral price flexibility (.256) would experience .48 percentage points higher inflation than a sector

[15]Figure B.11 shows that these patterns are robust in an instrumental variables specification.



(a) Energy Impact

(b) Oil Impact

Figure reports estimated local projection double interaction coefficients on interaction of energy inflation (Panel A) and oil inflation (Panel B) with sectoral price flexibility along with 95% confidence bands. Sectoral price flexibility is measured using the Rubbo (2023) measure. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure 11: Passthrough depending on sectoral price flexibility

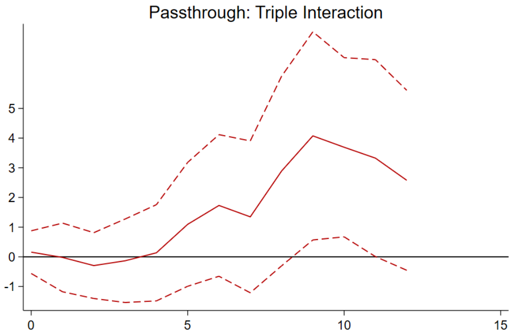
with one standard deviation lower energy dependence (.014) for a 33.4 percent energy inflation surge (US in 2022Q1).[16]

5 Conclusion

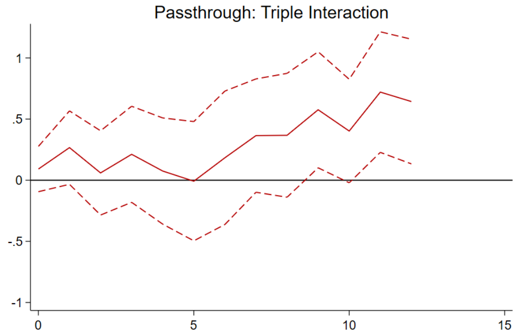
The prominent role of energy shocks during the 2021-2022 global inflation surge underscores the importance of understanding the passthrough dynamics from energy prices to overall inflation. This paper contributes to this understanding by documenting the magnitude, non-linear effects, and sectoral transmission channels of energy price passthrough using a comprehensive cross-country dataset with sectoral granularity. Our findings reveal that, despite the historical scale of recent energy shocks, the passthrough into headline inflation remained comparable to past episodes. This stability across both advanced and emerging economies suggests a certain structural rigidity in inflationary responses, even amid considerable price volatility.

Our analysis also identifies predictable non-linear effects in the passthrough mechanism, yet finds no evidence of a strengthened non-linear relationship across energy sources. This stability in non-linearities implies that inflationary responses to energy prices are consistent, even across diverse energy inputs and varied regional energy dependencies. Lastly, we find that sectoral attributes — notably energy dependence and price flexibility — play a vital role in shaping inflationary outcomes. Sectors with low energy intensity or rigid pricing structures demonstrate distinct passthrough behaviors, highlighting the critical importance of sectoral

[16] Figure B.7 shows that these findings are robust to defining discrete interaction terms with dummy variables.



(a) Energy Impact



(b) Oil Impact

Figure reports estimated local projection triple interaction coefficients on interaction of sectoral price flexibility and energy dependence with energy inflation (Panel A) and oil inflation (Panel B) with sectoral price flexibility along with 95% confidence bands. Sectoral price flexibility is measured using the Rubbo (2023) measure. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure 12: Passthrough depending on sectoral energy dependence and sectoral price flexibility

heterogeneity in understanding aggregate inflationary pressures.

The results suggest that gathering more detailed data on price-setting mechanisms, intersectoral connectivity, and other sector-specific structural characteristics could be a valuable endeavor in better understanding the passthrough of energy shocks into overall inflation. Such data would provide central banks with critical insights, improving inflation forecasts and allowing them to tailor policy responses to inflationary shocks more effectively.

References

Abdallah, C. and Kpodar, K. (2023). How large and persistent is the response of inflation to changes in retail energy prices? *Journal of International Money and Finance*, 132:102806.

Adolfsen, J. F., Kuik, F., Schuler, T., and Lis, E. (2022). The impact of the war in ukraine on euro area energy markets. *Economic Bulletin Boxes*, 4.

Adolfsen, J. F., Minesso, M. F., Mork, J. E., and Van Robays, I. (2024). Gas price shocks and euro area inflation. *Journal of International Money and Finance*, 149:103183.

Afrouzi, H. and Bhattarai, S. (2023). Inflation and gdp dynamics in production networks: A sufficient statistics approach. *NBER Working Paper No. 31218*.

Afrouzi, H., Bhattarai, S., and Wu, E. (2024). Relative-price changes as aggregate supply shocks revisited: Theory and evidence. *Journal of Monetary Economics*, 148:103650.

Albrizio, S., Bluedorn, J., Koch, C., Pescatori, A., and Stuermer, M. (2023). Sectoral shocks and the role of market integration: The case of natural gas. In *AEA Papers and Proceedings*, volume 113, pages 43–46. American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203.

Alessandri, P. and Gazzani, A. (2025). Natural gas and the macroeconomy: not all energy shocks are alike. *Journal of Monetary Economics*, page 103749.

Alvarez, F. and Neumeyer, P. A. (2020). The passthrough of large-cost shocks in an inflationary economy. *Serie Banca Central, análisis y políticas económicas, no. 27*.

Alvarez, J., Bluedorn, J. C., Hansen, N.-J., Huang, Y., Pugacheva, E., and Sollaci, A. (2024). Wage–price spirals: what is the historical evidence? *Economica*, 91(364):1291–1319.

Alvarez-Blaser, S., Auer, R., Lein, S. M., and Levchenko, A. A. (2024). The granular origins of inflation. *NBER Working Paper No. 33404*.

Aruoba, S. B. and Drechsel, T. (2024). The long and variable lags of monetary policy: Evidence from disaggregated price indices. *NBER Working Paper No. 32623*.

Auer, R., Pedemonte, M., and Schoenle, R. (2024). Sixty years of global inflation: a post-gfc update. *BIS Working Paper No. 1189*.

Baba, C. and Lee, M. J. (2022). Second-round effects of oil price shocks–implications for europe's inflation outlook. *IMF Working Paper 22/173*.

