All in the same boat?
The global transmission of gas supply shocks*

Piergiorgio Alessandri Andrea Gazzani

30 October 2026

Abstract

Natural gas is an increasingly important source of energy for the world economy. Thanks to the LNG revolution, it is now also traded on integrated international markets. This paper studies a key implication of these structural shifts: shocks to the supply of natural gas have global macroeconomic effects. We identify the shocks by combining narrative evidence on supply disruptions with event-day changes in gas futures prices, and trace their effects in global and country-level proxy-BVARs. Supply news originating in different regions moves gas prices jointly in the European and Asian markets. Adverse shocks depress industrial production, trade and equity prices at the global level, while raising inflation and interest rates. However, their propagation is highly heterogeneous across countries. Gas importers bear the brunt of the shocks, experiencing currency depreciations along with stagflation. Gas exporters are less exposed to the slowdown but still face inflationary pressures.

JEL classification: E31, E32, F41, Q41, Q43.
Keywords: natural gas, supply shocks, external instruments, international transmission, LNG.

*Corresponding author: Andrea Gazzani, Bank of Italy, andreagiovanni.gazzani@bancaditalia.it; Piergiorgio Alessandri, Bank of Italy, piergiorgio.alessandri@bancaditalia.it. We thank Fabrizio Ferriani, Diego Känzig, Jim Stock, and Giovanni Veronese for helpful suggestions. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Bank of Italy or the Eurosystem.

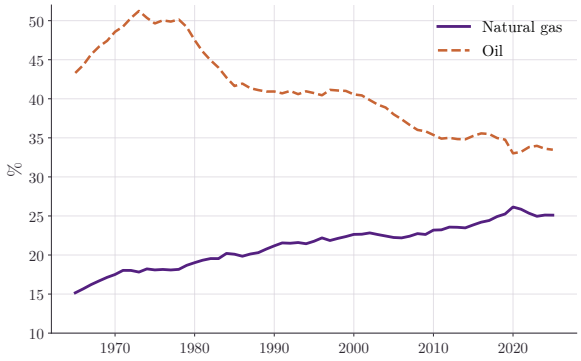
1. Introduction

Natural gas accounts for nearly one quarter of world primary energy and plays a central role in electricity generation, industrial production, and household heating. Its share of the global energy mix has risen over recent decades, alongside a decline in the share of oil (Figure 1, panel a).

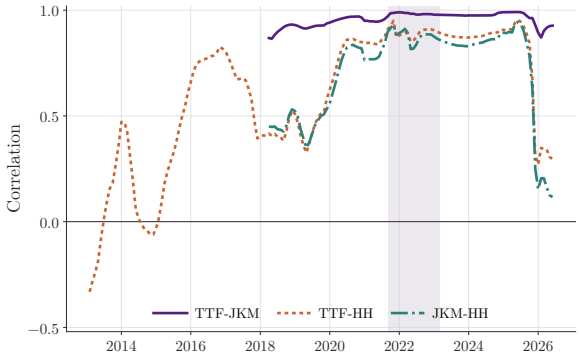
At the same time, the structure of the market has changed dramatically. Liquefied natural gas (LNG), which can be shipped over long distances, has become much more widely available. This has reshaped the trade landscape, allowing a large number of buyers and sellers to connect without relying on regional pipelines that constrained gas flows in the past. One telltale sign of this structural shift is the strong correlation between gas prices in different markets (Figure 1, panel b). European and Asian prices comove very strongly with one another. Their correlations with US prices increased significantly over the last decade as well, as the US took on an increasingly prominent role as an LNG exporter, but remain lower and less stable owing to physical bottlenecks and infrastructural constraints. In 2026, in particular, a combination of abundant supply, low domestic demand and lack of spare liquefaction capacity pushed US prices well below their international counterparts.

FIGURE 1. Structural Changes in the Natural Gas Market

(a) Share of world primary energy



(b) Correlations in futures prices across markets



Notes: Panel (a) shows the shares of world primary energy supplied by natural gas and by oil. Panel (b) shows 36-month rolling correlations between the monthly front-month futures prices of the three regional benchmarks, converted to US dollars per MMBtu: the Dutch Title Transfer Facility (TTF) for Europe, the Japan–Korea Marker (JKM) for Asia, and Henry Hub (HH) for the United States.

In a nutshell, the natural gas market has become both more important and more integrated at the global level, but remains subject to frictions that set it apart from the oil market. This paper examines the macroeconomic implications of fluctuations originating in the gas market. Are gas supply shocks still local in nature? Can they generate widespread fluctuations in output and prices around the world? If they do, who is most exposed to them?

To answer these questions, we adapt and extend the methodology developed in Alessandri and Gazzani (2025), using gas futures prices from the European *Title Transfer Facility (TTF)* market to build an instrument for gas supply shocks covering the period between 2010 and 2026. Given Europe's size and its role as a major gas importer, the highly liquid TTF market should in principle efficiently incorporate information on changes in gas demand and supply conditions. The instrument exploits a narrative high-frequency identification strategy to isolate supply-side events that are plausibly exogenous to changes in demand and other confounding factors. We aggregate the resulting series of daily TTF surprises to the

monthly frequency, and use it as an external instrument in a range of global and country-specific Bayesian VARs that dissect the propagation of the shocks along a number of dimensions.

Our first result is that the supply news we identify is priced across the European and Asian gas markets, not in Europe alone. Along with the invasion of Ukraine and the 2026 conflict in the Persian Gulf, our narrative approach identifies a number of idiosyncratic events that took place elsewhere in the world – from climate-related disruptions in Oman and Qatar in 2010, to strikes at LNG plants in Australia in 2023. These events turn out to have a large, contemporaneous impact on both the TTF and the Asian JKM benchmark. In fact, replacing our baseline TTF surprises with a set of JKM surprises measured on the same dates produces very similar responses in our VAR models. This result shows that the gas market is highly integrated and confirms that restricting the identification to a specific exchange – in our case TTF – does not unduly narrow the scope of the analysis.

Our second and most important result is that adverse gas supply shocks are globally stagflationary. Gas production and inventories decline, consistent with reduced gas availability rather than stronger demand. World industrial production, equity prices, and trade fall after a negative shock, while consumer prices and short-term interest rates rise. In this regard, we are indeed all in the same boat.

Our third result is that these aggregate effects conceal substantial differences across countries. Importers experience output losses, currency depreciation and inflationary pressures. Exporters are relatively shielded from output losses, but face rising inflation too. The terms of trade improve for the United States, a major gas exporter, and deteriorate for the euro area, a large importer. The intensity of gas usage relative to economic activity is closely associated with price pressures, but not with output losses. Cross-country comparisons provide no clear evidence that a higher non-fossil share of electricity generation reduces the impact of the shock.

The main findings are robust to alternative measures of the instrument, to controlling for the overlap between gas and other news (e.g., oil), and to several perturbations of our baseline VAR specification.

Our work relates to three strands of literature. First, it contributes to research on energy shocks and the macroeconomy, encompassing oil, natural gas, and carbon pricing. Studies of oil distinguish the underlying sources of price changes and examine news about future supply (Hamilton, 2003; Kilian, 2009; Baumeister and Hamilton, 2019; Känzig, 2021; Degasperi, 2026a; Mori and Peersman, 2026). Related work studies the macroeconomic and distributional effects of carbon pricing (Känzig, 2026) and natural gas supply shocks (Alessandri and Gazzani, 2025). Other contributions examine how international trade positions shape the transmission of energy shocks (Degasperi, 2026b; Känzig et al., 2026). We extend the European gas analysis of Alessandri and Gazzani (2025) to study a common supply disturbance at two levels: the global economy and its incidence across countries.

Second, the analysis contributes to research on the integration of natural gas markets. Studies of shale gas and LNG examine how changes in production and trade affect regional prices, comparative advantage, and welfare (Joskow, 2013; Hausman and Kellogg, 2015; Arezki et al., 2017; Albrizio et al., 2023; Stock and Zaragoza-Watkins, 2024; Emiliozzi et al., 2025). Our focus is on how these market connections transmit unexpected supply disturbances. By relating international shocks to domestic responses and to countries' positions in gas trade, the paper connects the physical organization of gas trade to macroeconomic transmission. Integration and bottlenecks are not competing descriptions of the market: both are needed to understand how the same disturbance can have widespread but unequal effects.

Third, the paper builds on the literature on high-frequency identification in macroeconomics. Research on monetary policy uses financial-market surprises around announcements to identify macroeconomic

responses (Gertler and Karadi, 2015; Miranda-Agrippino and Ricco, 2021). This literature also examines information effects and the predictability of measured surprises, highlighting why narrow event windows alone need not ensure exogeneity (Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020; Bauer and Swanson, 2023). We apply this approach to international gas supply news, combining narrative event selection with futures-price surprises and checks for predictability and concurrent monetary and oil news.

The paper proceeds as follows. Section 2 describes the instrument and documents its empirical properties. Section 3 presents the proxy-BVAR framework. Sections 4 and 5 illustrate the global and cross-country impact of gas supply shocks. Section 6 collects the robustness tests. Section 7 concludes.

2. Identifying Gas Supply Shocks

Natural gas markets are increasingly connected, but still constrained by infrastructural frictions. The frictions are obvious in the case of pipelines, as these tie producers and consumers to specific routes and end-to-end connections. But they are also relevant in the LNG market. To function smoothly, this market requires the availability of liquefaction and regasification capacity and safe shipping conditions for the cargoes – none of which can be taken for granted. Motivated by the evidence of high integration in Figure 1, we focus on European TTF futures to measure supply news that could (at least in principle) have important international repercussions. We construct the instrument from narrative events and event-day price changes, assess its empirical properties, and aggregate it to the monthly frequency. In the process, we explicitly investigate to what extent the events we identify using TTF data are priced across regional benchmarks despite the market frictions that could isolate Europe from the rest of the world.

2.1. Narrative event selection

The event set extends the news-based identification of Alessandri and Gazzani (2025) in three steps. First, we search Refinitiv News and Factiva.[1] Second, we retain dates on which reports identify a supply catalyst: an unplanned production outage, a pipeline or terminal failure, a strike, a maintenance surprise, or a geopolitical development affecting expected gas availability. Third, we exclude movements attributed to demand news, weather revisions, storage surprises, or multiple drivers that contemporaneous reporting cannot distinguish. The events up to October 2022 are those of Alessandri and Gazzani (2025). For the extension from December 2022 onward, 78 dates pass the price screen, of which 31 are classified as supply news, 41 as other news, and 6 as ambiguous and excluded. In the baseline proxy, seven event-day returns that span a contract roll are replaced by returns on the same delivery month.

The final sample includes 86 event days between 2010 and 2026, covering both adverse and favorable supply news; Table A.3 in Appendix A lists them. The identifying variation is thus the repricing associated with documented changes in gas supply, including actual changes in gas flows, as well as news and risk on future supply.

Narrative selection reduces the risk of endogeneity but cannot eliminate it. Evidence on the source and timing of a disruption does not rule out other relevant news on the same date. The diagnostics in Sections 2.3 and 2.5 therefore look for concurrent macroeconomic, geopolitical, monetary, and oil-market news, and Section 6 excludes overlapping dates or residualizes the proxy on the corresponding shocks.

[1] We focus on days when the TTF front contract moves by at least 5 percent. Three events retained from Alessandri and Gazzani (2025) involve smaller price changes due to front-month future contracts roll correction.

2.2. Event-day surprises

Let I_d equal one on a retained event day and zero otherwise, and let P_d^{TTF} denote the closing price of the roll-adjusted TTF front future. The baseline daily proxy is

$$s_d^g = 100 I_d \left(\log P_d^{\mathrm{TTF}} - \log P_{d-1}^{\mathrm{TTF}} \right). \tag{1}$$

The proxy is measured in log-percentage points, as 100 times the within-contract close-to-close log return. This window accommodates events whose release times vary or fall outside the most liquid European trading hours. Alternative measures use the historical continuous TTF future, TTF day-ahead prices, the first principal component of the first twelve TTF futures, and JKM futures.

Figure 2 plots the daily surprises and their monthly sums. Positive values indicate news of greater expected scarcity; negative values indicate unexpectedly favorable supply developments. The proxy is sparse by construction because it isolates discrete supply news rather than all gas-price movements.

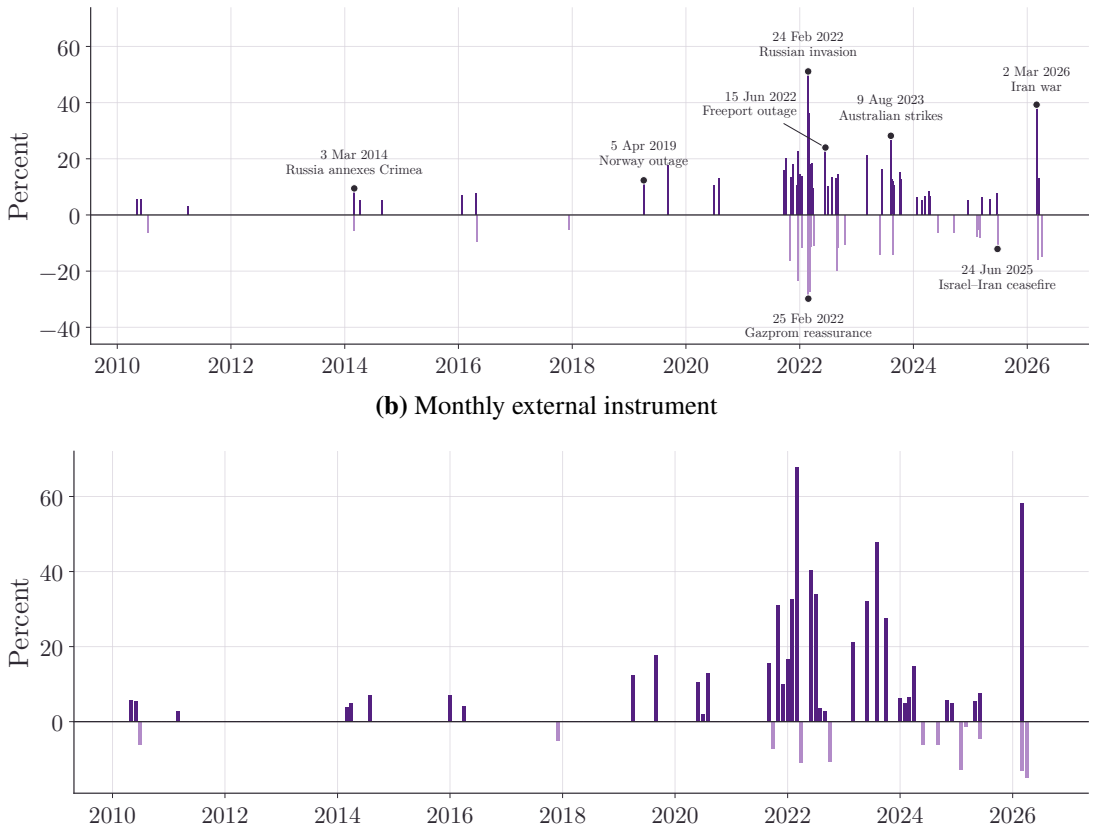
The events include unplanned outages in gas facilities, extension of maintenance, labor disputes, infrastructure failures and suspected sabotage, weather-related shutdowns, sanctions and other policy decisions, and geopolitical events. They span events related to Russia and Ukraine, Norwegian gas output, Australian liquefaction plants, supply from Qatar and the wider Middle East, and U.S. Gulf Coast production. The events also include both positive and negative news. Significant price increases followed the Russian invasion of Ukraine in 2022, strike threats at Australian LNG plants in August 2023, industrial action at French and British terminals in March 2023, and conflict in the Middle East in March 2026. Favorable news is also well represented: Gazprom's reassurances on flows the day after the invasion of Ukraine, approvals of new liquefaction capacity in the United States and elsewhere, the agreement that averted the Australian strikes, and the Middle Eastern ceasefires of 2025 and 2026. Finally, Russian events become much less frequent after 2022, and the later part of the sample includes prominent LNG-related supply news originating outside Europe.

2.3. Daily diagnostics

The first diagnostic asks whether narrative dates are especially informative about gas markets. For each variable x_d, we compare the variance of daily changes on event dates with that on ordinary trading days. Table 1 reports selected ratios. TTF, European coal, and JKM exhibit the largest increases. Brent, global equities, exchange rates, and interest rates also become more volatile, but less markedly; geopolitical-risk and economic-surprise measures have ratios below one. Since large TTF movements enter the initial screen, the TTF ratio is not an independent validation test. The relevant evidence is the cross-asset pattern: volatility increases are concentrated in gas and closely related energy markets.

The second diagnostic tests whether pre-event information predicts the surprises. Regressions on industrial-production news for the euro area, Japan, and China, lagged TTF returns, TTF volatility, and deviations of European storage from seasonal norms yield negative adjusted R^2 values and joint p-values between 0.35 and 0.62. Table A.4 reports the estimates. Although these tests cannot establish exogeneity, they provide no evidence that the surprises systematically respond to the observed macroeconomic and gas-market conditions.

FIGURE 2. The daily and monthly gas supply proxies



Notes: Panel (a) shows the change in the TTF futures price on each of the 86 event days, measured on the same contract from one close to the next (100 times the log change). Panel (b) adds up these surprises within each month; months without events are zero.

TABLE 1. Event-day variance ratios

Variable	Ratio	Variable	Ratio
TTF future	21.16	EU coal future	15.90
JKM future	15.49	Brent future	2.80
U.S. two-year yield	2.61	STOXX 600	2.17
U.S. five-year breakeven	2.14	VSTOXX	2.06
Henry Hub future	2.04	Broad nominal dollar	1.82
MSCI World	1.63	S&P 500	1.41
VIX	1.26	Global CESI	0.77
Geopolitical risk	0.76	Euro-area CESI	0.74

The table reports the variance of daily changes on narrative event dates divided by the variance on ordinary trading days. Values above one indicate greater event-day volatility. Futures returns compare the same contract on consecutive trading days, and days on which a futures market was closed are excluded. CESI denotes the Citigroup Economic Surprise Index.

2.4. International repricing of supply news

A central question for the interpretation of the instrument is whether the selected supply news is priced beyond the European market.