Bai, X., Fernández-Villaverde, J., Li, Y., and Zanetti, F. (2024). The causal effects of global supply chain disruptions on macroeconomic outcomes: evidence and theory.

Ball, L., Leigh, D., and Mishra, P. (2022). Understanding us inflation during the covid-19 era. *Brookings Papers on Economic Activity*, 1:54.

Bartelme, D. and Gorodnichenko, Y. (2015). Linkages and economic development. *NBER Working Paper No. 21251*.

Bernanke, B. and Blanchard, O. (2023). What caused the us pandemic-era inflation? *Hutchins Center Working Paper No.86*.

Bobasu, A., Dobrew, M., and Repele, A. (2024). Heterogeneous effects of monetary tightening in response to energy price shocks. *Research Bulletin*, 123.

Boeck, M., Zörner, T. O., and Nationalbank, O. (2025). Natural gas prices and unnatural propagation effects: The role of inflation expectations in the euro area. *Energy Economics*.

Caballero, R. J. and Engel, E. M. (2007). Price stickiness in ss models: New interpretations of old results. *Journal of monetary economics*, 54:100–121.

Casoli, C., Manera, M., and Valenti, D. (2024). Energy shocks in the euro area: disentangling the pass-through from oil and gas prices to inflation. *Journal of International Money and Finance*, 147:103154.

Cavallo, A., Lippi, F., and Miyahara, K. (2023). *Inflation and misallocation in New Keynesian models*. EIEF, Einaudi Institute for Economics and Finance.

Cavallo, A., Lippi, F., and Miyahara, K. (2024). Large shocks travel fast. *American Economic Review: Insights*, 6(4):558–574.

Chen, S., Igan, D., Lee, D. Q., and Mishra, P. (2024). Inflation and labor markets: A bottom-up view. *IMF Working Paper No. 24/220*.

Choi, S., Furceri, D., Loungani, P., Mishra, S., and Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: Evidence from advanced and developing economies. *Journal of International Money and Finance*, 82:71–96.

Clark, T. E. and Terry, S. J. (2010). Time variation in the inflation passthrough of energy prices. *Journal of Money, credit and Banking*, 42(7):1419–1433.

Corsello, F. and Tagliabracci, A. (2023). Assessing the pass-through of energy prices to inflation in the euro area. *Bank of Italy Occasional Paper*, (745).

Dao, M., Dizioli, A., Jackson, C., Gourinchas, P.-O., and Leigh, D. (2023). Unconventional fiscal policy in times of high inflation. *IMF Working Paper No. 23/178*.

Dao, M. C., Gourinchas, P.-O., Leigh, D., and Mishra, P. (2024). Understanding the international rise and fall of inflation since 2020. volume 148, page 103658. Elsevier.

De Gregorio, J. (2012). Commodity prices, monetary policy, and inflation. *IMF Economic Review*, 60(4):600–633.

De Soyres, F., Santacreu, A. M., and Young, H. L. (2023). Demand-supply imbalance during the covid-19 pandemic: The role of fiscal policy. *Federal Reserve Bank of St. Louis Review*.

Di Giovanni, J., Kalemli-Özcan, Ş., Silva, A., and Yıldırım, M. A. (2023). Quantifying the inflationary impact of fiscal stimulus under supply constraints. In *AEA Papers and Proceedings*, volume 113, pages 76–80. American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203.

Erceg, C. J., Kolasa, M., Lindé, J., and Pescatori, A. (2024). Can energy subsidies help slay inflation? *IMF Working Paper No. 24/81*.

Fund, I. M. (2023). Regional economic outlook for asia and the pacific: Challenges to sustaining growth and disinflation.

Gagliardone, L. and Gertler, M. (2023). Oil prices, monetary policy and inflation surges. *NBER Working Paper No. 31263*.

Gagliardone, L., Gertler, M., Lenzu, S., and Tielens, J. (2023). Anatomy of the phillips curve: Micro evidence and macro implications. *NBER Working Paper No. 31382*.

Ganapati, S., Shapiro, J. S., and Walker, R. (2020). Energy cost pass-through in us manufacturing: Estimates and implications for carbon taxes. *American Economic Journal: Applied Economics*, 12(2):303–342.

Golosov, M. and Lucas Jr, R. E. (2007). Menu costs and phillips curves. *Journal of Political Economy*, 115(2):171–199.

Guerrieri, V., Lorenzoni, G., Straub, L., and Werning, I. (2022). Macroeconomic implications of covid-19: Can negative supply shocks cause demand shortages? *American Economic Review*, 112(5):1437–1474.

Hansen, N.-J., Toscani, F., and Zhou, J. (2023). Euro area inflation after the pandemic and energy shock: Import prices, profits and wages. *IMF Working Paper No. 2023/131*.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1):161–182.

Känzig, D. R. (2021). The macroeconomic effects of oil supply news: Evidence from opec announcements. *American Economic Review*, 111(4):1092–1125.

Karadi, P., Amann, J., Bachiller, J. S., Seiler, P., and Wursten, J. (2023). Price setting on the two sides of the atlantic-evidence from supermarket scanner data. *Journal of Monetary Economics*, 140:S1–S17.

Karadi, P. and Reiff, A. (2019). Menu costs, aggregate fluctuations, and large shocks. *American Economic Journal: Macroeconomics*, 11(3):111–146.

Kleibergen, F. and Paap, R. (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of econometrics*, 133(1):97–126.

Lafrogne-Joussier, R., Martin, J., and Mejean, I. (2023). *Cost pass-through and the rise of inflation*. Insee, Institut national de la statistique et des études économiques.

La'O, J. and Tahbaz-Salehi, A. (2022). Optimal monetary policy in production networks. *Econometrica*, 90(3):1295–1336.

Minton, R. and Wheaton, B. (2023). Hidden inflation in supply chains: Theory and evidence.

Miranda-Pinto, J., Pescatori, A., Stuermer, M., and Wang, X. (2024). Beyond energy: Inflationary effects of metals price shocks in production networks. *IMF Working Paper No. 24/215*.

Miyamoto, W., Nguyen, T. L., and Sergeyev, D. (2024). How oil shocks propagate: Evidence on the monetary policy channel. *Federal Reserve Bank of San Francisco Working Papers*.

Ocampo, S., Schoenle, R., and Smith, D. A. (2022). How robust are robust measures of pce inflation? *US Department of Labor, US Bureau of Labor Statistics, Office of Prices and . . .* .

Pasten, E., Schoenle, R., and Weber, M. (2024). Sectoral heterogeneity in nominal price rigidity and the origin of aggregate fluctuations. *American Economic Journal: Macroeconomics*, 16(2):318–352.

Patzelt, P. and Reis, R. (2024). Estimating the rise in expected inflation from higher energy prices. *Working Paper*.

Rubbo, E. (2023). Networks, phillips curves, and monetary policy. *Econometrica*, 91(4):1417–1455.

Silva, A. (2023). Inflation in disaggregated small open economies. *Mimeo, The University of Maryland*.

Silva, A., Caraiani, P., Miranda-Pinto, J., and Olaya-Agudelo, J. (2024). Commodity prices and production networks in small open economies. *Journal of Economic Dynamics and Control*, page 104968.

Strauch, R., Meyler, A., Beck, R., Consolo, A., Costantini, R., Fidora, M., Gattini, L., Landau, B., Lima, A., Lodge, D., et al. (2010). Energy markets and the euro area macroeconomy. *ECB Occasional Paper Series No. 113*.

Vlieghe, G. (2024). Core strength: international evidence on the impact of energy prices on core inflation. *Economica*.

A Data

This annex provides additional details on the aggregate and sectoral data

A.1 Aggregate Data

GDP and CPI inflation data are sourced from the World Economic Outlook (WEO) database. The output gap is constructed using a univariate HP filter.

Commodity price indices are obtained from the IMF Primary Commodity Prices System Database. These commodity indices are weighted averages of select commodity price indices, based on identified benchmark prices that are representative of the global market.

Central bank policy rates are collected from the Bank for International Settlements (BIS). We select end-of-period monthly rates to convert into quarterly data (that is, for the first quarter, the March observation is used).

A.2 Sectoral Data

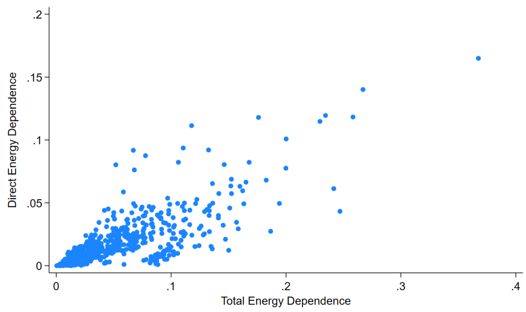
The sectoral dataset uses the OECD 11-sector classification as the primary method for sector classification, integrating Gross Value Added (GVA) data sourced from the OECD. This classification adheres to the International Standard Industrial Classification of All Economic Activities, Revision 4 (ISIC Rev. 4), which groups industries based on shared characteristics such as the nature of the goods and services produced, their usage, and the inputs and processes involved in their production. We map these OECD sectors to the corresponding NACE Rev.2 classification at the section level (a first level consisting of headings identified by an alphabetical code), ensuring alignment in sector description and classification. This allows us to incorporate Producer Price Index (PPI) data from Eurostat.

For Brazil and the US which are missing in the OECD data, we merge data from Haver Analytics (for Brazil) and from the BEA (for the US). To map OECD sectors to the US Bureau of Economic Analysis (BEA) sector classification, we manually match sectors based on the sector descriptions from the BEA "value-added by industry" data file, aggregating multiple BEA sectors into broader OECD categories when they share production processes, goods, services, and technological uses. This allows us to incorporate US value added data from BEA.

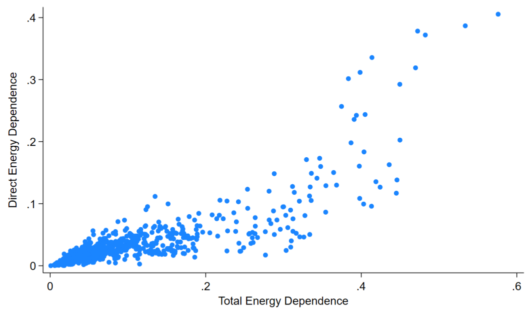
B Robustness Checks

B.1 Sectoral Energy Dependence Measures

Figure B.1 shows that our measures of direct and total sectoral energy dependence remain highly correlated when using the full 1995-2020 sample. Here, we residualize the sectoral energy dependence measures on country and time fixed effects to remove time-invariant and country-invariant heterogeneity. A priori, adding the fixed effects should reduce the correlation. Yet, the different sectoral measures of energy dependence remain highly correlated.



(a) Narrow Energy Definition



(b) Broad Energy Definition

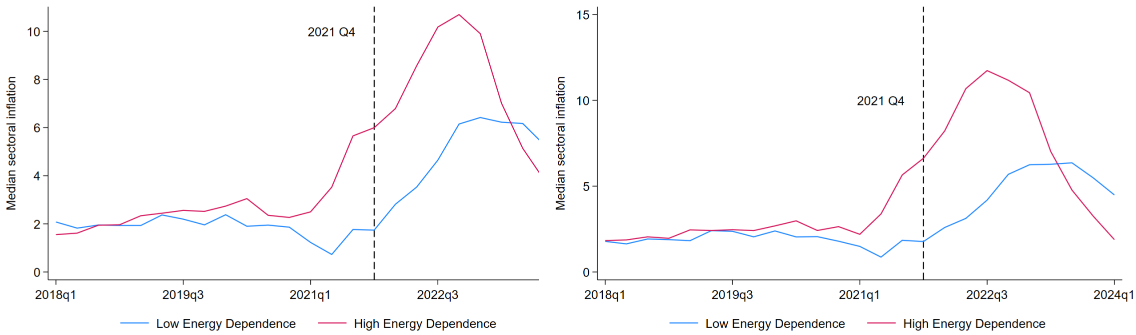
Panels show correlation of sectoral energy dependence measures computed from OECD ICIO data for direct and total energy dependence. Energy sector is defined as ICIO sector C19 (Panel a) and as ICIO sectors C19 and D (Panel b). Data covers 1995-2020. Sectoral energy dependence is residualized on time fixed effect and on country fixed effect.