The Asian and European benchmarks (JKM and TTF) co-move strongly after a supply shock. The correlation is 0.72 for the front-contract surprises across 70 common events, and it rises to 0.96 when we compare the first principal components of the two futures curves over maturities of one to twelve months (Figure 3). The comovement is large and systematic: a 100 basis point shift of the TTF curve is associated with an approximately 75 basis point shift of the JKM curve, and the two move in the same direction in 67 of the 70 events. A stronger alignment of the curves is consistent with common news affecting several delivery horizons. Front contracts are relatively more likely to reflect hub-specific delivery and liquidity conditions. The alignment is not confined to the 2022 crisis or to Russian supply news: the curve correlation is 0.98 across the 47 events outside 2022, and 0.97 across the 24 events without explicit Russian or Ukrainian references. The link is much weaker for the US benchmark (HH). Its correlation with TTF is 0.30 for front contracts and 0.32 for the curve components. The associated repricing is one order of magnitude smaller.

This evidence is consistent with the notion that Europe and Asia are tightly linked by LNG trade, and it corroborates the idea that the shocks captured by our instrument are transmitted internationally even though they originate in a particular region. Using surprises in the TTF does not confine the analysis to Europe. Daily local projections based on financial market data strongly support this conclusion: following adverse supply news, international gas and coal prices rise, global equities fall, risk measures increase, importer currencies depreciate, and inflation compensation rises (see Figures A.1–A.3). [2]

The evidence also shows that Henry Hub is less exposed to these shocks in the short run, possibly on account of liquefaction and export capacity constraints. Whether this fully insulates the US from foreign shocks, and/or reduces the global relevance of these shocks, is examined in Sections 4 and 5.

2.5. Monthly aggregation and overlap with other shocks

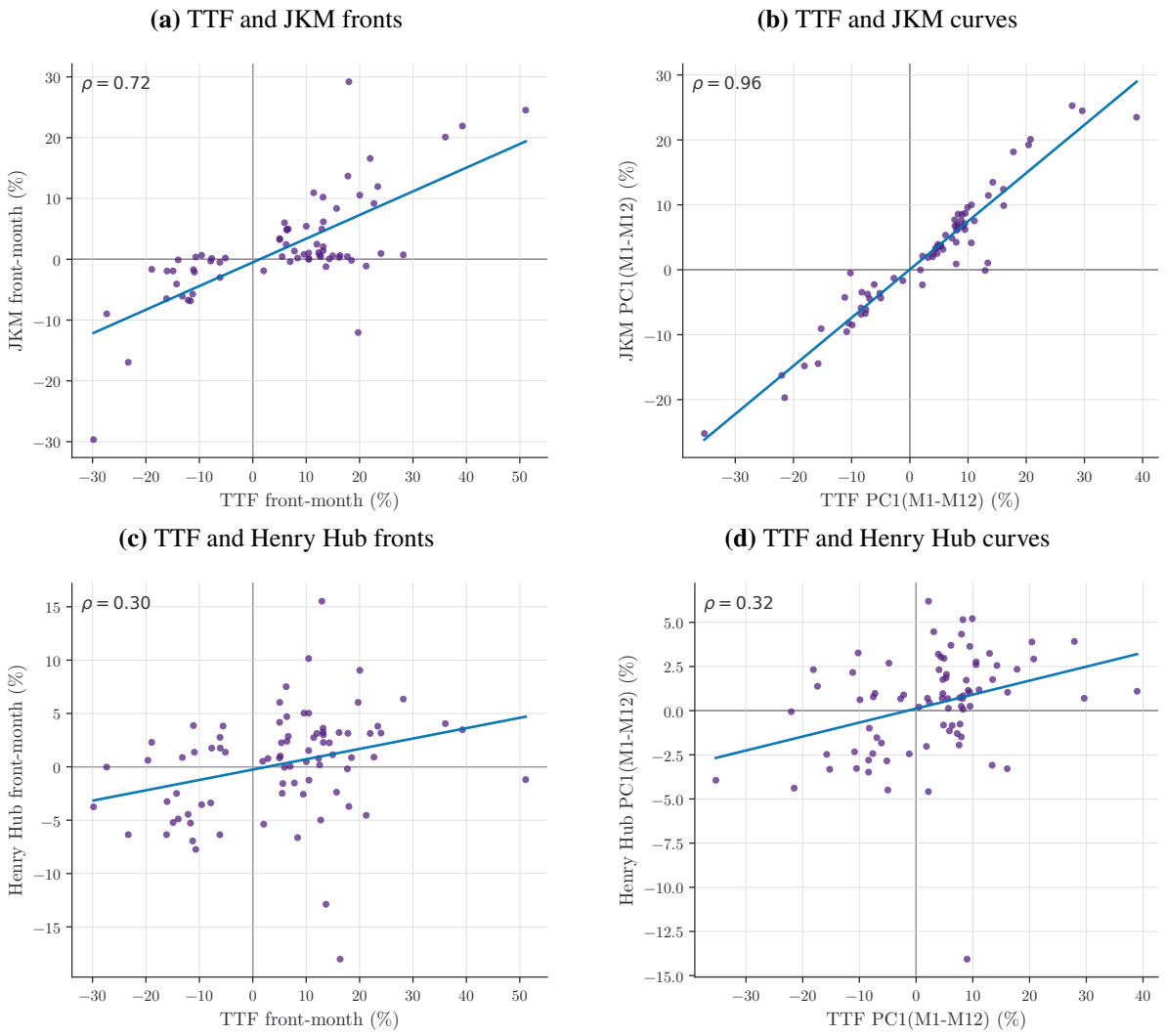
The baseline monthly instrument sums the retained event-day surprises:

$$z_t = \sum_{d \in \mathcal{D}_t} s_d^g, \tag{2}$$

where $\mathcal{D}_t$ is the set of retained event days in month t. Summation preserves the total within-month high-frequency innovation, as in Alessandri et al. (2023); Kilian (2024) provides a general treatment of monthly VAR proxies constructed from daily futures-market surprises. We also consider linear, triangular, and MIDAS weights, as well as instruments pre-filtered on their own lags or lagged gas prices. Aggregation can be important because the events often cluster within a month and the associated news can point in opposite directions. Section 6 shows that in our case alternative aggregation schemes yield similar results.

[2] Notice that the comovement between TTF and JKM is not a necessary condition for a shock to be globally relevant. In theory, there might be gas supply shocks that trigger real or financial spillovers without jointly affecting international gas price benchmarks. We do not attempt to examine these episodes in isolation because our instrument is not sufficiently dense and granular. Hence, our VAR estimates conflate global shocks that affect all gas markets simultaneously and local shocks that affect one market on impact (likely but not necessarily the TTF) and subsequently propagate across borders.

FIGURE 3. The same narrative news across regional gas markets



Notes: Each dot is an event day and the lines are least-squares fits. Each panel includes the event days on which both markets were open. The left panels compare front-contract price changes; the right panels compare the first principal components of price changes on contracts maturing in one to twelve months, scaled to the average fitted return across maturities. Events without explicit Russian or Ukrainian references, discussed in the text, are those whose descriptions do not mention Russia, Ukraine, Gazprom, Nord Stream, or Yamal.

The proxy has small correlations with most published energy and supply-chain shocks. Its correlations with the Känzig (2021) oil supply surprise and structural oil shock are -0.009 and 0.077, respectively. Correlations with the structural oil-market shocks of Baumeister and Hamilton (2019) are also small, ranging from -0.040 to 0.111, with a correlation of 0.095 for the oil-supply shock (Table A.5). A notable exception is its monthly correlation of 0.254 with a U.S. monetary-policy shock. This overlap remains a threat to identification despite the narrative screen. Section 6 addresses it by residualizing the proxy on U.S. and euro-area policy and information shocks and excluding dates coinciding with central-bank events.

3. Empirical Framework

This section presents the external-instrument identification strategy and the baseline global proxy-BVAR. The country-specific models are introduced in Section 5, alongside the corresponding results.

3.1. External-instrument identification

The reduced-form VAR is

$$y_t = c + \sum_{\ell=1}^{p} A_\ell y_{t-\ell} + u_t, \qquad u_t = B\varepsilon_t, \tag{3}$$

where the structural shocks in ε_t are mutually uncorrelated and normalized to unit variance. Let ε_t^g denote the gas supply shock and b_g the associated column of B. The external instrument identifies b_g up to scale if

$$\mathbb{E}[z_t \varepsilon_t^g] \neq 0, \tag{4}$$

$$\mathbb{E}[z_t \varepsilon_t^j] = 0, \qquad j \neq g, \tag{5}$$

$$\varepsilon_t \in \operatorname{span}\{y_\tau : -\infty < \tau \leq t\}. \tag{6}$$

Equations (4) and (5) impose relevance and exogeneity, respectively. The invertibility condition in equation (6) requires that the structural shocks lie in the linear span of current and past observables. Under these conditions, the covariance between the proxy and the reduced-form innovations selects the impact vector associated with the gas supply shock (Mertens and Ravn, 2013; Stock and Watson, 2018). We normalize the impact response of the real gas price to 10 percent.

The narrative screen and daily diagnostics motivate the exogeneity restriction in equation (5); the first-stage diagnostics reported in the notes to Figure 4 provide evidence of relevance. The proxy-BVAR serves as a benchmark under the conventional invertibility condition. Although the available diagnostic does not reject invertibility, Section 6 reports VARX estimates following Noh (2019) and generalized external instrument estimates following Forni et al. (2026) as robustness checks that relax the invertibility assumption.

3.2. Baseline proxy-BVAR

The baseline vector is

$$y_t = \left[p_t^g,\ q_t^{eq},\ i_t^{2y},\ q_t^w,\ p_t^w\right]', \tag{7}$$

where p_t^g is the real international natural gas price, q_t^{eq} is real world equity prices, i_t^{2y} is the U.S. two-year interest rate, q_t^w is world industrial production, and p_t^w is the global consumer price level. Prices and quantities enter in log differences and the interest rate in levels; figures cumulate the responses of growth rates back to log levels.

Equity prices and the two-year rate capture financial and monetary-policy responses that may anticipate and shape the adjustment of economic activity and consumer prices. Because identification comes from the external instrument, the ordering of the variables in equation (7) is irrelevant. We keep the baseline compact and, in extensions, add commodity, financial, trade, and risk indicators one at a time.

The monthly VAR sample spans 1999m2–2026m5, and the instrument is available from 2010m1. We estimate the VAR coefficients over the full sample and the covariance between the proxy and the innovations over the instrument sample. The model has twelve lags and a Minnesota prior with hyperparameters optimized as in Giannone et al. (2015), and the volatility correction of Lenza and Primiceri (2022) limits the influence of the exceptional 2020 observations on the covariance estimates. Figures report posterior medians and 68 and 90 percent pointwise intervals.

The instrument is relevant. The first-stage regression of the gas price innovation on the instrument yields an F statistic of 33.9 and a Robust-F of 13.1, the latter computed with standard errors robust to heteroskedasticity and autocorrelation.

4. Global Effects

Adverse gas supply shocks cause a rise in global inflation, a contraction in economic activity and a tightening in financial conditions. We present the baseline responses below and examine additional evidence on gas production, inventories and terms-of-trade effects in the following subsection.

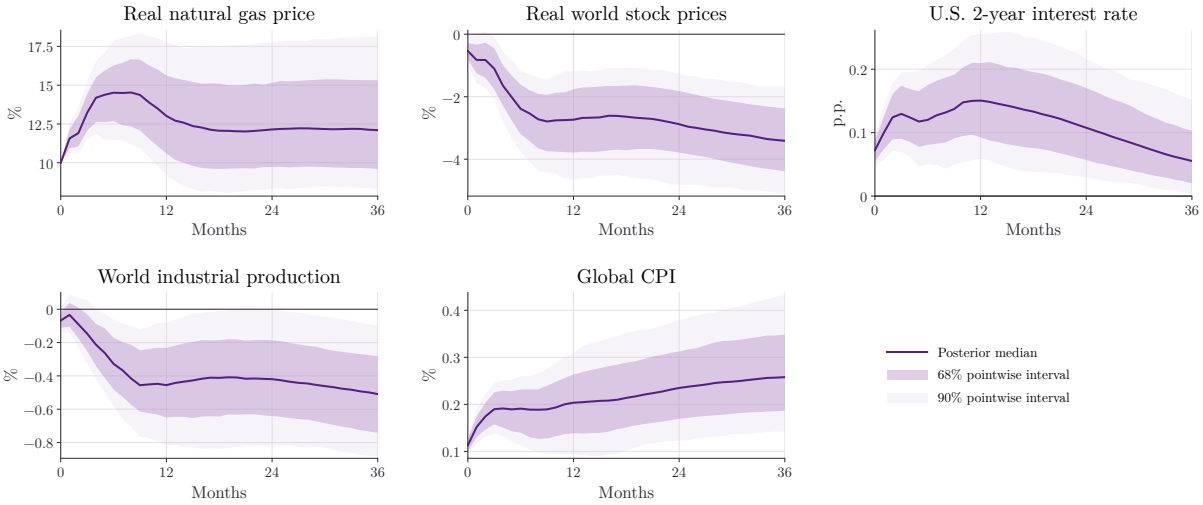
4.1. Baseline responses

Figure 4 reports the baseline impulse responses. The shock is normalized to deliver a 10 percent increase in real gas prices on impact (top-left panel). After the initial increase, gas prices rise further, reaching roughly 14.5 percent above baseline after seven months and remaining about 12 percent higher after three years. This persistence is consistent with slow adjustment in production, infrastructure, storage and contracts in the gas market. Financial markets respond immediately, with real equity prices falling on impact and settling almost 3 percent below baseline.

Economic activity and consumer prices (bottom row) move in opposite directions. Industrial production declines gradually, contracting by approximately 0.5 percent within a year. The global CPI level rises quickly, to about 0.2 percent above baseline within three months, and drifts further up afterwards. Persistently higher gas and consumer prices, together with lower equity values and production, characterize a clearly stagflationary response.

Against this background, the US two-year yield rises by approximately 15 basis points before declining back towards its baseline level. This response is consistent with greater near-term inflationary pressures and expected monetary-policy adjustments.

FIGURE 4. Global responses to an adverse gas supply shock



Notes: The shock raises the real gas price by 10 percent on impact. Lines are posterior medians and shaded areas 68 and 90 percent posterior intervals. The model is estimated over 1999m2–2026m5, and the instrument is available from 2010m4. First-stage $F = 33.94$, Robust-$F = 13.05$, and $R^2 = 0.15$.

4.2. Gas quantities, substitution, and trade

Global gas production and inventories fall after the shock (Figure 5). These estimates are less precise, possibly because the underlying series are available only from 2010, rely on voluntary national data collections, and cover only a subset of countries rather than the market as a whole. However, the direction of the responses is informative despite these limitations. The decline in production and stocks supports the success of our narrative approach in identifying genuine supply-side shocks.

Brent oil and coal prices rise, consistent with fuel substitution and greater energy scarcity. Non-energy commodity prices weaken after the initial response, in line with slower global demand (Figure A.18 in Appendix F). Adding these prices, the broad dollar, geopolitical risk, or volatility measures one at a time leaves the baseline responses largely unchanged (Figure A.12). Thus, the estimated gas shock has effects beyond gas markets, and no single additional variable accounts for the baseline pattern.

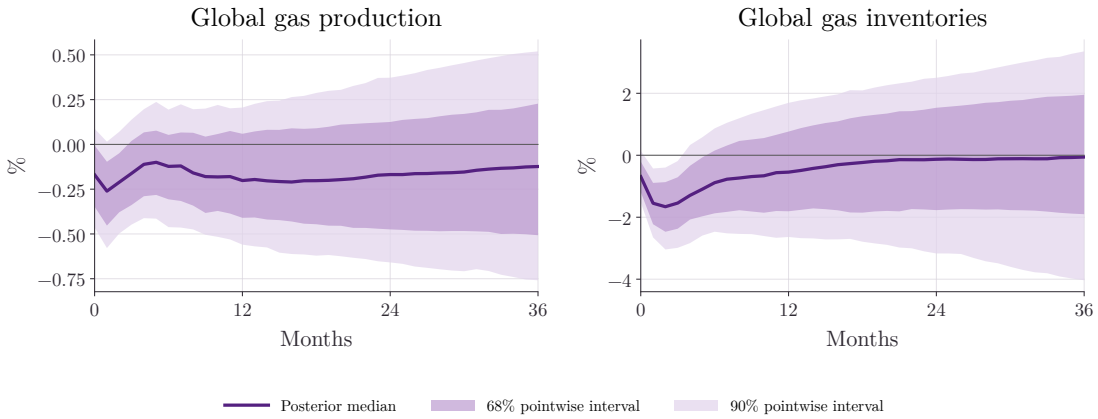
The shock also triggers a contraction in global trade (Figure 6). The terms of trade improve for the United States, a major gas exporter, and deteriorate for the euro area, a large importer. These responses provide an important link between the aggregate contraction documented above and the cross-country results examined in Section 5: the shock raises input costs broadly, but its effect on the terms of trade depends on a country's position in gas trade.

Appendix F reports the forecast-error variance decomposition and the historical contributions of gas supply shocks to the real gas price and to global inflation (Figures A.19–A.21).

5. Cross-country Effects

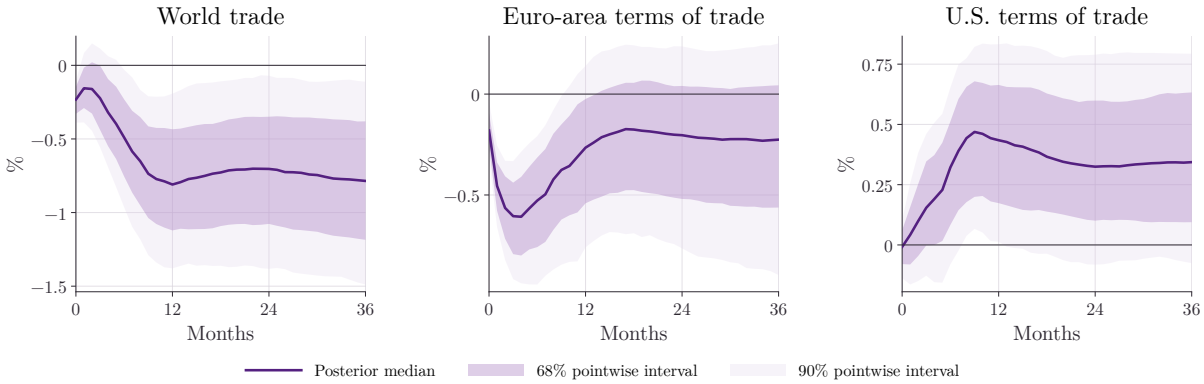
The global contraction masks substantial differences across countries. We first compare the responses of a set of advanced and emerging economies, and then relate them to each country's predetermined dependence on gas imports and to alternative measures of exposure.

FIGURE 5. Gas production and inventories



Notes: Responses of gas production and inventories aggregated across reporting countries to the shock in Figure 4. Lines are posterior medians and shaded areas 68 and 90 percent intervals. The quantity data begin in 2010.

FIGURE 6. World trade and terms-of-trade redistribution



Notes: Responses of world trade and of the euro-area and U.S. terms of trade, each added in turn to the baseline model, to the shock in Figure 4. Lines are posterior medians and shaded areas 68 and 90 percent intervals.

5.1. Country models and responses

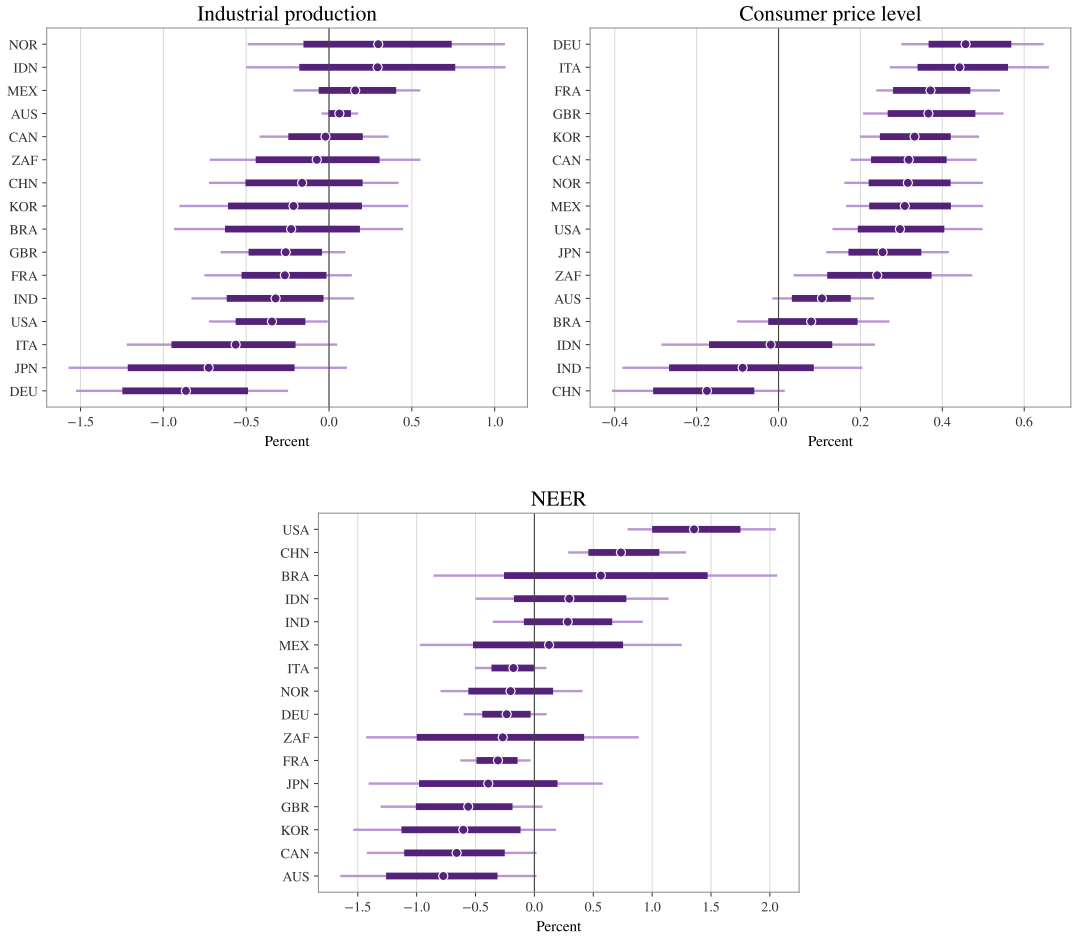
To trace the shock into individual economies, we estimate a ten-variable proxy-BVAR for each country. The first five variables form the global block of the aggregate model: the real gas price, world real equity prices, the U.S. two-year yield, world industrial production, and world consumer prices. The other five are domestic: industrial production, the consumer price level, the local-currency equity index, the BIS nominal effective exchange rate (NEER), and a benchmark government yield.[3] We use government yields rather than official policy rates because in the major advanced economies policy rates were at or near their

[3]For Australia, the World Bank industrial production series ends in 2015 and is extremely volatile over the period it covers, so we replace it with a monthly activity index constructed from the quarterly national accounts, with monthly employment as the within-quarter indicator. The magnitude of the output response therefore is not comparable to that of other countries, and its bands do not reflect the uncertainty stemming from the construction of the series. Appendix G describes the construction and reports the exposure regressions with and without Australia.

effective lower bound for long stretches of the sample after 2009, whereas short-maturity yields continued to reflect the expected path of monetary policy, including forward guidance and asset purchases.[4]

All variables, including the global block, are endogenous. Every model uses the same external instrument and the same 10 percent normalization of the gas-price response, as well as the twelve lags, optimized Minnesota prior, and COVID correction of the global model. With ten variables and twelve lags, each equation has 121 coefficients, so we retain countries with at least 144 complete months and a Robust-F above ten. Each country is estimated separately.

FIGURE 7. Cross-country responses at twelve months



Notes: Responses twelve months after a gas supply shock that raises the gas price by 10 percent on impact. Dots are posterior medians; thick and thin bars are 68 and 90 percent intervals. The country models are described in Section 5.1. For Australia, activity is measured by an index built from the quarterly national accounts (Appendix G). Countries are ordered by the posterior median in each panel. A rise in the NEER is an appreciation.

Figure 7 reports the responses at twelve months. Turkey is estimated but not shown, because its responses are much larger than those of the other countries. Industrial production is the most heterogeneous

[4]We use the shortest benchmark government yield available in our dataset: two years for twelve countries, three years for Indonesia and Mexico, and five years for Norway and South Africa; the US system has nine variables only because the two-year Treasury yield is already included in the global block. Argentina, Russia, and Saudi Arabia are excluded because no benchmark yield is available for them. A market yield also avoids the gaps in the BIS policy-rate series for Japan during the zero-rate periods.

variable: it falls in Germany, Japan, Italy, the United States, and India, whereas the other exporters and the less exposed economies show small or positive point estimates. Consumer prices rise in most countries, with the largest increases in Germany, Italy, France, and the United Kingdom, all European importers. Price increases are thus more widespread than output losses. Appendix G also reports the responses of energy consumer prices and producer prices (Figure A.25).

Exchange rates divide the sample more sharply. The currencies of import-dependent European and Asian economies tend to depreciate, possibly reflecting a deterioration in their energy trade balances, while the U.S. dollar and the renminbi appreciate.

The United States shows that the weak repricing of Henry Hub documented in Section 2.4 does not insulate the economy from the shock. U.S. industrial production falls by about 0.3 percent after twelve months and consumer prices rise by a similar amount, even though the dollar appreciates and the U.S. terms of trade improve (Figure 6). Australia provides another example: the Australian dollar appreciates on impact but depreciates at the one-year horizon (Figure A.24 in Appendix G). This reversal may reflect broader general-equilibrium effects, including weaker global activity and exchange-rate adjustments associated with the appreciation of trading partners' currencies, such as the U.S. dollar. The relative protection enjoyed by exporters is therefore not uniform.

5.2. Predetermined import dependence

We measure exposure before each narrative event. Let $m_{c,e-}$ denote net gas imports relative to domestic gas use in country c, observed immediately before event e. The baseline measure averages it across events,

$$\bar{m}_c = \sum_{e=1}^{E} \omega_e m_{c,e-}, \qquad \sum_{e=1}^{E} \omega_e = 1, \tag{8}$$

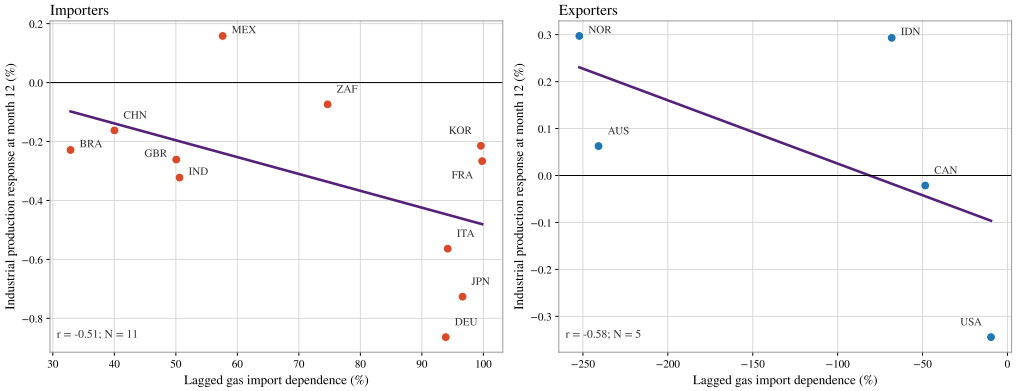
with equal weights ω_e. Measuring exposure before each event prevents the response itself from mechanically changing the regressor. Alternative weights are proportional to the absolute surprise or to the event's absolute contribution to the first-stage covariance, and separate measures capture gas use relative to GDP and the gas share of primary energy. Import dependence is not randomly assigned, so the cross-country relationships describe how responses vary with exposure; they do not identify the causal effect of changing it.

Figure 8 plots the twelve-month responses against this measure, again omitting Turkey. Among the eleven remaining importers, gas-import dependence is negatively correlated with the industrial-production response (-0.51), and the largest output declines occur in highly exposed economies such as Germany, Japan, and Italy. Exposure does not explain everything: Mexico shows a positive point estimate despite being an importer, and countries differ in sectoral composition and in their policy responses.

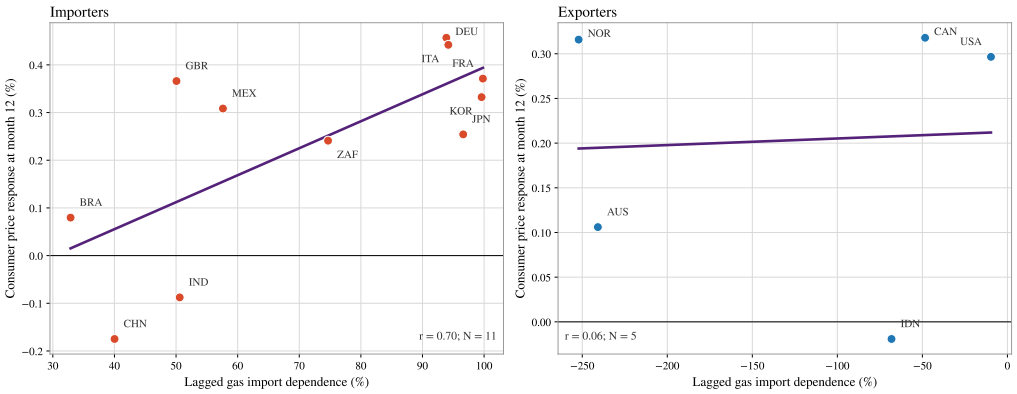
Prices and exchange rates are more closely related to exposure than output is. Among the same importers, the correlation with gas-import dependence is 0.70 for consumer prices and -0.74 for the NEER: the more dependent economies, such as Germany, Italy, France, the United Kingdom, and Korea, experience larger price increases and tend to depreciate more. China and India are the main exceptions, with consumer prices slightly lower at twelve months. Weighting events by the absolute surprise or by the first-stage covariance leaves the importer correlations virtually unchanged: -0.49 to -0.51 for industrial production, 0.70 to 0.71 for consumer prices, and -0.74 for the NEER. For the five exporters—Australia,

FIGURE 8. Predetermined gas-import dependence, activity, prices, and exchange rates

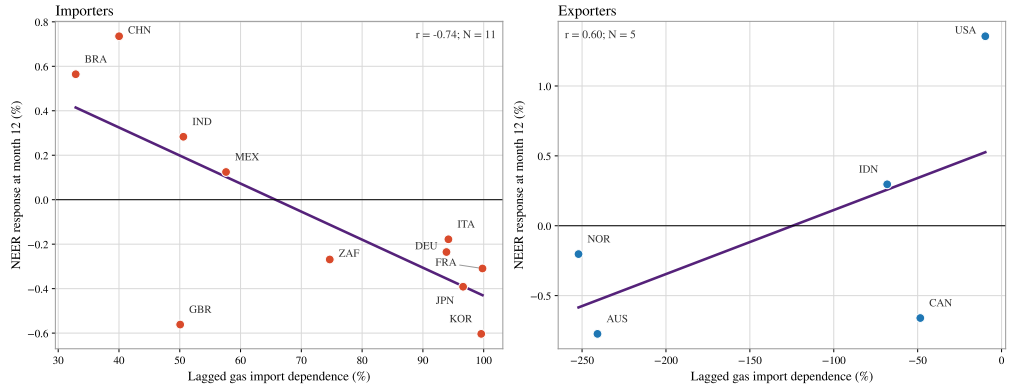
(a) Industrial production



(b) Consumer prices



(c) Nominal effective exchange rates



Notes: Each dot is a country's response at twelve months, plotted against its dependence on gas imports measured before each event and averaged over events. Negative values denote net exports relative to domestic gas use. Lines are least-squares fits, estimated separately for importers and exporters. A rise in the NEER is an appreciation.

Canada, Indonesia, Norway, and the United States—the correlations change substantially when Australia, whose activity series is constructed differently, is excluded, so we draw no conclusions from them.

Finally, we relate the responses to gas consumption relative to GDP, the gas share of primary energy, and the non-fossil share of electricity generation (Figures A.26, A.27, and A.28 in Appendix G). Among importers, gas intensity and the gas share are positively associated with the consumer-price responses but only weakly with industrial production, and a higher non-fossil share is not clearly associated with smaller responses. As with import dependence, these comparisons describe the cross-country pattern and do not identify the effect of changing the energy mix.

6. Robustness

The robustness analysis addresses six potential sources of sensitivity in the global estimates: proxy measurement, temporal aggregation, concurrent monetary and oil news, the role of the most influential events, model specification, and shock recoverability.

6.1. Measuring and aggregating the shock

The results are not specific to one TTF contract or one mapping from daily to monthly data. The historical continuous TTF front contract, the same-delivery roll-adjusted contract, the first principal component of the TTF curve, TTF day-ahead prices, and JKM futures yield similar responses. A specification pairing the JKM instrument with the World Bank LNG price is less precise but preserves the qualitative pattern (Figure A.4).

Daily to monthly temporal aggregation of the instrument across different schemes such as summation, linear, triangular, and MIDAS also produces similar paths (Figure A.5). Residualizing the proxy using AR(4) and AR(12) specifications or lagged gas prices yields series with correlations of 0.93–0.95 with the baseline and leaves the estimates largely unchanged (Figure A.6). The findings thus reflect the underlying narrative repricing rather than a particular measurement choice.

6.2. Monetary and oil-market news

The monthly correlation with a U.S. monetary-policy shock warrants explicit checks for monetary contamination. We residualize the proxy on U.S. policy shocks, on U.S. and euro-area shocks jointly, and on both policy and information shocks. A separate exercise excludes gas events that coincide with FOMC or ECB dates. Gas-price, equity, activity, and consumer-price responses remain similar across these specifications (Figures A.7 and A.8).

We address the overlap with oil price fluctuations in three steps. First, we residualize daily gas surprises on Brent returns before monthly aggregation, using either the full daily sample or only narrative event days (Figure A.8). Second, we exclude gas dates that overlap with identifiable oil news (Figure A.9). Third, we combine the gas shock with separately identified oil shocks in counterfactual exercises (McKay and Wolf, 2023). Appendix H describes the construction and compares the counterfactuals that employ Baumeister–Hamilton, Känzig, and Mori–Peersman shocks (Figure A.29); Figures A.30, A.31, and A.32 report the corresponding uncertainty bands. Stabilizing oil with the Baumeister and Hamilton (2019) or Känzig (2021) shock does not eliminate the decline in activity or the increase in consumer prices; the additional counterfactual uses the shock of Mori and Peersman (2026). These exercises show that the stagflationary response persists when the oil price response is approximately offset.

6.3. Influential events and sample composition

Large events are concentrated in the European energy crisis, raising the possibility that the global estimates depend on that episode. We assess this concern in two ways: a leave-one-event-out exercise tests the influence of individual dates, and a broader exclusion removes every event in 2022.

The leave-one-event-out exercise re-estimates the model 86 times. Dropping one event at a time leaves the response paths close to the baseline, with no single date driving the main responses. Excluding all 2022 events also preserves the signs of the median gas-price, equity, activity, and consumer-price responses. The qualitative pattern is therefore not confined to a single date or to the 2022 crisis. Figures A.10 and A.11 report both exercises.

The median responses also remain similar when we omit the Lenza and Primiceri (2022) pandemic adjustment or extend the sample back to 1992 (Figure A.16). The correction primarily limits the influence of exceptional volatility in 2020 on the covariance matrix and posterior uncertainty.

6.4. Specification and recoverability

The main responses remain stable when the system includes Brent, coal, non-energy commodities, the dollar, geopolitical risk, the VIX, terms of trade, trade balances, or world trade, added one at a time (Figure A.12). A flat-prior BVAR and an OLS proxy-SVAR preserve the same qualitative pattern (Figure A.13). Long-lag BVARs following Antolín-Díaz and Surico (2025), estimated with 24 and 48 lags and the baseline variable transformations, and bivariate local projections of each outcome on the estimated shock provide further comparisons (Figures A.14 and A.15). This agreement is useful because VARs and local projections impose different finite-sample smoothing choices while targeting the same population responses (Jordà, 2005; Plagborg-Møller and Wolf, 2021).