Figure B.1: Correlation of sectoral direct and total energy dependence in 2019

B.2 Sectoral Energy Inflation Trends

Figure B.2 shows that the patterns of Figure 5 are robust to different definitions of energy dependence. While Figure 5 only included sector C19 - coke and refined petroleum products - in its energy definition, we now also include sector D - utilities - in the definition of energy.

As before, inflation in more energy dependent sectors rose significantly faster than in less energy dependent sectors. The passthrough of inflation pressures into less energy dependent sectors occurred gradually over time. Yet, sectoral inflation was again more persistent in less energy dependent sectors.



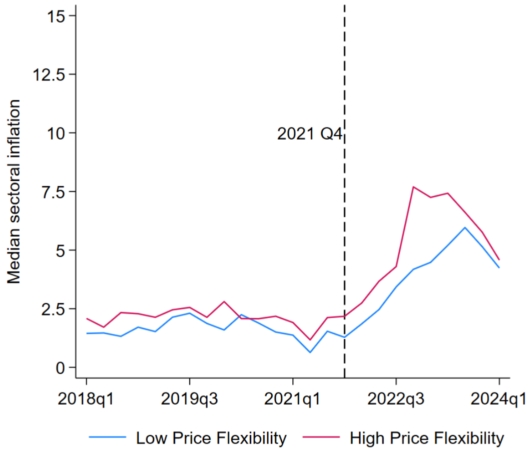
(a) Direct Energy Dependence

(b) Total Energy Dependence

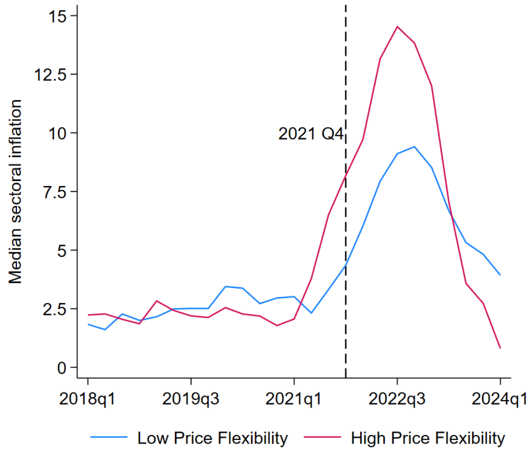
Figures report median quarterly inflation by sector, measured using sectoral value-added deflators, for a panel of 36 countries and 11 sectors per country. Sectoral energy dependence is computed as direct input share of energy (sector C19 - coke and refined petroleum products and sector D - utilities) in OECD ICIO Tables or as direct + indirect share using the Leontief inverse.

Figure B.2: Evolution of Sectoral Inflation depending on energy dependence

Figure B.3 shows that the pattern documented in Figure 6 is also robust to a wider definition of sectoral energy dependence that includes reliance on utilities as an input.



(a) Sectors with Low Energy Dependence



(b) Sectors with High Energy Dependence

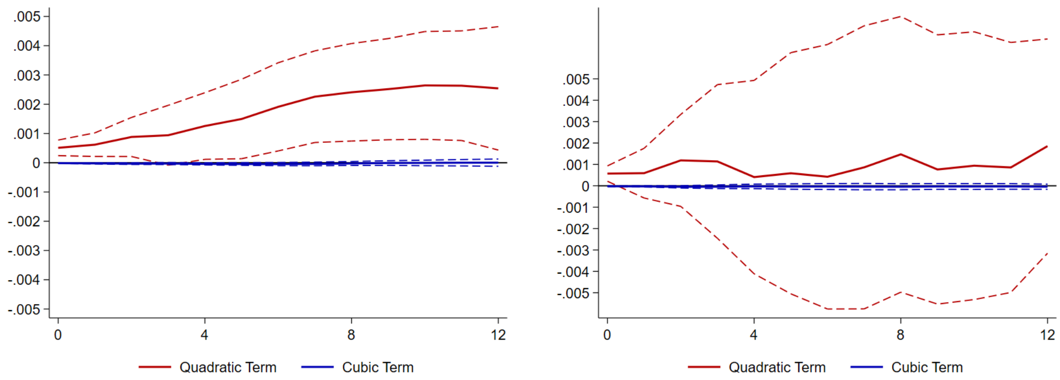
Figure reports median sectoral inflation splitting sectors first along the median of sectoral energy dependence and then within those sectors across the median of sectoral price flexibility. Sectoral energy dependence is measured using total (direct plus indirect) input reliance on sector C19 - coke and refined petroleum products. Price flexibility is measured using the measure of Rubbo (2023). Dashed line indicates 2021Q4, the last quarter before the Russian invasion of Ukraine. Quarterly sectoral inflation is reported in annualized rates and collapsed using median across sectors.

Figure B.3: Role of Energy Dependence vs. Price Flexibility

B.3 Country-level Local Projection Regressions

B.3.1 Non-linearities

Figure B.4 reports the coefficients on the quadratic and cubic terms for the baseline and provide further evidence of non-linearities in AEs. In AEs, the quadratic term is consistently positive and statistically significant. For EMDEs, however, there is no clear evidence for non-linearities with wide confidence bands but small point estimates.



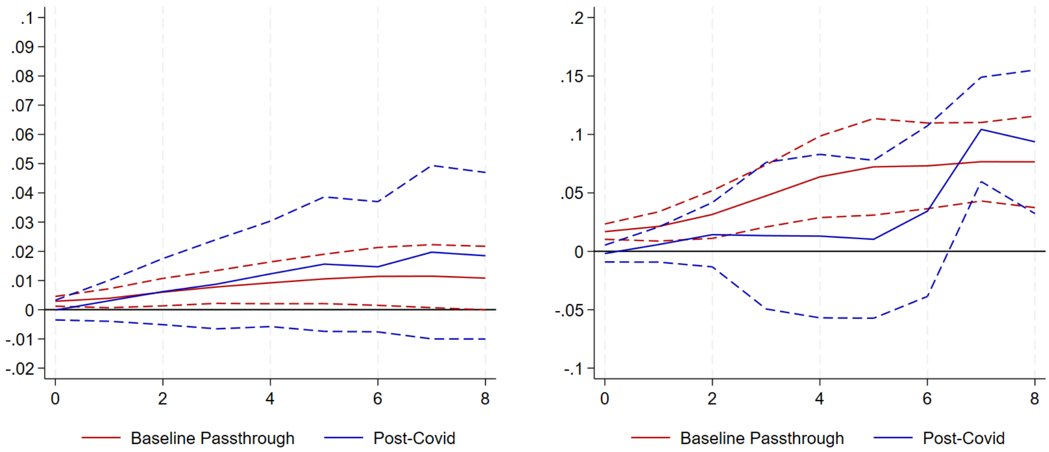
(a) AE **(b)** EMDE

Figures report quadratic and cubic terms for energy inflation estimated from equation 4 along with 95% confidence bands. Red line reports quadratic term, blue line reports cubic term, both for baseline. Sample starts in 2010. AE = Advanced Economies. EMDE = Emerging and Developing Economies. Standard errors are double clustered by country and time.