A Granger diagnostic tests whether the proxy predicts future VAR innovations. The test is joint over innovations one to six months ahead in the twelve-lag system, with wild-bootstrap (HC1) inference based on 10,000 replications, the Lenza–Primiceri COVID correction, and a common sample that allows for leads of up to twelve months, which gives 182 observations from 2010m4 to 2025m5. The test does not reject the null.[5]

We still report two estimators that do not require invertibility. Noh VARX specifications with 4, 8, and 12 lags of the proxy preserve the decline in activity but imply larger nominal responses (Noh, 2019): at twelve months, consumer prices rise by 0.42 to 0.47 percent, against 0.20 in the baseline, and the two-year yield by 20 to 39 basis points, against 15. Without proxy lags, the decline in activity is close to the baseline, but the nominal responses are smaller: at twelve months, consumer prices rise by 0.14 percent and the two-year yield by 10 basis points. These differences document sensitivity of the nominal responses to the estimator rather than evidence that the baseline is biased in a known direction. Generalized external instrument estimates following Forni et al. (2026) do not overturn the qualitative pattern.

Figure A.17 compares the Noh VARX and generalized external instrument estimates with the baseline.

[5]The p-values are 0.58 and 0.49 for the OLS residuals under Rademacher and Mammen weights, and 0.18 and 0.16 for the Minnesota residuals.

7. Conclusion

This paper studies the global implications of disruptions to the supply of natural gas. We identify supply shocks by combining narrative evidence with event-day changes in European futures prices between 2010 and 2026, and use the resulting surprises as an instrument in a range of Bayesian VAR models. The supply news we identify moves European and Asian gas prices together, including when it originates far from Europe, a sign of how integrated gas markets have become. In the monthly VAR models, adverse gas supply shocks lower global output, equity prices, and trade, and raise consumer prices and short-term interest rates.

The effects are global, but highly uneven across countries. A high dependence on gas imports is associated with larger responses of economic activity and inflation and with a weaker currency, while the terms of trade deteriorate for the euro area and improve for the United States. Integration spreads gas supply shocks across the world economy, but their incidence remains closely tied to each country's position in gas trade.

References

Albrizio, Silvia, John Bluedorn, Christoffer Koch, Andrea Pescatori, and Martin Stuermer. 2023. "Sectoral Shocks and the Role of Market Integration: The Case of Natural Gas." *AEA Papers and Proceedings* 113: 43–46.

Alessandri, Piergiorgio, and Andrea Gazzani. 2025. "Natural Gas and the Macroeconomy: Not All Energy Shocks Are Alike." *Journal of Monetary Economics* 151: 103749.

Alessandri, Piergiorgio, Andrea Gazzani, and Alejandro Vicondoa. 2023. "Are the Effects of Uncertainty Shocks Big or Small?" *European Economic Review* 158: 104525.

Antolín-Díaz, Juan, and Paolo Surico. 2025. "The Long-Run Effects of Government Spending." *American Economic Review* 115(7): 2376–2413.

Arezki, Rabah, Thiemo Fetzer, and Frank Pisch. 2017. "On the Comparative Advantage of U.S. Manufacturing: Evidence from the Shale Gas Revolution." *Journal of International Economics* 107: 34–59.

Baumeister, Christiane, and James D. Hamilton. 2019. "Structural Interpretation of Vector Autoregressions with Incomplete Identification: Revisiting the Role of Oil Supply and Demand Shocks." *American Economic Review* 109(5): 1873–1910.

Bauer, Michael D., and Eric T. Swanson. 2023. "A Reassessment of Monetary Policy Surprises and High-Frequency Identification." *NBER Macroeconomics Annual* 37(1): 87–155.

Degasperi, Riccardo. 2026a. "Identification of Expectational Shocks in the Oil Market Using OPEC Announcements." Bank of Italy Working Paper 1516.

Degasperi, Riccardo. 2026b. "Barrels of Trouble: The Change in Correlation Between Oil and the Dollar." Working paper.

Emiliozzi, Simone, Fabrizio Ferriani, and Andrea Gazzani. 2025. "The European Energy Crisis and the Consequences for the Global Natural Gas Market." *The Energy Journal* 46(1): 119–145.

Forni, Mario, Luca Gambetti, and Giovanni Ricco. 2026. "Generalised External-Instrument SVAR Analysis." *American Economic Journal: Macroeconomics*, forthcoming.

Gertler, Mark, and Peter Karadi. 2015. "Monetary Policy Surprises, Credit Costs, and Economic Activity." *American Economic Journal: Macroeconomics* 7(1): 44–76.

Giannone, Domenico, Michele Lenza, and Giorgio E. Primiceri. 2015. "Prior Selection for Vector Autoregressions." *Review of Economics and Statistics* 97(2): 436–451.

Hamilton, James D. 2003. "What Is an Oil Shock?" *Journal of Econometrics* 113(2): 363–398.

Hausman, Catherine, and Ryan Kellogg. 2015. "Welfare and Distributional Implications of Shale Gas." *Brookings Papers on Economic Activity*, Spring: 71–125.

Jarociński, Marek, and Peter Karadi. 2020. "Deconstructing Monetary Policy Surprises—The Role of Information Shocks." *American Economic Journal: Macroeconomics* 12(2): 1–43.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95(1): 161–182.

Joskow, Paul L. 2013. "Natural Gas: From Shortages to Abundance in the United States." *American Economic Review* 103(3): 338–343.

Känzig, Diego R. 2021. "The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements." *American Economic Review* 111(4): 1092–1125.

Känzig, Diego R. 2026. "The Unequal Economic Consequences of Carbon Pricing." *American Economic Review*, forthcoming.

Känzig, Diego R., and Ramya Raghavan. 2026. "The Macroeconomic Effects of Supply Chain Shocks: Evidence from Global Shipping Disruptions." Working paper, Northwestern University.

Känzig, Diego R., James H. Stock, and Luca Zanotti. 2026. "From Importer to Exporter: Oil Shocks and the U.S. Economy." NBER Working Paper 35864.

Kilian, Lutz. 2009. "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market." *American Economic Review* 99(3): 1053–1069.

Kilian, Lutz. 2024. "How to Construct Monthly VAR Proxies Based on Daily Surprises in Futures Markets." *Journal of Economic Dynamics and Control* 168: 104966.

Lenza, Michele, and Giorgio E. Primiceri. 2022. "How to Estimate a Vector Autoregression after March 2020." *Journal of Applied Econometrics* 37(4): 688–699.

McKay, Alisdair, and Christian K. Wolf. 2023. "What Can Time-Series Regressions Tell Us about Policy Counterfactuals?" *Econometrica* 91(5): 1695–1725.

Mertens, Karel, and Morten O. Ravn. 2013. "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States." *American Economic Review* 103(4): 1212–1247.

Miranda-Agrippino, Silvia, and Giovanni Ricco. 2021. "The Transmission of Monetary Policy Shocks." *American Economic Journal: Macroeconomics* 13(3): 74–107.

Mori, Lorenzo, and Gert Peersman. 2026. "Estimating the Macroeconomic Effects of Oil Supply News." *Review of Economics and Statistics*, forthcoming.

Nakamura, Emi, and Jón Steinsson. 2018. "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect." *Quarterly Journal of Economics* 133(3): 1283–1330.

Noh, Eul. 2019. "Impulse Response Analysis with Proxy Variables." Chapter 1 in *Essays in Macroeconometrics*, Ph.D. dissertation, University of California San Diego.

Plagborg-Møller, Mikkel, and Christian K. Wolf. 2021. "Local Projections and VARs Estimate the Same Impulse Responses." *Econometrica* 89(2): 955–980.

Stock, James H., and Mark W. Watson. 2018. "Identification and Estimation of Dynamic Causal Effects in Macroeconomics Using External Instruments." *The Economic Journal* 128(610): 917–948.

Stock, James H., and Matthew Zaragoza-Watkins. 2024. "The Market and Climate Implications of U.S. LNG Exports." NBER Working Paper 32228.

Appendix

A. Data, Transformations, and Event Construction

This appendix describes the data sources, variable transformations, and narrative coding protocol. It also lists all 86 events used to construct the baseline instrument.

A.1. Baseline variables and transformations

Table A.1 summarizes the variables in the main systems. Prices and quantities enter as monthly growth rates, with cumulative impulse responses reported as changes in log levels. Interest rates enter in levels, both the U.S. two-year rate in the global block and the domestic benchmark yields in the country systems, and their responses are reported in percentage points without cumulation. Asset prices are deflated where indicated in the main text; Table A.2 provides the series-specific construction details.

TABLE A.1. Variables and transformations in the main specifications

Variable	Transformation	Role
Real international natural gas price	Log difference; cumulative response	Shocked price in all monthly systems
Real world equity prices	Log difference; cumulative response	Global financial conditions
U.S. two-year interest rate	Level	Expected short-rate and policy response
World industrial production	Log difference; cumulative response	Global real activity
Global consumer price level	Log difference; cumulative response	Global inflation
Country industrial production	Log difference; cumulative response	Domestic real activity
Country consumer price level	Log difference; cumulative response	Domestic inflation
Country equity prices	Log difference; cumulative response	Domestic financial conditions
BIS NEER	Log difference; cumulative response	External relative price
Domestic benchmark government yield	Level	Domestic expected short rate

Notes: The baseline monthly macroeconomic sample spans 1999m2–2026m5, and the external-instrument sample spans 2010m4–2026m5. Quantity extensions with shorter data coverage use their maximum common sample. The country systems carry the first five variables of this table alongside the five domestic ones. The domestic yield is the shortest benchmark government yield available in our dataset, averaged over the month: two years for twelve countries, three years for Indonesia and Mexico, and five years for Norway and South Africa. The U.S. system omits it, since the U.S. two-year rate is already in the global block. Australian industrial production is replaced by an activity index built from quarterly national accounts, as described in Appendix G.

A.2. Detailed data sources and construction

Table A.2 documents the sources, transformations, coverage, and construction choices for the baseline data and all empirical extensions.

TABLE A.2. Data sources and variable construction

Variable / dataset	Source	Freq.	Definition, construction and coverage
A. Monthly global baseline and supporting deflators			
Real natural gas price	World Bank Pink Sheet: NGAS_EUR; Eurostat HICP and FRED EUR/USD	M	European gas price converted from USD/MMBtu to EUR/MWh using the monthly mean exchange rate, deflated by euro-area HICP and seasonally adjusted with X-13. VAR input: $100\Delta \log P_t^{gas,real}$. IRFs are cumulated percent changes. Baseline input window: 1999-02 to 2026-05, before lag loss.
Real world stock prices	MSCI World price index in USD, via LSEG Workspace	D to M	Monthly arithmetic mean of daily price-index levels, deflated by OECD G20 CPI. VAR input: $100\Delta \log P_t^{equity,real}$; not a total-return index. Baseline input window: 1999-02 to 2026-05, before lag loss.
U.S. 2-year interest rate	Federal Reserve via FRED: GS2	M	Two-year constant-maturity Treasury yield. VAR input is the level, in percent; the response is reported in percentage points without cumulation. Baseline input window: 1999-02 to 2026-05, before lag loss.
World industrial production	Baumeister-Hamilton world IP data; OECD + six non-member economies	M	The series is provided as $100 \log IP_t$ and differenced before estimation. The VAR input is $100\Delta \log IP_t$; plotted IRFs are cumulated. Baseline input window: 1999-02 to 2026-05, before lag loss.
Global CPI	OECD G20 consumer-price index	M	X-13-adjusted aggregate CPI; VAR input $100\Delta \log CPI_t$. Cumulated responses represent the price level, not year-on-year inflation. Baseline input window: 1999-02 to 2026-05, before lag loss.
Deflators and currency conversion	Eurostat/FRED: CP0000EZCCM 086NEST; BLS/FRED: CPIAUCNS; Federal Reserve/FRED: DEXUSEU	M; D to M	Euro-area headline HICP with changing country composition; U.S. all-items CPI, NSA; and USD per EUR. Euro-area HICP deflates the baseline gas price; U.S. CPI deflates dollar-denominated oil and alternative gas prices. Currency conversion uses the monthly mean exchange rate rather than its end-of-month value.
B. Narrative instrument, daily validation and information controls			
Narrative gas-supply instrument	Alessandri-Gazzani event set; subsequent narrative extension (Platts)	D to M/W	86 supply events, 2010-05-06 to 2026-04-08. Baseline: same-delivery TTF surprises, with corrections to seven contract-roll observations. Daily surprises are summed within each month or week. All five high-oil-overlap events remain in the baseline.

Variable / dataset	Source	Freq.	Definition, construction and coverage
TTF, JKM and Henry Hub futures curves	LSEG Workspace; contracts with maturities from one to 72 months	D	Daily front-contract prices and same-delivery returns. Curve-factor robustness uses the first principal component (PC1) over maturities one to six or one to twelve months. The twelve-maturity specification retains events with missing contracts by projecting returns at observed maturities onto fixed loadings. JKM data begin in 2015-05; TTF/HH comparison data begin in 2010-03.
TTF day-ahead spot	LSEG: PNX-TTFEOD-DA / TRDPRC_1	D	Dutch TTF day-ahead end-of-day price in EUR/MWh; event-day return used as an alternative instrument, not as the baseline monthly gas-price variable.
Daily commodities	LSEG: Brent and coal/wheat front futures; S&P GSCI copper and industrial-metals excess-return indices	D	Positive price/index levels enter daily LP-IV outcomes as $100 \log x_{t+h} - 100 \log x_{t-1}$. Copper and industrial metals are excess-return indices, not spot prices. Coverage: 2010-03 to 2026-05; industrial metals begins in 2016-01.
Daily stock indices and risk	LSEG: MSCI World/Pacific, S&P 500, STOXX Europe 600, VSTOXX; FRED/LSEG VIX; Caldara-Iacoviello GPR	D	Stock and volatility indices use log-level differences; geopolitical risk uses $100\Delta_h \log(1 + GPR)$. EURO STOXX 50 is reconstructed from returns. Coverage is generally 2010-03 to 2026-05.
Daily U.S. rates and expected inflation	Federal Reserve/FRED: DGS2, DGS10, T5YIE, T5YIFR	D	Two- and ten-year Treasury yields, five-year breakeven inflation and five-year/five-year forward inflation compensation. LP outcomes: $x_{t+h} - x_{t-1}$ in percentage points. These market measures include risk premia.
Daily euro-area rates and expected inflation	ECB euro-area yield curve; LSEG inflation swaps; Euribor	D	Two- and ten-year euro-area yields (ECB all-rating government-bond curve); 3-month Euribor; 1y1y, 2y2y and 5y5y euro-area inflation swaps. Outcomes are percentage-point changes. The 1y1y measure is a one-year forward swap starting in one year. Swaps begin in 2012-12 or 2013-10.
Daily effective exchange rates	BIS broad nominal effective exchange-rate indices: WS_EER	D	Broad NEER for U.S., euro area, U.K., Japan, China, Korea, India, Canada, Australia and Norway. An increase is appreciation. Daily LP outcomes use $100 \log(NEER_{t+h}/NEER_{t-1})$. Euro area is the BIS euro-area series, not German NEER.
Industrial-production news controls	LSEG/Reuters actual releases and median polls: euro area, Japan and China	Event	Actual minus survey median, with conservative availability lags of 50, 35 and 25 calendar days after reference-month end. Predictability regressions use only information assigned as available before each event.

Variable / dataset	Source	Freq.	Definition, construction and coverage
European storage information	Gas Infrastructure Europe, AGSI: EU storage fullness (%)	D	Storage fullness less its same-calendar-day mean over up to five previous years, together with the 20-calendar-day change in this gap. Both measures are sampled two days before the event. The predictability specification uses 82 of the 86 events.
Monetary and macro-surprise controls	ECB/FOMC decision-date calendar; Citi Economic Surprise Index via LSEG	D	Monetary announcement indicators identify exact decision dates. The euro-area and global CESI indices instead measure quantitative economic surprises; they are not release calendars. These variables enter diagnostic and contamination checks, not the five-variable baseline system.
C. Monthly global extensions and alternative measurements			
Alternative European and Japanese gas prices	IMF/FRED: PNGASEUUSDM; World Bank Pink Sheet: Japanese LNG	M	Dollar prices deflated by U.S. CPI and X-13 adjusted; input $100\Delta \log P_t^{real}$. European long-sample growth coverage: 1992-02 to 2026-05. Japanese LNG: 1990-02 to 2026-05. These are alternative price concepts, not a splice into the baseline gas series.
Monthly TTF futures alternative	LSEG contract curve	D to M	Roll-clean front-contract index, deflated by euro-area HICP and X-13 adjusted; $100\Delta \log P_t$. Growth coverage: 2010-04 to 2026-05.
Alternative global activity indicators	Dallas Fed/Kilian IGREA; OECD/FRED G7 and OECD composite leading indicators	M	IGREA enters in its published detrended level, and amplitude-adjusted CLIs enter as deviations from 100. Neither measures industrial-production growth. IGREA/G7 coverage ends in 2026-05; the OECD-wide CLI sample ends in 2022-11.
Real Brent oil price	World Bank Pink Sheet: CRUDE_BRENT; BLS/FRED U.S. CPI	M	USD/barrel deflated by U.S. CPI, X-13 adjusted; $100\Delta \log P_t^{oil,real}$. Added to the five-variable system in the six-variable oil-counterfactual exercise. Growth coverage: 1990-02 to 2026-05.
Coal and non-energy commodity prices	World Bank Pink Sheet	M	Australian coal prices are deflated by U.S. CPI and log-differenced. The non-energy commodity index is log-differenced in nominal terms. Both are price measures, not quantity series.
Monthly dollar, VIX and geopolitical risk	BIS broad dollar via LSEG; CBOE/FRED VIX; Caldara-Iacoviello GPR	M; D to M	BIS nominal broad dollar: $100\Delta \log$ index. VIX: log of the monthly mean. GPR: $\log(1 + GPR)$. Coverage generally spans the 1999-2026 baseline window.

Variable / dataset	Source	Freq.	Definition, construction and coverage
Terms of trade and trade balance	BLS/FRED: IQ, IR; ECB extra-euro-area trade unit values; FRED: BOPTEXP/BOPTIMP	M	Terms of trade are the ratio of export-price to import-price indices, transformed to $100\Delta \log$. Euro-area growth coverage is 2002-02 to 2026-04. The U.S. trade balance is $100(X - M)/(X + M)$ for goods and services: a share in levels, not a goods-only volume measure.
World trade volume	CPB World Trade Monitor: world merchandise trade volume	M	Seasonally adjusted volume index, transformed to $100\Delta \log$. Coverage: 2000-02 to 2026-05. Cumulated IRFs are percentage changes in trade volume.
Global gas production, stocks and flows	JODI-Gas: INDPROD, CLOSTLV, TOTDEMO, TOTIMPSB, IMPLNG, IMPPIP, MAINTOT	M	Flow-specific fixed-country aggregates in terajoules, X-13 adjusted, then $100\Delta \log$. Stocks are end-month closing inventories; imports and consumption are flows. Aggregate growth coverage: 2010-02 to 2025-12. These are observed-country aggregates, not exhaustive world totals.
Long-sample global CPI and real equity	World Bank global inflation database/GEM and OECD G20; MSCI World	M	The Kose-GEM CPI prehistory is rebased using the median OECD/Kose level ratio over the first 12 common observations; OECD CPI is retained wherever observed. The resulting long CPI also deflates MSCI World. Used with FRED gas for the sample beginning 1992-02. It is not the baseline CPI construction.
D. Country-specific systems with the global block and a domestic interest rate			
Global block in the country systems	As in panels A–B above	M	The baseline country system carries the five global variables—real European gas price, real world equity prices, the U.S. two-year rate, world industrial production and global consumer prices—ahead of the five domestic ones, all endogenous and with no block-exogeneity restriction. The series are identical to those used in the aggregate model, so the country systems differ from it only by the domestic block.

Variable / dataset	Source	Freq.	Definition, construction and coverage
Domestic industrial production	World Bank Global Economic Monitor; Australia: LSEG AUGDPQ=ECI and AUEMP=ECI	M	Seasonally adjusted country IP index, transformed to $100\Delta \log$. Each system uses the longest complete contiguous sample shared by CPI, equity, EER, the interest rate, and the common European gas price. Samples therefore vary across countries rather than imposing a common 1999-2026 window. Australia is the exception: the Global Economic Monitor series ends in 2015-12 and, over the window it covers, has a monthly log-change standard deviation of 47 against 1 to 6 elsewhere. It is replaced by a monthly activity index obtained by Denton proportional first differences of quarterly national accounts, with monthly employment as the within-quarter indicator, covering 1999-01 to 2026-05. That series measures aggregate activity rather than industrial production and is smoother than the indices used elsewhere.
Domestic headline CPI	BIS long consumer-price database: WS_LONG_ CPI	M	Monthly country CPI, rebased by BIS; $100\Delta \log$ enters the system. No additional X-13 adjustment is applied in this extension. Missing CPI observations remain unfilled, unlike the interpolated observations in the separate U.S. outcome exercise.
Domestic equity prices	World Bank Global Economic Monitor: DSTKMKTXN	M	Nominal local-currency stock-market price index, transformed to $100\Delta \log$. This is neither MSCI World nor a CPI-deflated domestic total-return series.
Domestic NEER	BIS broad indices: WS_ EER, 2020=100	M	Broad NEER enters in $100\Delta \log$. Positive responses denote appreciation. BIS replaces the shorter World Bank NEER histories in these country specifications.

Variable / dataset	Source	Freq.	Definition, construction and coverage
Domestic interest rate (baseline)	LSEG benchmark government yields: ⟨ISO2⟩2YT=RR and the corresponding 3Y and 5Y RICs, field MID_ YLD_1	M	Monthly average of daily benchmark government yields, in levels (% per annum); IRFs in percentage points, not cumulated. The maturity is the shortest benchmark available in our dataset: two years for Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Korea, Turkey and the United Kingdom; three years for Indonesia and Mexico; five years for Norway and South Africa. The U.S. system omits the domestic yield, since the U.S. two-year rate is already in the global block. Argentina, Russia and Saudi Arabia drop out of the country sample because no benchmark yield series is available to us for them. A market yield is used rather than the policy rate because policy rates sat at or near their effective lower bound for much of the sample in several economies, while short-maturity yields continue to price the expected policy path. As with the U.S. two-year rate in the global block, these yields capture changes in the expected path of monetary policy together with term and risk premia, and differences in maturity and sovereign risk limit their comparability across countries. It also avoids the gap in the BIS policy series for Japan, which is blank across the zero-rate windows and would truncate that system to 113 contiguous months.
Alternative domestic price indices	World Bank Global Database of Inflation: ecpi_m, ppi_m	M	Energy CPI and PPI replace headline CPI one at a time, in $100\Delta \log$. Country-specific available samples and source selection are preserved; these substitutions can shorten the estimation sample.
E. Cross-country gas exposure and energy mix			
Gas net-import dependence	Our World in Data Energy; annual gas consumption and production in common TWh units	A	$D_{i,y} = 100(C_{i,y} - P_{i,y})/C_{i,y}$. Positive values denote net-import dependence; negative values denote net exports. The measure is a consumption-production balance, not gross import penetration or LNG-only dependence.
Event-weighted predetermined exposure	Annual gas dependence matched to the 86 narrative events	A to event	$D_i^{(w)} = \sum_e w_e D_{i,y_e-1} / \sum_e w_e$. Source data must precede the event year by at least one year. Older observations may be carried forward when recent values are unavailable. Baseline weights are uniform; alternatives use the absolute narrative surprise or absolute first-stage covariance contribution. Usable exposure is required for all 86 events.

Variable / dataset	Source	Freq.	Definition, construction and coverage
Gas use per unit of GDP	OWID energy intensity and gas share	A	Primary-energy use per unit of GDP multiplied by gas share/100, measured in kWh per 2017 international dollar. For each country, the descriptive measure averages lagged annual inputs with equal weights over the 1999-2026 observation window; it is not event weighted.
Gas share of primary energy	OWID primary-energy consumption by fuel	A	Gas as a percent of primary-energy consumption. The alternative scatter uses equal-weight country-year means of lagged annual shares over observation years 1999-2026 (source years no later than 1998-2025). Missing recent values may use older source years; no future exposure is assigned.
Gas and low-carbon electricity shares	Ember Monthly Electricity Data	M to A	Gas generation/total generation, and renewables plus nuclear generation/total generation, in %. Monthly shares are first averaged within country-year, then across years in the available 1999-2026 window. These are descriptive full-sample electricity shares, not event-specific predetermined primary-energy exposures.
F. Published oil shocks and motivation figures			
Published oil supply shocks	Baumeister-Hamilton; Känzig; Mori-Peersman author data	M	BH uses the updated oil-supply structural shock (sign reversed to adverse supply). The oil-price counterfactuals use Känzig's structural news shock, distinct from the raw OPEC-window surprises. Mori-Peersman uses the updated-sample oil supply news shock from the financially augmented SVAR. Only overlapping observed months identify each oil shock.
World primary-energy shares	OWID Energy Mix; Energy Institute 2026, Smil and EIA, with OWID processing	A	World gas and oil shares of total energy supply, in %. Coverage: 1965-2025. The global series and the country-exposure panel use different data vintages.
Benchmark price levels and rolling correlations	LSEG front-month TTF, JKM and HH; FRED currency conversion	D to M	Monthly price levels in common USD/MMBtu. Rolling correlations use a 36-month window on monthly price levels. Coverage: TTF from 2010-03, JKM from 2015-05, HH from 2010-01; all end in 2026-06.

Notes: D = daily, W = weekly, M = monthly, and A = annual. Δ denotes a one-period difference. Unless stated otherwise, monthly growth inputs are $100\Delta \log x_t$, are not annualized, and have IRFs cumulated to percentage changes in levels. SA = seasonally adjusted; NSA = not seasonally adjusted. The baseline input window is 1999-02 to 2026-05 (328 months before lag loss); the identification window is 2010-04 to 2026-05. Individual series coverage may exceed the effective regression sample because lags, horizon leads, and joint missingness reduce the available observations. Monthly and weekly structural responses are normalized to a 10% impact increase in the target gas price; daily LP-IV plots use 1%. Displayed daily LP paths use a trailing five-trading-day moving average, with the impact response restored to its unsmoothed value. This smoothing affects presentation only, not source data. Selected price series contain geometric-mean interpolations for October 2025; these are not officially observed values. Lenza–Primiceri scaling treats COVID volatility during estimation without redefining the source series.

A.3. Narrative coding protocol

Narrative coding uses contemporaneous reporting in Refinitiv News and Factiva/Platts Daily. A candidate date qualifies when reports identify a discrete change in expected gas availability. Eligible developments include unplanned field outages, pipeline disruptions, liquefaction or regasification failures, strikes, maintenance surprises, and geopolitical events with direct supply implications. The screen excludes demand news, temperature revisions, routine storage releases, and events with inseparable drivers.

Events are classified before examining lower-frequency macroeconomic responses. Both favorable and adverse supply news are eligible; the event-day proxy records the sign and magnitude of the associated TTF price change. Table A.3 lists the 86 retained dates between 2010 and 2026.

TABLE A.3. Narrative gas-supply events used in the baseline

No.	Date	Narrative event	TTF (%)
1	2010-05-06	Russia's proposal to merge gas network rebuked by Ukraine	+5.63
2	2010-06-04	Oman and Qatar LNG facilities down for climatic events	+5.36
3	2010-07-20	ENI pushes forward pipeline project in Azerbaijan; LNG tankers diverted from Mexico to EU	-6.09
4	2011-03-31	Internal political tensions in Russia; Russian gas facility delayed by 3 months; worries on LNG supply for EU market	+2.85†
5	2014-03-03	Tensions piling up between Russia and Ukraine	+9.45
6	2014-03-04	Gazprom says Russian gas flows to Europe via Ukraine not affected by tensions	-5.56
7	2014-04-07	Deadline for Ukraine to pay Gazprom expires without transactions	+5.01
8	2014-08-28	EU Commissioner Oettinger cannot rule out disruptions in gas flows from Russia	+5.16
9	2014-08-29	Gazprom accuses Ukraine of stealing gas	+1.86†
10	2016-01-22	Dispute between Gazprom and Naftogaz	+7.00
11	2016-04-21	Russia starts providing gas to China	+5.94
12	2016-04-26	Gazprom unavailable to discuss its monopoly position	+7.80
13	2016-04-28	Gazprom hopes Nord Stream 2 avoids problems with Brussels faced by predecessor	-9.56
14	2017-12-13	Yamal starts exporting LNG	-5.13
15	2019-04-05	Reduced supply from Norway to EU and UK	+12.33
16	2019-09-10	EU court ruling against Gazprom on OPAL pipeline; Putin suggests diverting gas from EU to China	+17.72
17	2020-06-29	US threatens sanctions on EU over Nord Stream 2	+10.46†
18	2020-07-30	Pompeo makes strong declaration against Nord Stream 2	+2.05†
19	2020-08-03	Tensions between Poland and Gazprom	+12.93
20	2021-09-20	Gazprom is not booking gas transit via Ukraine; Ukraine to reconfigure gas transmission system	+15.69
21	2021-10-05	Putin: Gazprom will prioritize domestic market	+20.04

No.	Date	Narrative event	TTF (%)
22	2021-10-28	Gazprom declares it can pump gas into EU storage	-11.25[†]
23	2021-10-29	Gazprom reaches agreement with ENI and Moldova	-16.15
24	2021-11-03	Increasing uncertainty over Russian supply to EU	+13.22
25	2021-11-16	Nord Stream 2 certification halted by German authorities	+17.81
26	2021-12-14	Talk of Western sanctions on Russia	+10.52
27	2021-12-21	Russia is not booking gas volume towards EU but increases flows to Turkey; Yamal flows eastbound	+22.69
28	2021-12-23	Russian news agencies: gas to EU increased in 2021; LNG tankers diverted from Asia towards EU	-23.31
29	2022-01-03	Gazprom draws on storage but misses 2021 export target to Europe	+14.35
30	2022-01-13	IEA chief Birol: Russia worsened EU gas crisis; US Congress discusses Nord Stream 2 sanctions	+13.71
31	2022-01-17	Gazprom increases gas output	-11.45
32	2022-02-23	Biden announces sanctions on Nord Stream 2	+11.41
33	2022-02-24	Russia invades Ukraine	+51.10
34	2022-02-25	Reassurances from Gazprom on gas flows	-29.81[†]
35	2022-03-01	Several EU gas companies sever ties with Gazprom	+23.41
36	2022-03-02	Yamal stops; sanctions on EU-Russian gas joint ventures	+36.05
37	2022-03-04	Nord Stream 2 holding files for bankruptcy; fears on Russian supply to EU	+19.73
38	2022-03-07	Talk of EU sanctions on Russian gas	+18.00
39	2022-03-09	Gazprom books Yamal transit	-27.35
40	2022-03-10	Regular Gazprom supply to EU; new LNG projects approved worldwide	-18.91
41	2022-03-16	Norway can provide more gas to EU; new LNG projects approved in US	-11.10
42	2022-03-23	Gazprom will require payments in rubles	+18.49
43	2022-03-30	EU-Russia tensions over ruble gas payments	+9.59[†]
44	2022-04-01	US exports more gas to EU	-10.93
45	2022-06-14	Nord Stream 1 capacity limited because turbine is stuck in Canada	+16.35
46	2022-06-15	Nord Stream 1 volumes drop further; implications of Freeport LNG fire continue to grow	+24.00
47	2022-07-04	Gazprom may ask for ruble payment also for LNG exports; Norwegian flows drop due to strike	+10.26
48	2022-07-25	Gazprom announces Nord Stream flow cut amid Siemens turbine dispute	+10.48
49	2022-07-26	Nord Stream flows drop to 20% of capacity	+13.19
50	2022-08-22	Three-day Nord Stream stop announced	+13.17
51	2022-08-25	Gazprom states turbines are not being repaired in Canada	+10.02
52	2022-08-29	Flows to Ukraine increase; Yamal flows regularly	-19.63
53	2022-09-02	Data signal Nord Stream 1 flows to resume	-11.66

No.	Date	Narrative event	TTF (%)
54	2022-09-05	New halt to Nord Stream 1 flows	+14.56
55	2022-10-21	Italy approves new LNG terminal; Mozambique starts exporting LNG to EU	-10.67
56	2023-03-10	Strikes in French LNG facilities and risk of strikes in UK LNG facilities	+21.23
57	2023-06-01	LNG plant in Norway (Hammerfest) stops leakage	-13.96
58	2023-06-13	Norwegian maintenance Nyhamna extended (by more than 3 weeks)	+16.16
59	2023-08-09	Risk of strike in Australia LNG plants	+28.19
60	2023-08-15	Risk of strike in Australia LNG plants	+12.72
61	2023-08-21	Continued concerns over potential strikes at LNG projects in Western Australia	+12.01
62	2023-08-23	Optimism about ongoing negotiations to avert Australian LNG strikes	-14.27
63	2023-08-24	Woodside Energy and Offshore Alliance reach an in-principle agreement following talks on August 23, easing Australian LNG strike concerns	-13.18
64	2023-08-28	Norwegian flows fall to their lowest level in more than a year following planned maintenance at the Troll field. Gassco reports additional work at fields supplying the UK-linked Segal network, with uncertain duration of the capacity reductions. Uncertainty over Australian LNG strikes continues	+10.46
65	2023-10-09	Escalating clashes between Hamas and Israeli forces, plans to resume industrial action at Chevron's Australian LNG facilities, and the temporary shutdown of the Finland–Estonia Balticconnector following a suspected leak	+14.97
66	2023-10-10	Israel orders Chevron to suspend Tamar gas production following the October 7 Hamas attack, with expected spillovers to Egyptian LNG exports. Finland attributes Balticconnector damage to external activity, and Gasgrid warns that repairs could take several months. Strike risks persist at Chevron's Gorgon and Wheatstone LNG facilities in Australia	+12.52
67	2024-01-24	Red Sea tensions divert shipping around the Cape of Good Hope, lengthening voyages and raising Eastern Mediterranean price premiums amid supply-security concerns	+6.25
68	2024-02-28	News that the Russia–Ukraine gas transit agreement will not be extended beyond 2024. Freeport LNG extends the Train 3 outage by two weeks beyond the expected end-February restart to complete repairs	+5.03
69	2024-03-18	Supply concerns due to output issues in Norway, US LNG production and cyclone in Australia	+6.65
70	2024-04-11	Market uncertainty over Russia's attacks on two Ukrainian gas storage sites and technical constraints at Freeport's Train 3	+8.40
71	2024-04-16	Supply concerns from escalating Middle East tensions and ongoing unplanned maintenance at Norway's Nyhamna gas processing plant	+6.41
72	2024-06-04	Easing concerns over outages at the Nyhamna gas processing plant and Gorgon LNG Train 2	-6.16
73	2024-09-19	Media reports that Ukraine has agreed to allow temporary transit of Azerbaijani gas after the Russia–Ukraine transit agreement expires at the end of 2024	-6.13

No.	Date	Narrative event	TTF (%)
74	2024-12-19	Putin declared that the Russia-Ukraine transit agreement would not be renewed in the new year	+5.05
75	2025-02-13	Reports of a U.S.–Russia peace plan for Ukraine following talks between Donald Trump and Vladimir Putin on February 12	-7.69
76	2025-02-17	Geopolitical tensions eased further amid potential Ukraine peace talks	-5.03
77	2025-03-06	Expectations of a possible resumption of Russian pipeline gas flows to Europe under a peace settlement	-7.87
78	2025-03-19	Putin–Trump talks show no signs of leading to a resumption of Russian gas supplies	+6.38
79	2025-05-06	Anticipated halt to Russian spot LNG flows to Europe by the end of 2025, alongside maintenance at a Norwegian facility	+5.51
80	2025-06-19	Escalating tensions in the Middle East	+7.59
81	2025-06-24	Ceasefire agreement between Israel and Iran	-12.11
82	2026-03-02	Turmoil in the Middle East drives a surge in European natural gas prices	+39.26
83	2026-03-03	QatarEnergy halts LNG and downstream production after missile and drone attacks	+21.98
84	2026-03-10	Hopes of a potential de-escalation in the Middle East	-16.05
85	2026-03-19	LNG prices rise as QatarEnergy reports missile strikes on export facilities	+13.15
86	2026-04-08	European gas futures slide following ceasefire announcement	-14.92

Notes: The table lists the 86 events selected by the baseline narrative rule (Supply = 1), from 6 May 2010 to 8 April 2026. Events 1–55 come from the Alessandri–Gazzani replication; events 56–86 form the subsequent extension. The final column reports the daily TTF surprise used in the baseline, in percent and rounded to two decimal places. Positive values denote a TTF price increase. † identifies the seven same-delivery roll corrections. Daily surprises are summed to construct the monthly instrument. The baseline retains all five events with high oil-news overlap.