Figure B.4: Coefficients on Higher-order Terms

B.3.2 Median Inflation

Ball et al. (2022) argue that median CPI inflation is a better measure of overall inflationary pressures during the Covid period as supply chain disruptions and Covid shocks disrupted several sectors severely. Figure B.5 reports results for regressions with median inflation as the dependent variable. Overall, there is no clear evidence for a systematic strenghtening of the passthrough of energy inflation into median CPI inflation. The sample is significantly smaller as median CPI inflation is only available for 18 countries implying less precise estimates with wider confidence bands.



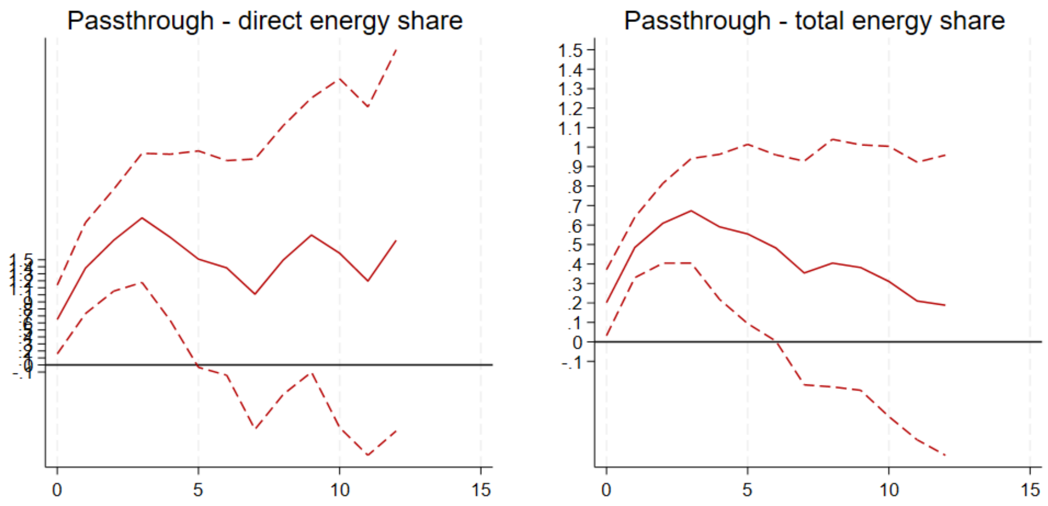
(a) AE **(b)** EMDE

Figure reports local projections coefficients from country-level specification 3 estimated using sample from 2010 onward. Post-Covid dummy equals one for 2020 onward, and zero otherwise. Dependent variable is median CPI inflation. Controls includes two lags of median CPI inflation, output gap, change in nominal effective exchange rate, and policy rate. Standard errors are double clustered by time and country.

Figure B.5: Passthrough into median inflation

B.4 Sectoral Local Projection Regressions

Figure B.6 confirms that the patterns from Figure 10 are robust to using a coarser definition of energy dependence that only includes ICIO sector ”C19 - coke and refined petroleum products”. While the estimated coefficients are now larger, this is due to the interaction variable, energy dependence, having a smaller mean. Marginal effects are comparable.



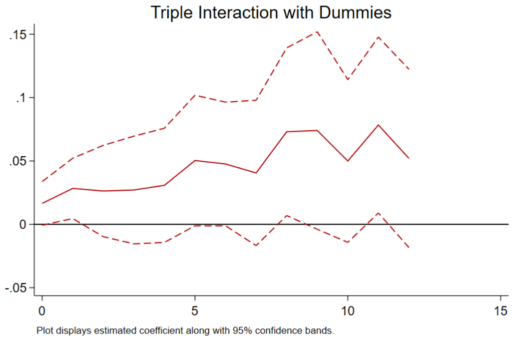
(a) Direct Impact

(b) Total Impact

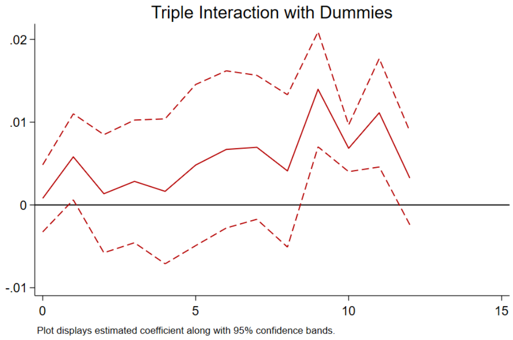
Figure reports estimated local projection double interaction coefficients on interaction of energy inflation with sectoral oil input share along with 95% confidence bands. Panel a) uses direct energy input share. Panel b) uses total energy input share. Energy sector is defined as ICIO sectors ”C19”. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.6: Passthrough depending on energy dependence

Figure B.7 repeats the analysis from Figure 12 with dummy interactions. For sectoral energy dependence and price flexibility, we create dummies splitting the sample at the median for each of the two sectoral characteristics. The reported local projections coefficients now capture the differential response of a sector with above median price flexibility and above median energy dependence. As before, sectors with higher energy dependence have higher price passthrough if they also have higher price flexibility and vice versa.



(a) Energy Impact



(b) Oil Impact

Figure reports estimated local projection triple interaction coefficients on interaction of sectoral price flexibility and energy dependence with energy inflation (Panel A) and oil inflation (Panel B) along with 95% confidence bands. Triple interactions are constructed with dummies (median split) for sectoral energy dependence and price flexibility. Sectoral price flexibility is measured using the Rubbo (2023) measure. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.7: Passthrough depending on sectoral energy dependence and sectoral price flexibility

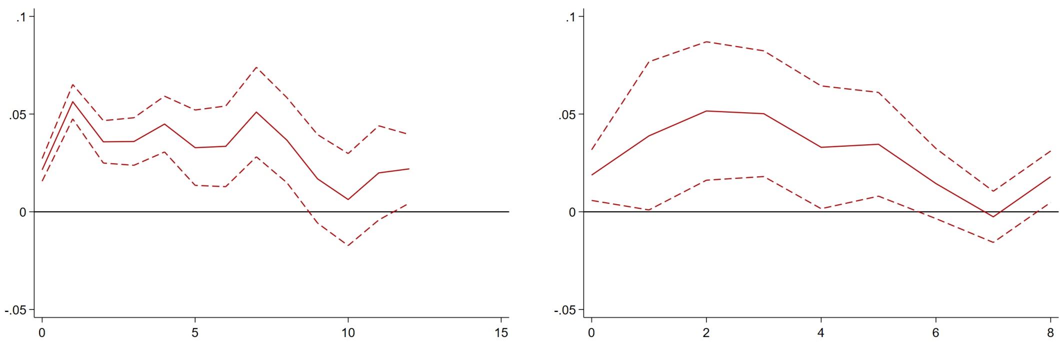
B.5 Local Projections using Instrumental Variables

This section provides a series of robustness checks for the main results in the paper using a local projections instrumental variables approach. One potential identification concern with the results in the paper is that energy price movements are not fully exogenous but could partly be driven endogenously giving rise to simultaneity bias or reverse causality. While a body of literature stresses the extraordinary nature of the Covid energy price shocks (e.g. Alessandri and Gazzani (2025), Hansen et al. (2023), Vlieghe (2024)) and we provide evidence thereto as well (Figures 2 - 4), this annex provides a formal test.

Our instruments are the oil supply news shocks from Känzig (2021). He constructs oil supply news shocks using high-frequency changes in oil price futures around OPEC announcements. This identifies plausibly exogenous variation in oil prices under the assumption that any response of OPEC to global economic conditions is ex-ante priced in before the high-frequency time window around the OPEC announcement. He shows that these shocks have an immediate negative impact on oil supply. We aggregate the Känzig (2021) shocks at the quarterly level, taking the unweighted average of oil supply news shocks over each quarter.

B.5.1 Aggregate Regressions

Figure B.8 reports coefficients from an aggregate instrumental variable specification. The passthrough of energy inflation into CPI inflation is remarkably similar across both the pre-Covid (2010-2019) and post-Covid (2020 - 2023) period, thus confirming the evidence in Figure 7.



(a) Pre-Covid period **(b)** Post-Covid period

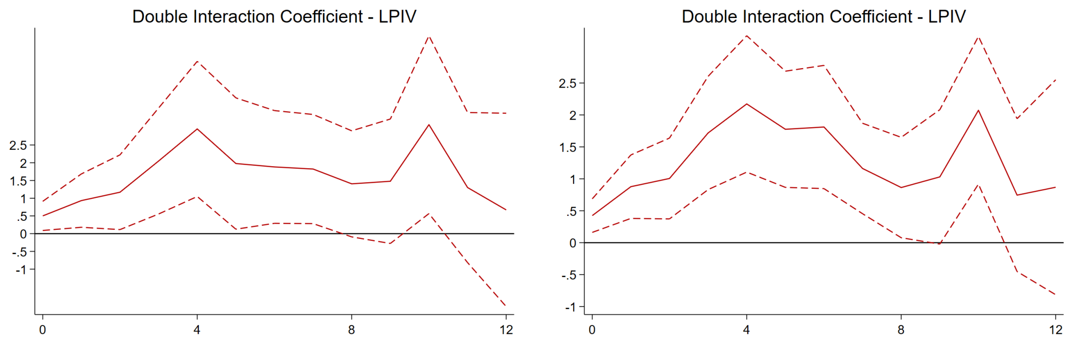
Figure reports estimated local projections IV coefficients of passthrough from energy inflation into CPI inflation along with 95% confidence bands from LP-IV specification with Känzig (2021) oil supply news shocks as instrument. Panel a) shows pre-2020 period. Panel b) shows post-2020 period. Regressions include country-sector fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.8: LP-IV with Sectoral Energy Dependence

B.5.2 Sectoral Regressions

Next, we conduct a series of robustness checks for the sectoral regressions where we instrument energy or oil prices with the oil supply news shock as described above. At the sectoral level, the instruments are strong with Kleibergen and Paap (2006) test statistics consistently above 10 (typically between 10 and 50). The main results are confirmed.

Figure B.9 confirms the results from Figure 10 in an IV specification. More energy dependent sectors have greater inflation passthrough in response to energy price changes.

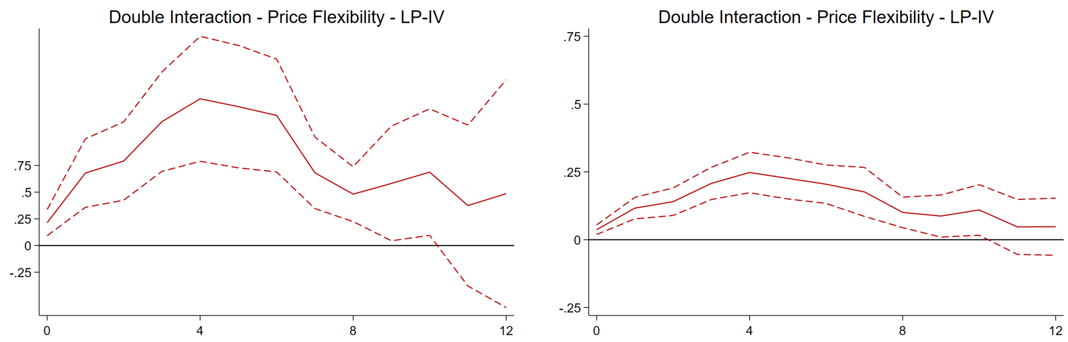


(a) Direct Impact **(b)** Total Impact

Figure reports estimated local projections IV double interaction coefficients on interaction of energy inflation with sectoral oil input share along with 95% confidence bands from LP-IV specification with Känzig (2021) oil supply news shocks as instrument. Panel a) uses direct energy input share. Panel b) uses total energy input share. Energy sector is defined as ICIO sectors "C19" and "BDE". Regressions include country-sector fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.9: LP-IV with Sectoral Energy Dependence

Figure B.10 confirms the results from Figure 11 in an IV specification. Sectors with greater sectoral price flexibility have greater passthrough from higher energy prices. As before, the passthrough is larger for overall energy prices (Panel a) as compared to oil prices only (Panel b). This suggests that it is important to consider energy prices beyond oil to get a comprehensive picture of the role of energy in production networks, which ultimately determines energy price passthrough.