B. Additional Daily and Monthly Identification Evidence

The tables and figures below complement the identification diagnostics in Section 2. They report event-day predictability regressions, monthly correlations with published shocks, and daily market responses.

TABLE A.4. In-sample predictability of daily TTF gas supply surprises

Predictor	IP news	Add TTF	Add storage
Euro-area IP surprise	1.598	2.292	1.807
	(0.243)	(0.104)	(0.182)
Japan IP surprise	−0.730	−0.758	−0.815
	(0.278)	(0.262)	(0.246)
China IP surprise	−0.775	−0.603	−0.677
	(0.472)	(0.601)	(0.571)
TTF 20-day log change		−0.065	−0.056
		(0.353)	(0.431)
TTF 20-day volatility		−0.022	−0.099
		(0.960)	(0.829)
EU storage gap			0.043
			(0.774)
20-day change in storage gap			0.734
			(0.349)
R^2	0.021	0.037	0.045
Adjusted R^2	−0.016	−0.026	−0.046
Joint p-value	0.351	0.443	0.623

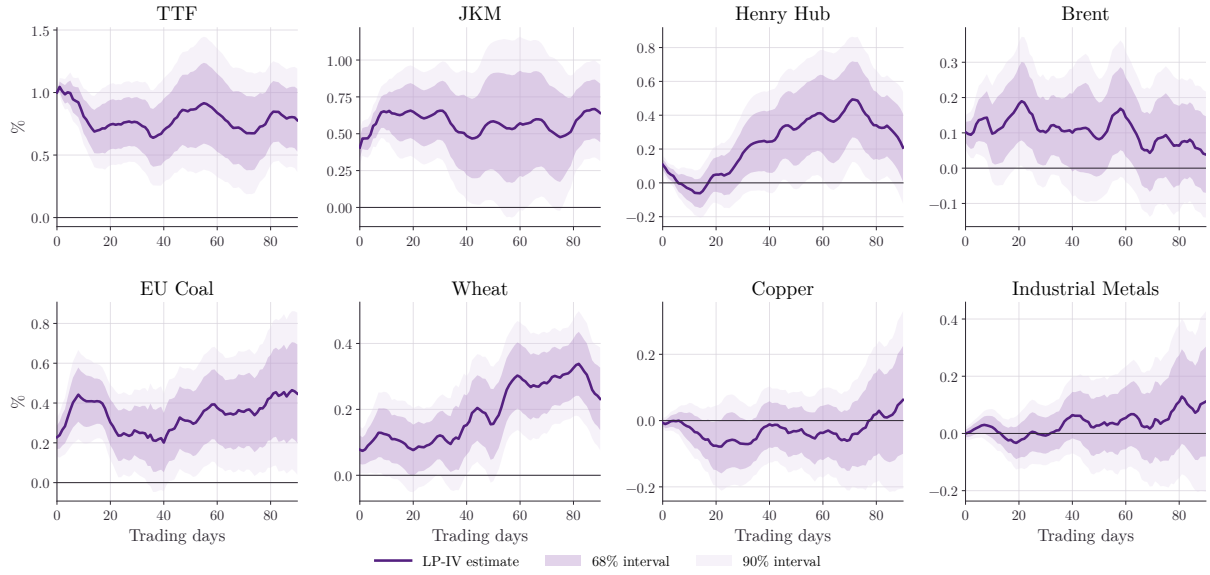
Notes: Regressions use the narrative event-day sample and information available before each event. Parentheses report p-values. The storage gap is the deviation of storage fullness from its seasonal norm, in percentage points.

TABLE A.5. Monthly diagnostics: published shocks

Published benchmark	N	ρ	p-value
External instrument			
Känzig carbon-policy surprise	117	−0.078	0.34
Känzig oil-supply surprise	189	−0.009	0.85
Känzig–Raghavan shipping surprise	153	0.017	0.68
Structural shock			
BH economic-activity shock	189	0.029	0.52
BH oil-consumption-demand shock	189	0.111	0.15
BH oil-inventory-demand shock	189	−0.040	0.56
BH oil-supply shock	189	0.095	0.16
Jarociński–Karadi EA information shock	187	0.104	0.13
Jarociński–Karadi EA monetary-policy shock	187	0.112	0.09
Jarociński–Karadi U.S. information shock	189	0.149	0.05
Jarociński–Karadi U.S. monetary-policy shock	189	0.254	0.01
Känzig carbon-policy shock	117	−0.116	0.20
Känzig oil-supply news shock	189	0.077	0.28
Känzig–Raghavan supply-chain shock	153	0.021	0.73

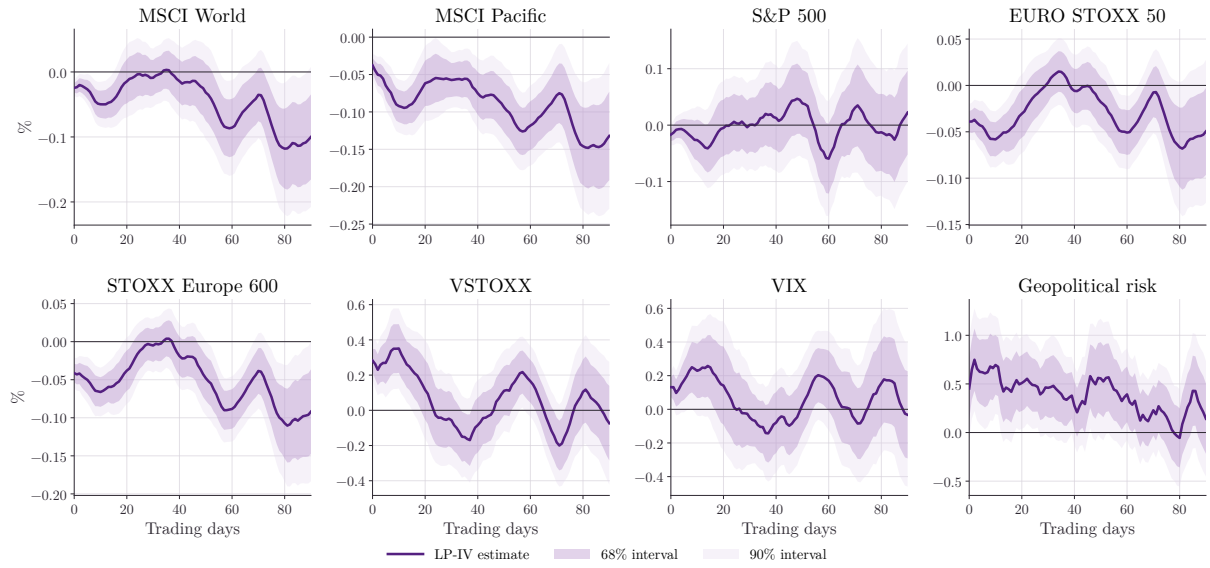
Notes: Contemporaneous monthly correlations between the gas-supply proxy and each published benchmark, computed over their overlapping samples. N denotes the number of observations and ρ the correlation coefficient. Carbon-policy surprises and shocks are from Känzig (2026); monetary-policy and information shocks are from Jarociński and Karadi (2020); oil-supply surprises and news shocks are from Känzig (2021); shipping surprises and supply-chain shocks are from Känzig and Raghavan (2026).

FIGURE A.1. Daily responses of energy and commodity prices



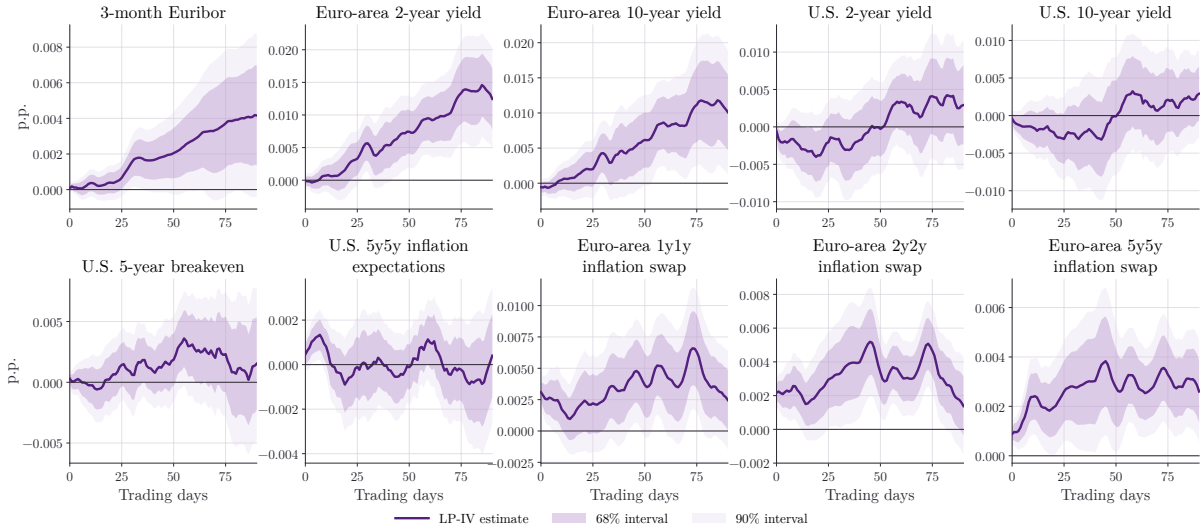
Notes: Responses on and after the event days, estimated by local projections with the TTF surprise as instrument and scaled to a 1 percent rise in the TTF price on impact. Lines are point estimates and shaded areas 68 and 90 percent intervals; the horizon is in trading days.

FIGURE A.2. Daily responses of equity and risk measures



Notes: See the note to Figure A.1.

FIGURE A.3. Daily responses of rates and inflation compensation

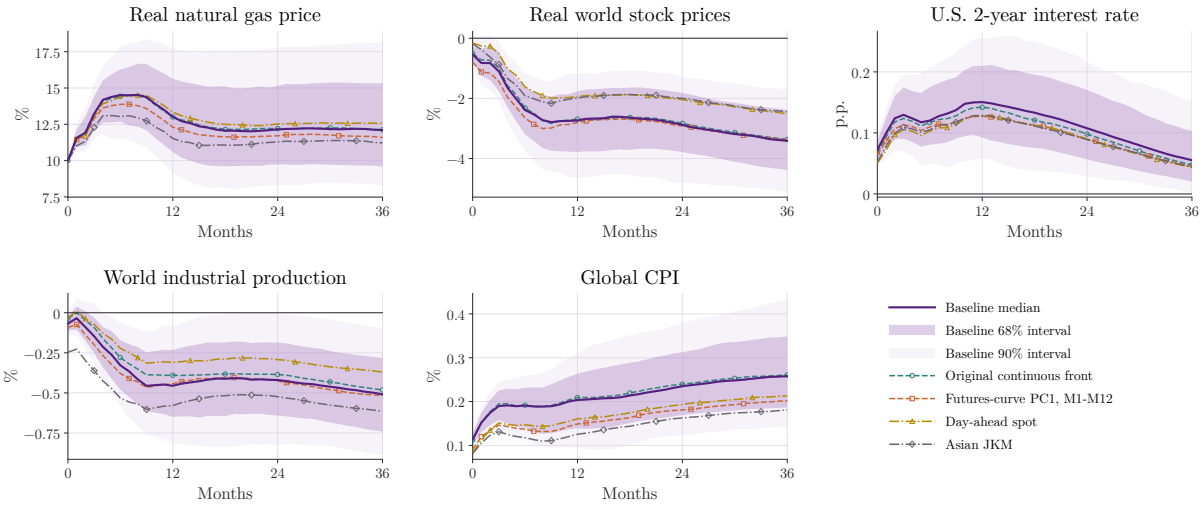


Notes: See the note to Figure A.1.

C. Instrument Construction and Contemporaneous-News Checks

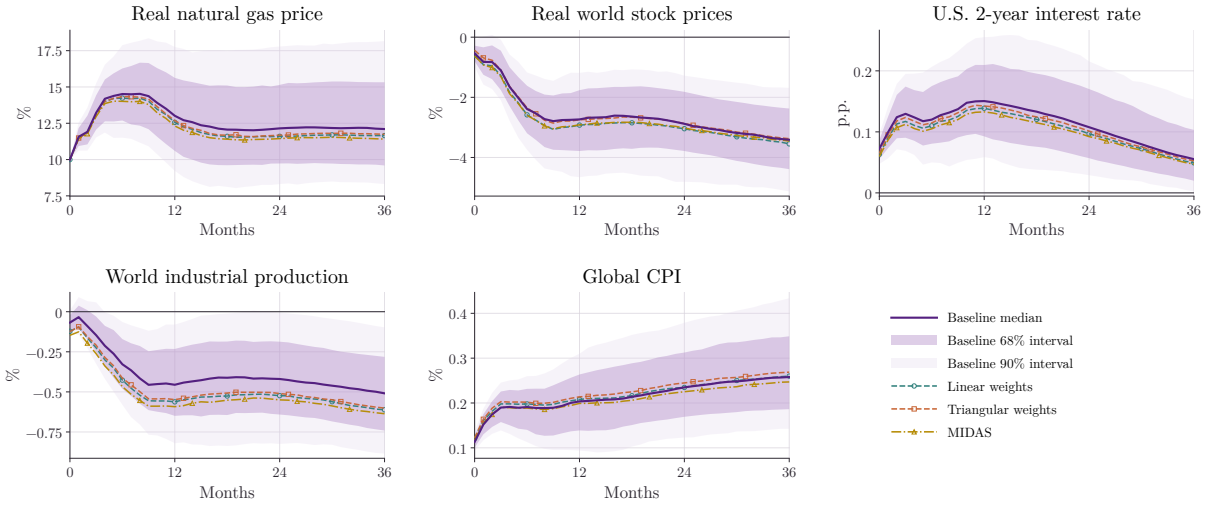
These exercises assess sensitivity to proxy construction and concurrent monetary and oil news. Baseline posterior bands provide a common reference for the alternative estimates.

FIGURE A.4. Alternative markets and gas-price measures



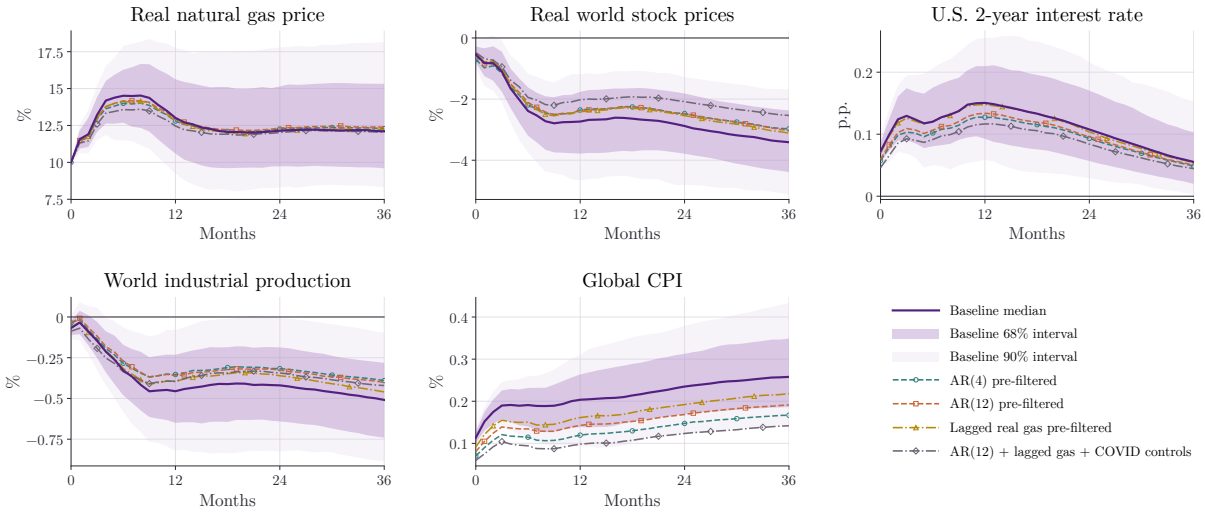
Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The other lines show posterior medians obtained with alternative TTF contracts, the first principal component of the TTF curve, TTF spot prices, and JKM-based instruments.

FIGURE A.5. Alternative daily-to-monthly aggregation schemes



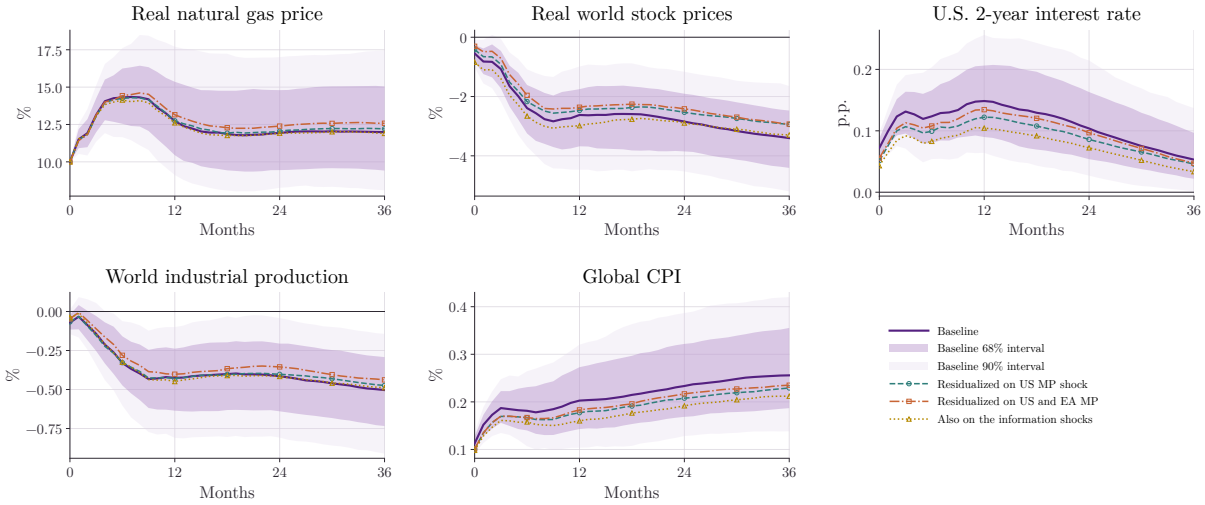
Notes: The solid line and shaded areas show the baseline median and posterior intervals, obtained by summing daily surprises within each month. The other lines show posterior medians under linear, triangular, and MIDAS weighting.