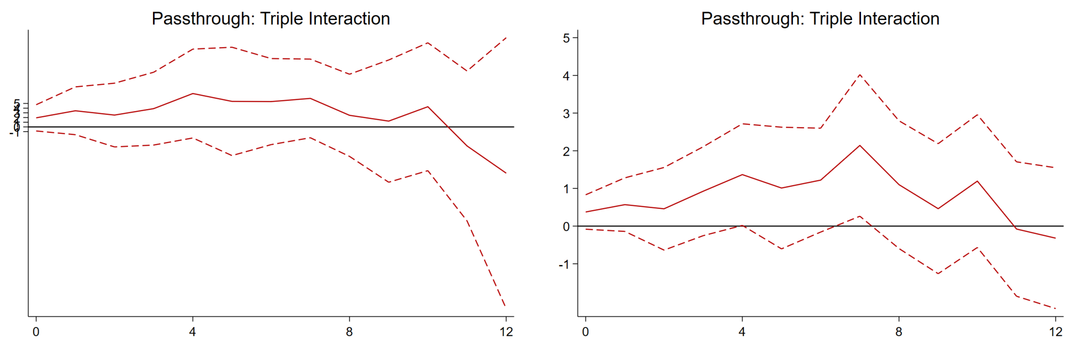
(a) Energy Impact

(b) Oil Impact

Figure reports estimated local projection IV double interaction coefficients on interaction of energy inflation (Panel A) and oil inflation (Panel B) with sectoral price flexibility along with 95% confidence bands. Energy and oil inflation are instrumented with Känzig (2021) oil supply new shock aggregated to quarterly frequency. Sectoral price flexibility is measured using the Rubbo (2023) measure. Regressions include country-sector fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.10: Passthrough depending on sectoral price flexibility

Figure B.11 confirms the results from Figure 12 in an IV specification. Sectors with higher energy dependence have slightly higher passthrough if they are also more price flexible but without statistical significance for energy overall.



(a) Energy Impact

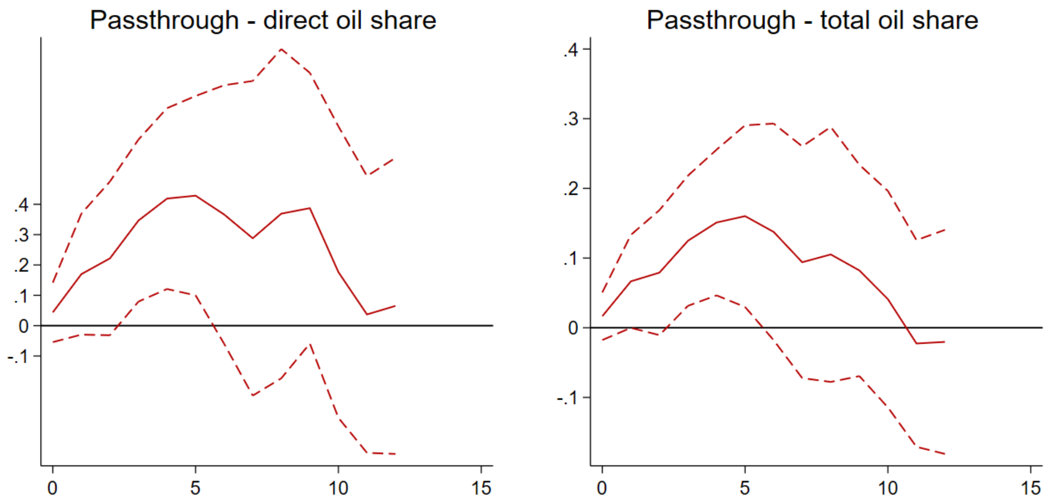
(b) Oil Impact

Figure reports estimated local projection IV triple interaction coefficients on interaction of sectoral price flexibility and energy dependence with energy inflation (Panel A) and oil inflation (Panel B) with sectoral price flexibility along with 95% confidence bands. Energy and oil prices are instrumented with Känzig (2021) oil supply news shock. Sectoral price flexibility is measured using the Rubbo (2023) measure. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure B.11: Passthrough depending on sectoral energy dependence and sectoral price flexibility

C Sectoral Passthrough of Oil Prices

Figure C.12 reports estimates for the heterogeneity in sectoral passthrough of oil price changes, rather than energy price changes as in Figure 10. The estimated double interaction coefficients are statistically and economically significant.



(a) Direct Impact

(b) Total Impact

Figure reports estimated local projection double interaction coefficients on interaction of oil inflation with sectoral oil dependence along with 95% confidence bands. Oil dependence is measured as direct input share of oil (sector C19) in Panel a), and as total input share of oil based on Leontief inverse. Regressions include country-sector and country-time fixed effects. Sample starts in 2010. Standard errors are double-clustered by country-sector and time.

Figure C.12: Passthrough depending on oil dependence

The impact of oil price changes onto sectoral inflation is similar for the direct input share, suggesting comparable passthrough to energy inflation. However, there is much less network amplification for oil. The estimated coefficients in Panel b) are substantially smaller for oil price changes as compared to those in Panel b) of Figure 10. This is consistent with the findings of Miranda-Pinto et al. (2024) who show that oil is used relatively downstream in the production network, thus limiting network amplification of oil price shocks.

D Energy Dependence Event Studies

Next, we formally test whether sectoral inflation evolved differently during the Covid years depending on time-invariant sectoral characteristics using the following event study specification:

$$\pi_{i,j,t} = \alpha_{i,j} + \alpha_{i,t} + \sum_{\tau=2018Q1;\tau\neq 2020Q3}^{2023Q3} \beta_\tau s_{i,j} + \epsilon_{i,j,t} \tag{8}$$

The dependent variable is sectoral inflation in sector j in country i in quarter t, measured as the sectoral value-added deflator (and using PPI inflation in a robustness check). $\alpha_{i,j}$ are country-sector fixed effects that absorb time-invariant heterogeneity between country-sector pairs. $\alpha_{i,t}$ are country-time fixed effects that absorb any changes in macroeconomic conditions at the country-level including growth rates, inflation, policy rates, and exchange rate movements. $s_{i,j}$ is a dummy variable that measures either sectoral energy dependence or sectoral price flexibility, which are defined as before. For the event study estimation, we focus on a sample starting in 2018 Q1 to capture the recent inflation surge and the 2 prior years of stable inflation. For the event studies, we normalize the coefficient in 2020 Q3 to zero.

D.1 Event Study Results

D.1.1 Event Study for Energy Dependence

Figure D.13 displays the event study coefficients along with 95 percent confidence bands when sectors are split along their energy dependence. While there were no notable differences in sectoral inflation prior to the Covid period, sectoral inflation in more energy-dependent sectors started surging in 2021 relative to sectoral inflation in less energy dependent sectors. However, as the underlying energy shocks moderated, the difference in inflation rates across sectors started narrowing. By 2023, sectoral inflation in more energy-dependent sectors was lower than in less energy-dependent sectors.

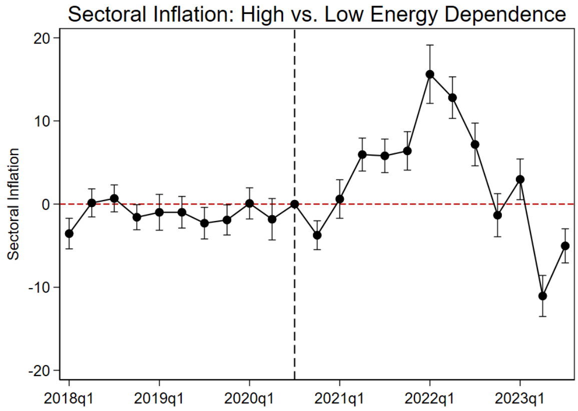


Figure reports event study coefficients along with 95 percent confidence bands for event study specification (8). Coefficient in 2020Q3 is normalized to zero. Regressions control for country-time and country-sector fixed effects. Sample starts in 2018Q1. Standard errors are double clustered by time and country-sector.

Figure D.13: Event Study for Energy Dependence

D.1.2 Event Study for Price Flexibility

Figure D.14 shows a comparable pattern when splitting sectors along their sectoral price flexibility. As shown and discussed in Figure 6, sectoral price flexibility and energy dependence were not perfect proxies during the recent inflation period.

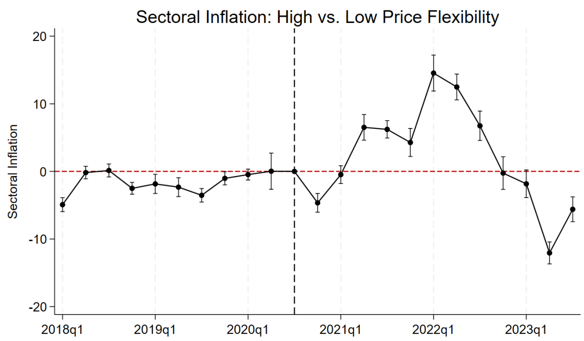


Figure reports event study coefficients along with 95 percent confidence bands for event study specification (8) with sectors split across the median of sectoral price flexibility. Coefficient in 2020Q3 is normalized to zero. Regressions control for country-time and country-sector fixed effects. Sample starts in 2018Q1. Standard errors are double clustered by time and country-sector.

Figure D.14: Event Study for Price Flexibility

D.2 Robustness Check for Event Studies

Rather than using sectoral value-added deflators, we also estimate the event study specifications with explicit PPI data from Eurostat. Focusing on Eurostat has the advantage of ensuring that data is compiled and aggregated in a consistent way across all countries in the sample. Compared to the sectoral value-added deflators, the Eurostat PPI data is not comprehensive across all sectors but only covers 8/11. The missing sectors are ”Financial and insurance activities”, ”education and related services”, and ”Other service activities”.

Results for the event study specifications are reported below. Figures D.15 and D.16 confirm the previous evidence.

D.2.1 Robustness Check for Energy Dependence

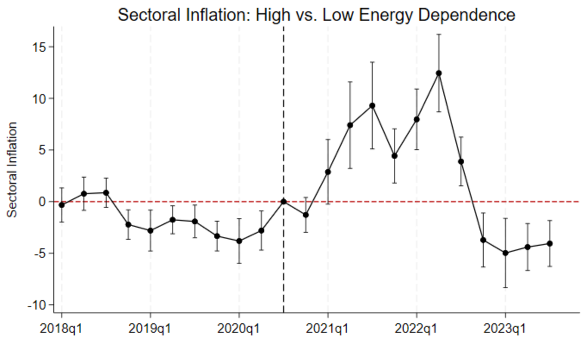


Figure D.15: Event Study for Energy Dependence

D.2.2 Robustness Check for Price Flexibility

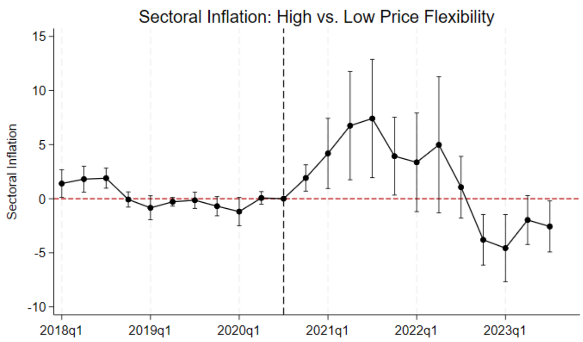


Figure D.16: Event Study for Price Flexibility

PUBLICATIONS

The Energy Origins of the Global Inflation Surge
Working Paper No. WP/2025/091