FIGURE A.6. Predictability and pre-filtered instruments



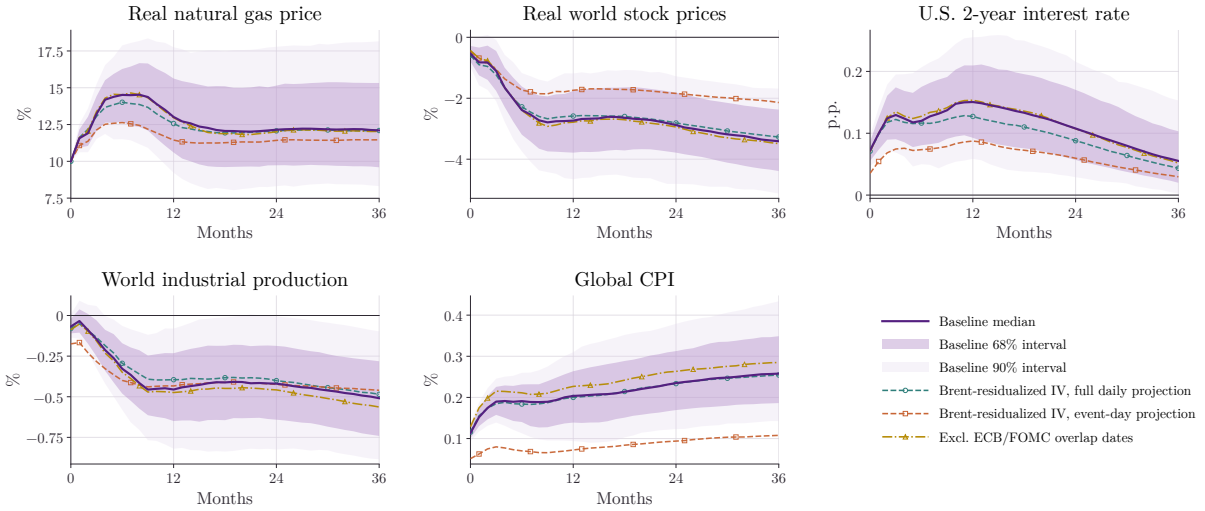
Notes: The solid line and shaded areas show the baseline median and posterior intervals. The other lines show posterior medians obtained after residualizing the instrument on its own lags or on lagged gas prices.

FIGURE A.7. Residualizing the instrument on monetary-policy shocks



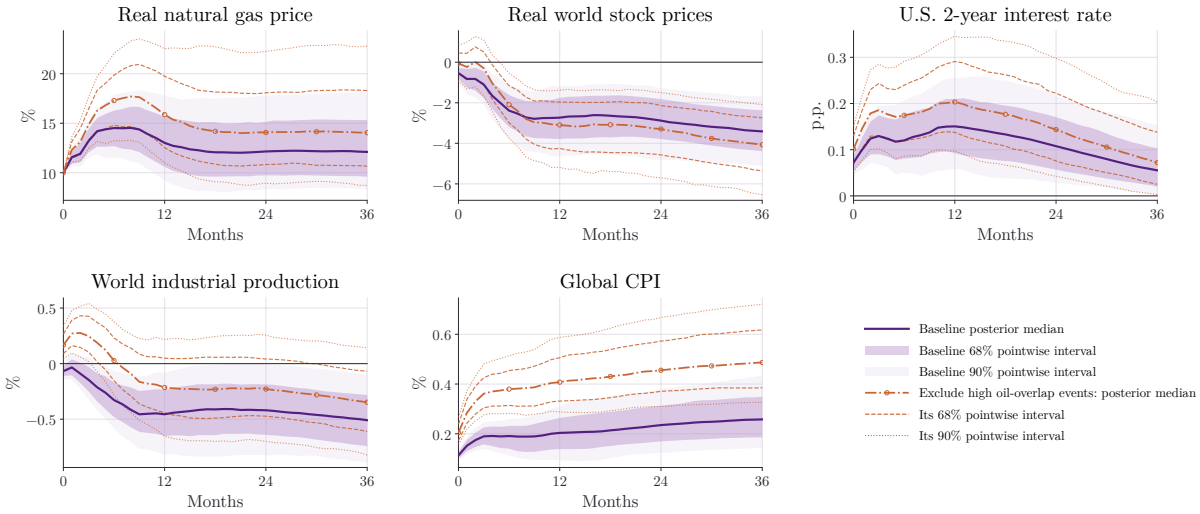
Notes: The figure compares the baseline responses with posterior medians obtained after residualizing the instrument on U.S. monetary-policy shocks, jointly on U.S. and euro-area monetary-policy shocks, and jointly on monetary-policy and information shocks from both economies.

FIGURE A.8. Oil-price residualization and central-bank overlap dates



Notes: The figure compares the baseline responses with posterior medians obtained after residualizing the daily surprises on Brent returns, or after excluding events that coincide with ECB or FOMC meetings. The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals.

FIGURE A.9. Excluding gas-supply events that overlap with oil-market news

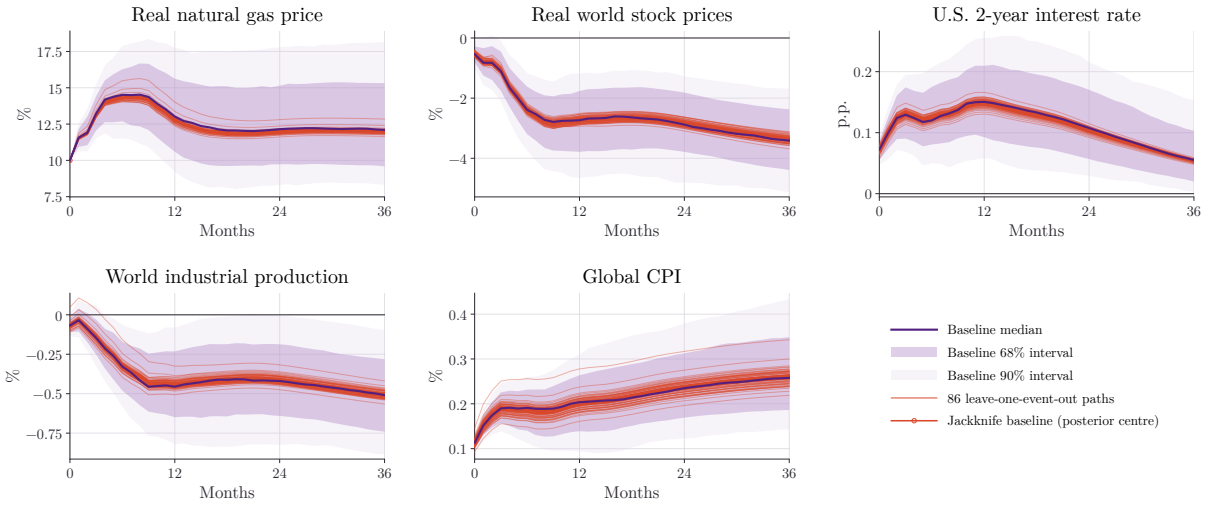


Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The dash-dotted line shows the posterior median after excluding gas events that coincide with oil-market news, and the dashed and dotted lines its 68 and 90 percent intervals.

D. Event Composition and Sample Dependence

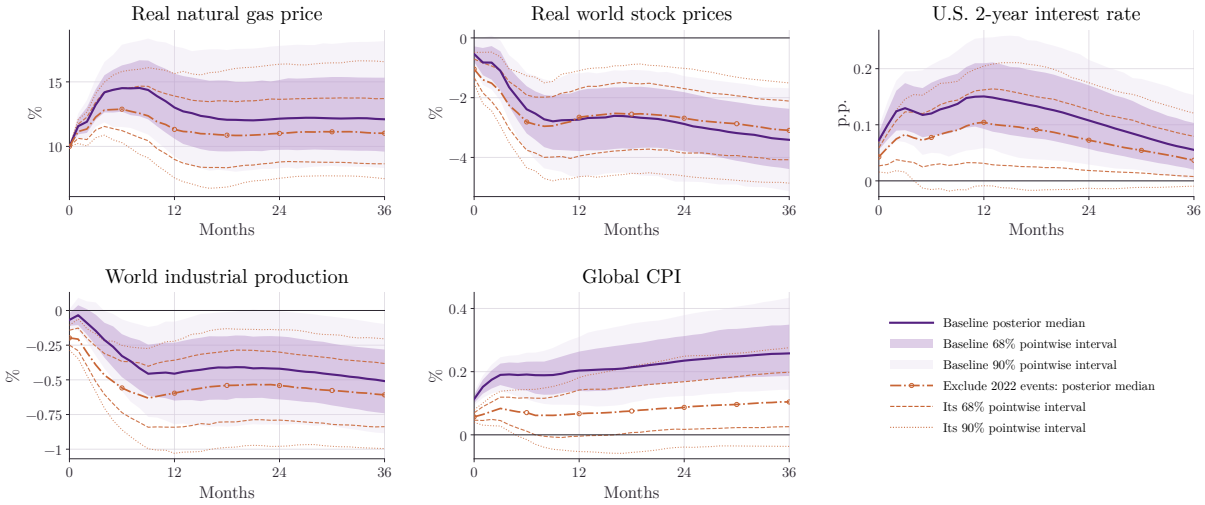
The first exercise assesses the influence of individual events; the second tests dependence on the 2022 crisis by excluding all narrative events from that year.

FIGURE A.10. Leave-one-event-out sensitivity analysis



Notes: Each thin line shows the posterior median obtained after omitting one of the 86 events from the instrument. Shaded areas show the baseline 68 and 90 percent posterior intervals.

FIGURE A.11. Excluding all 2022 narrative events

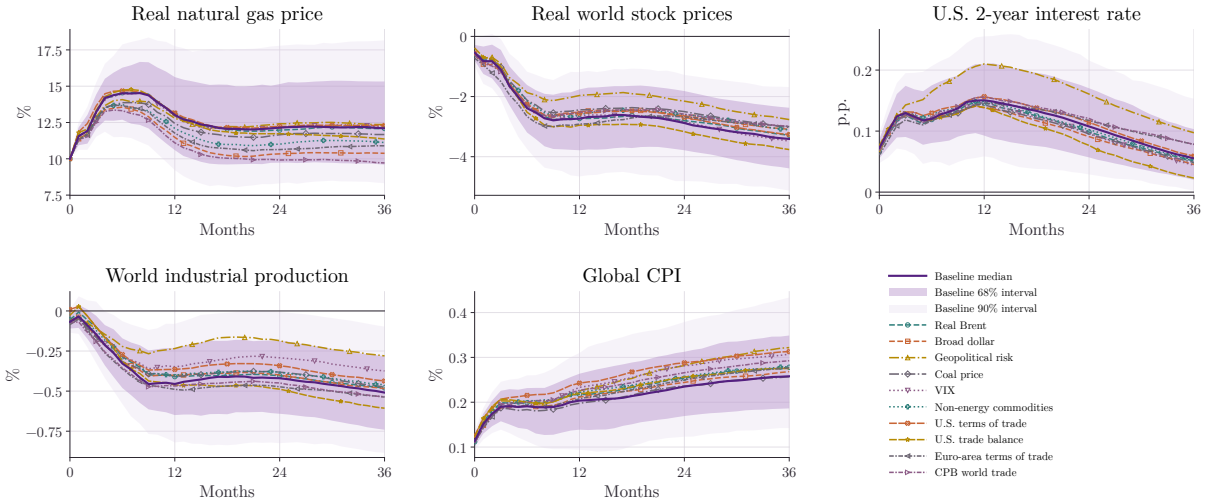


Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The dash-dotted line shows the posterior median after excluding all 2022 events from the instrument, and the dashed and dotted lines its 68 and 90 percent intervals.

E. Model, Sample, and Recoverability Checks

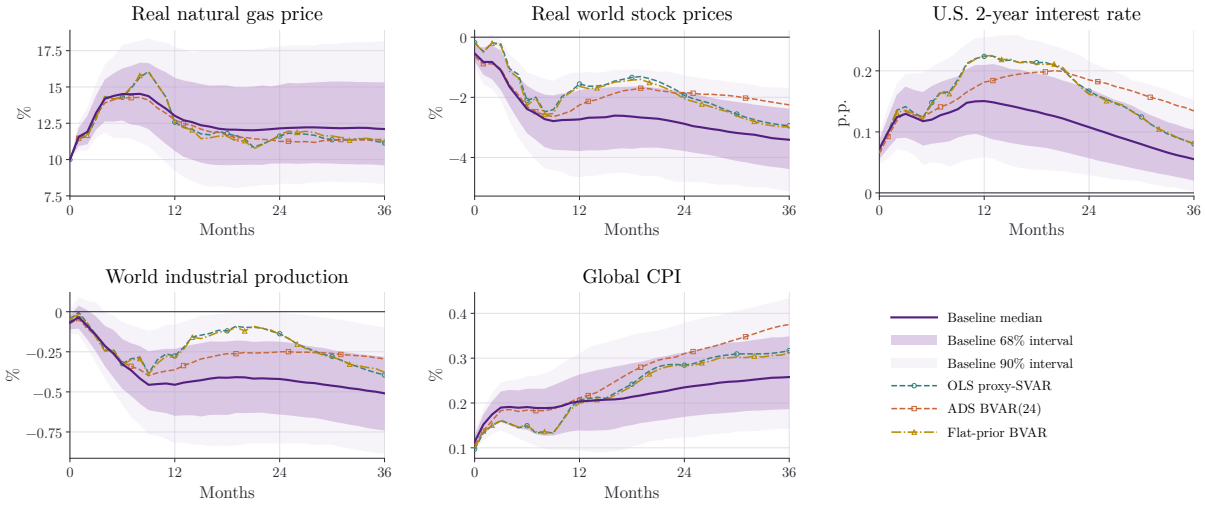
The following figures assess sensitivity to the information set, prior, estimator, lag structure, sample, and treatment of pandemic volatility. The final exercise considers methods that allow for non-invertibility.

FIGURE A.12. Adding financial, commodity, and trade variables



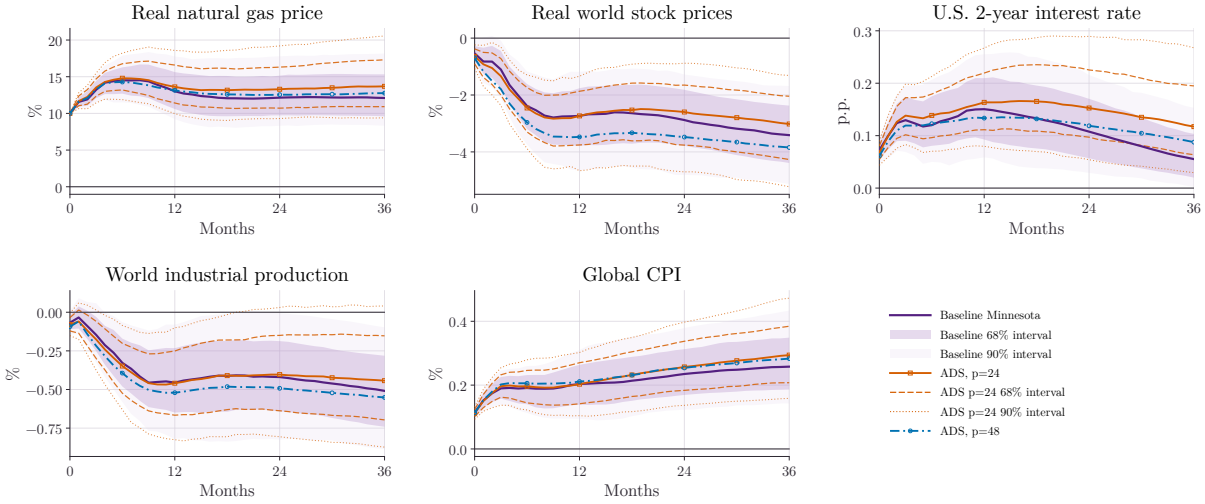
Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The other lines show posterior medians when each of the displayed variables is added in turn to the baseline model.

FIGURE A.13. Estimator and prior sensitivity



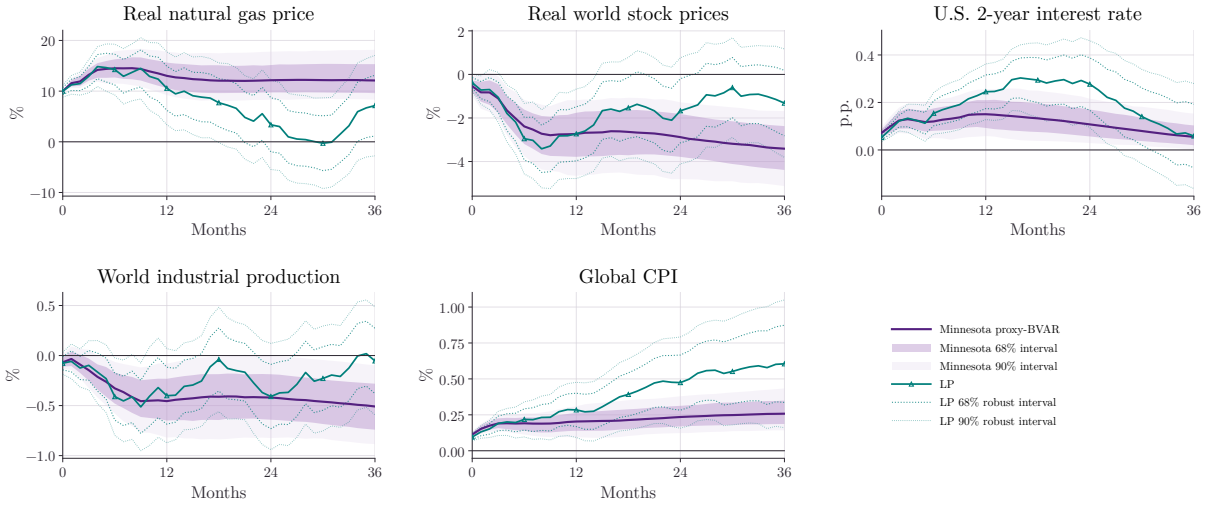
Notes: The shaded areas show the baseline posterior intervals. The other lines show the OLS proxy-SVAR point estimate and the posterior medians of a flat-prior BVAR and of long-lag BVARs.

FIGURE A.14. Long-lag BVAR estimates



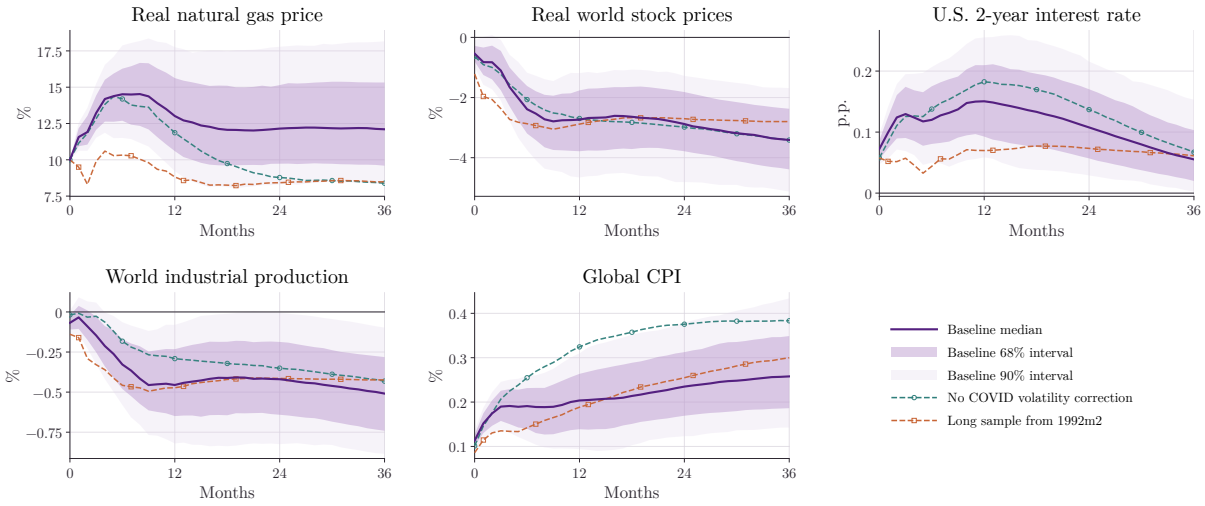
Notes: The figure compares the baseline responses with BVARs with 24 and 48 lags following Antolín-Díaz and Surico (2025), otherwise retaining the baseline specification. Intervals are shown for the baseline and the 24-lag model; only the median is shown for the 48-lag model.

FIGURE A.15. Local-projection estimates



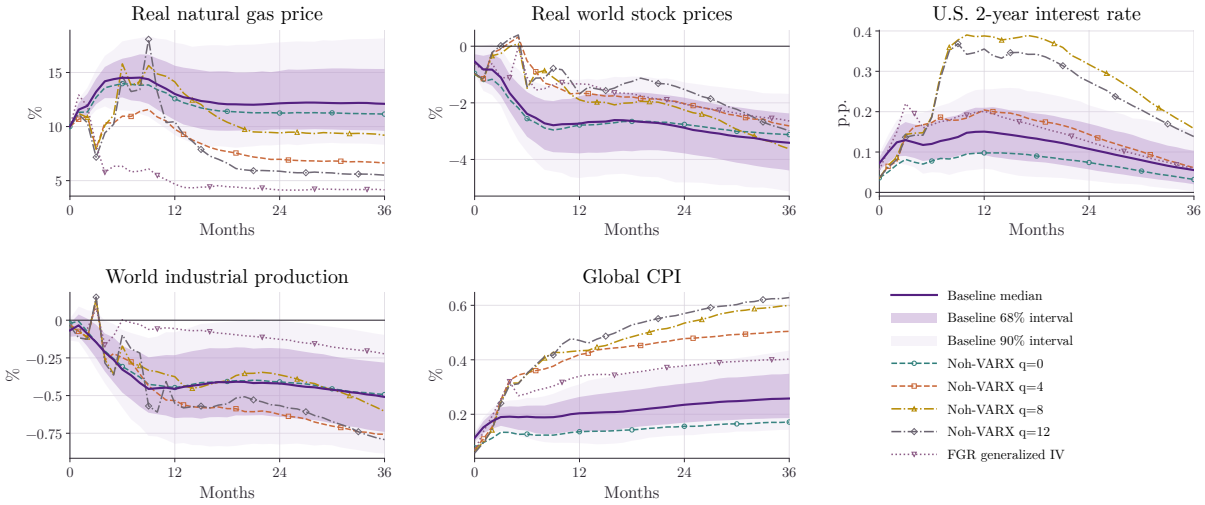
Notes: The figure compares the baseline responses with local projections of each variable on the estimated shock. The baseline shows 68 and 90 percent posterior intervals, the local projections 68 and 90 percent robust confidence intervals.

FIGURE A.16. COVID treatment and sample sensitivity



Notes: The figure compares the baseline posterior medians with estimates obtained, separately, without the COVID volatility correction and with the sample extended back to 1992.

FIGURE A.17. Methods robust to non-invertibility

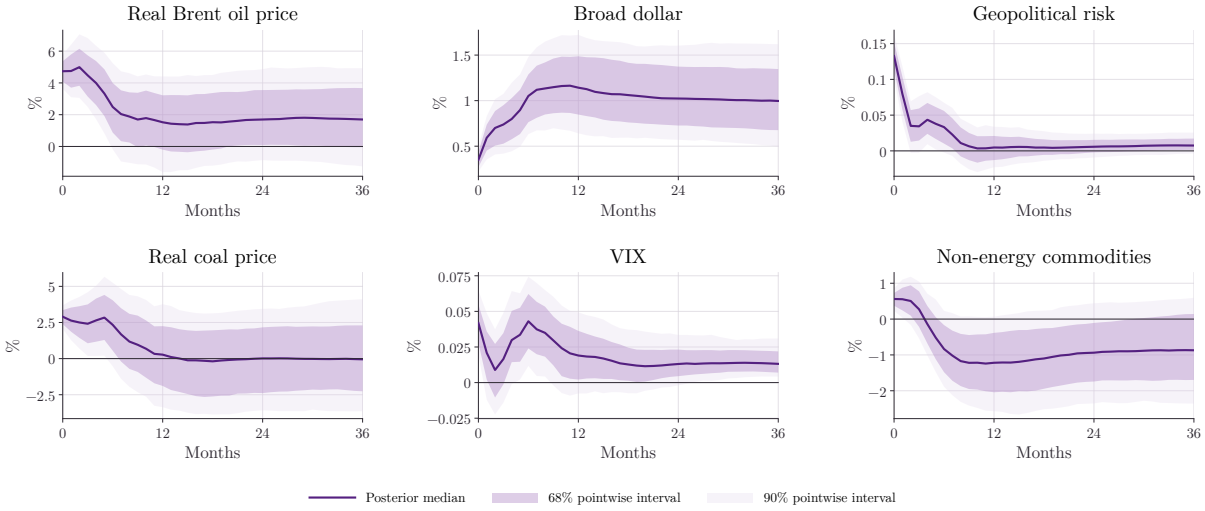


Notes: The shaded areas show the baseline posterior intervals. The other lines show Noh VARX estimates with 0, 4, 8, and 12 lags of the proxy and the generalized external-instrument estimate following Forni et al. (2026).

F. Additional Global Results and Historical Accounting

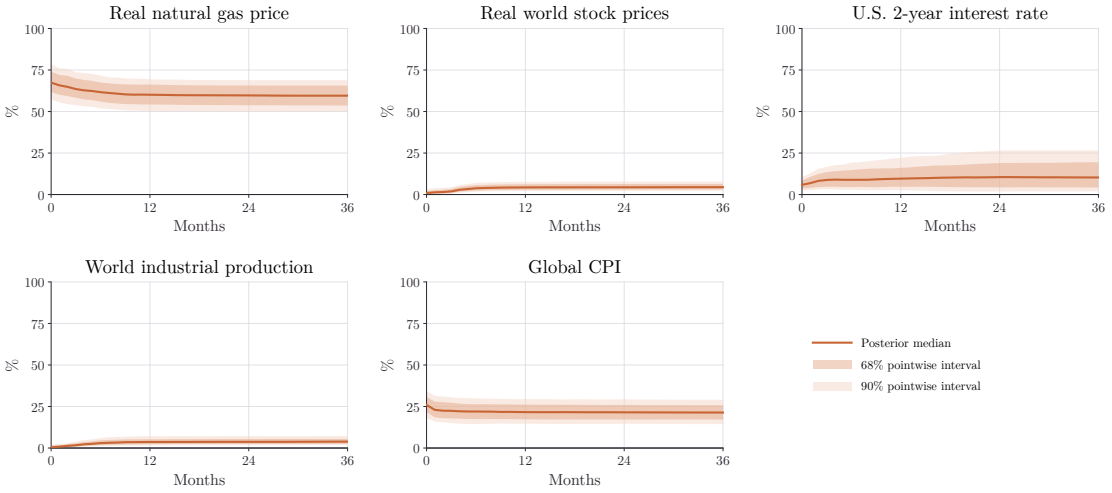
This appendix reports the responses of additional commodity and financial variables, the forecast-error variance decomposition, and the historical contributions of gas supply shocks. The decompositions summarize contributions implied by the model: they provide no independent evidence on identification, and they do not attribute the entire post-2020 inflation surge to gas supply.

FIGURE A.18. Broader commodity and financial responses



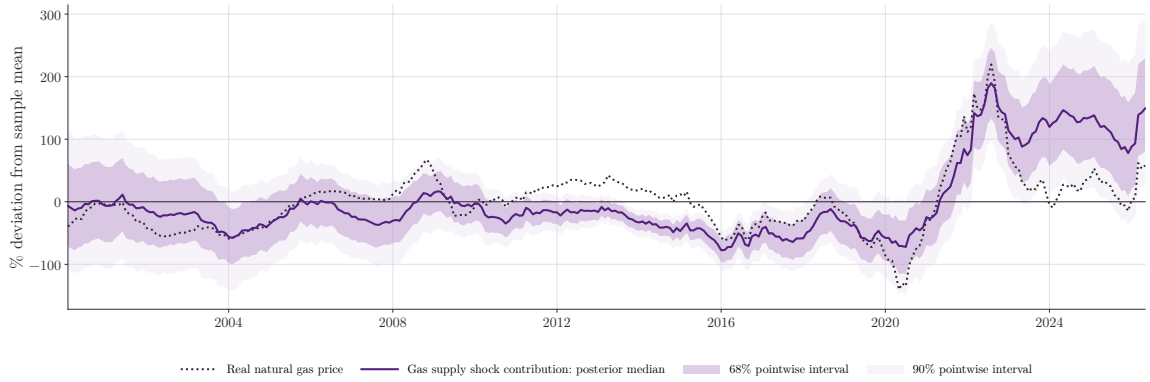
Notes: Responses of the variable added to the baseline model, one at a time: Brent, the broad dollar, geopolitical risk, coal, the VIX, and non-energy commodities. Lines are posterior medians and shaded areas 68 and 90 percent intervals.

FIGURE A.19. Forecast-error variance decomposition



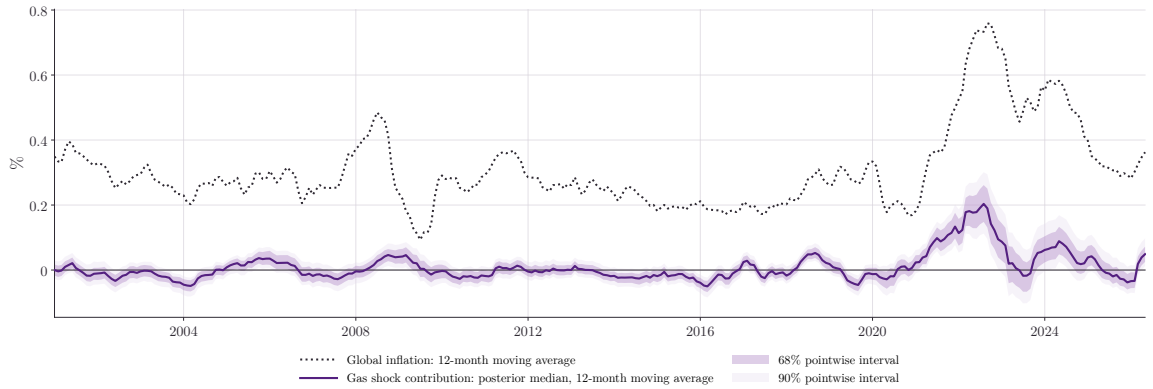
Notes: Share of the forecast-error variance of each variable due to the gas supply shock, by horizon. Lines are posterior medians and shaded areas 68 and 90 percent intervals.

FIGURE A.20. Historical contribution to the real gas price



Notes: The dotted line shows the real gas price in log percentage points relative to its sample mean. The solid line shows the posterior median contribution of gas supply shocks, demeaned over the same sample. Shaded areas show 68 and 90 percent posterior intervals.

FIGURE A.21. Historical contribution to global inflation



Notes: The dotted line shows the trailing twelve-month average of monthly global inflation. The solid line shows the corresponding contribution of gas supply shocks, with 68 and 90 percent posterior intervals.

G. Additional Cross-Country Evidence

This appendix reports the full response paths for each country, documents the Australian activity series, separates the energy consumer-price and producer-price responses, and relates the country responses to measures of gas intensity other than net import dependence.

G.1. Country response paths

Figures A.22 to A.24 report the full response paths by country. They show that the twelve-month horizon is a poor summary of the exchange-rate responses, as the Norwegian and Australian cases discussed in Section 5.2 illustrate.

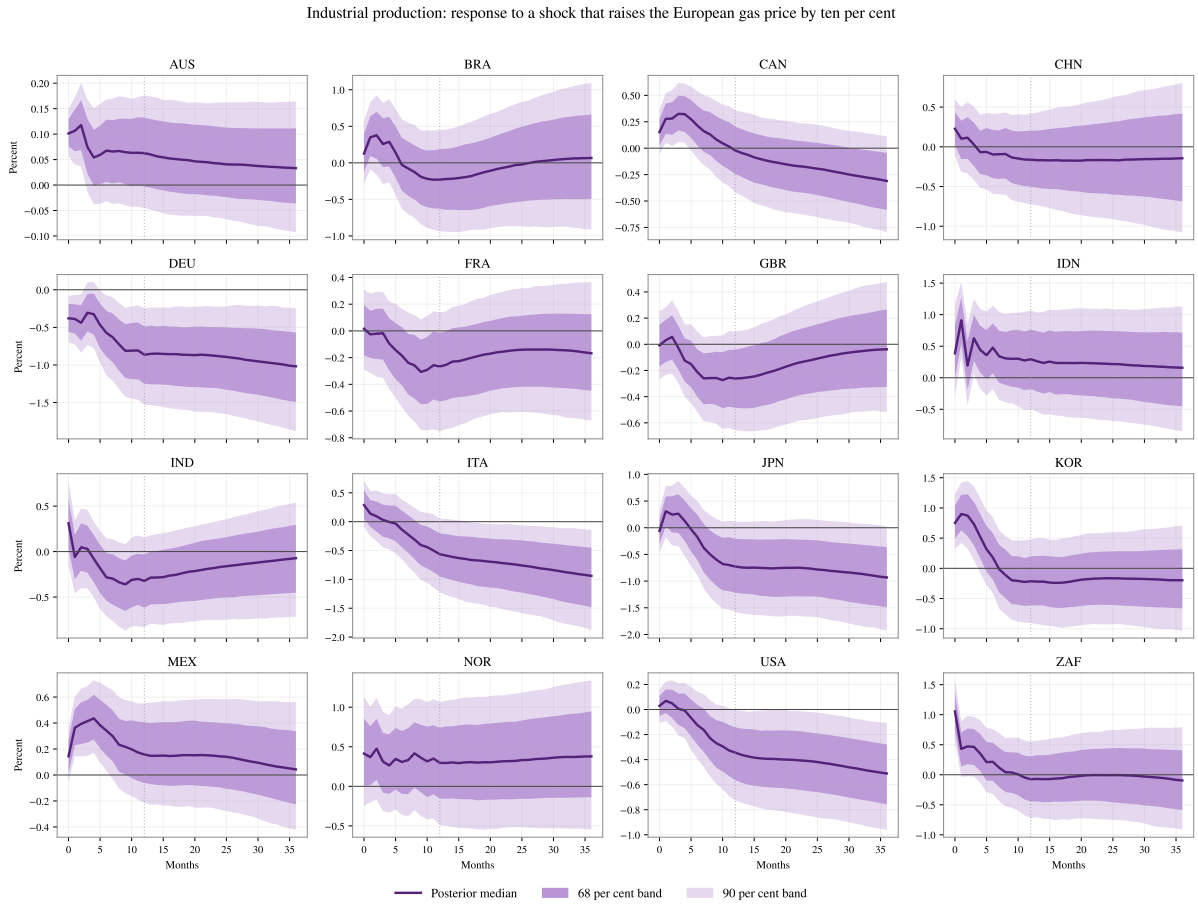
G.2. The Australian activity series

The World Bank Global Economic Monitor provides monthly industrial production for all countries in the sample, but the Australian series ends in December 2015 and is unreliable even before then: its monthly log change has a standard deviation of 47 percent, against at most 5.6 for the other countries.

We therefore construct a monthly activity index for Australia from the quarterly national accounts. Quarterly GDP growth is chained into a level index and distributed across months with the Denton proportional first-difference method, using monthly employment as the indicator, so that quarterly averages match the national accounts exactly. The index covers 1999–2026 without gaps. The replacement extends the Australian sample from 203 to 326 months and the number of months with a nonzero instrument from 7 to 44. As a result, the Robust-F rises from 2.8 to 13.0, and the twelve-month output response, previously uninformative, becomes close to zero. The results for the other countries are unaffected.

The series has two limitations. It measures aggregate activity rather than industrial production and is smoother than production indices, with a monthly standard deviation of 0.53 against a median of 2.30 for the other countries; the narrower Australian bands therefore reflect construction rather than precision, and the size of the Australian response should not be compared with the others. Moreover, matching the quarterly totals does not guarantee that the monthly dynamics are measured correctly, and the posterior bands do not account for the uncertainty of the reconstruction.

FIGURE A.22. Industrial production: full response paths

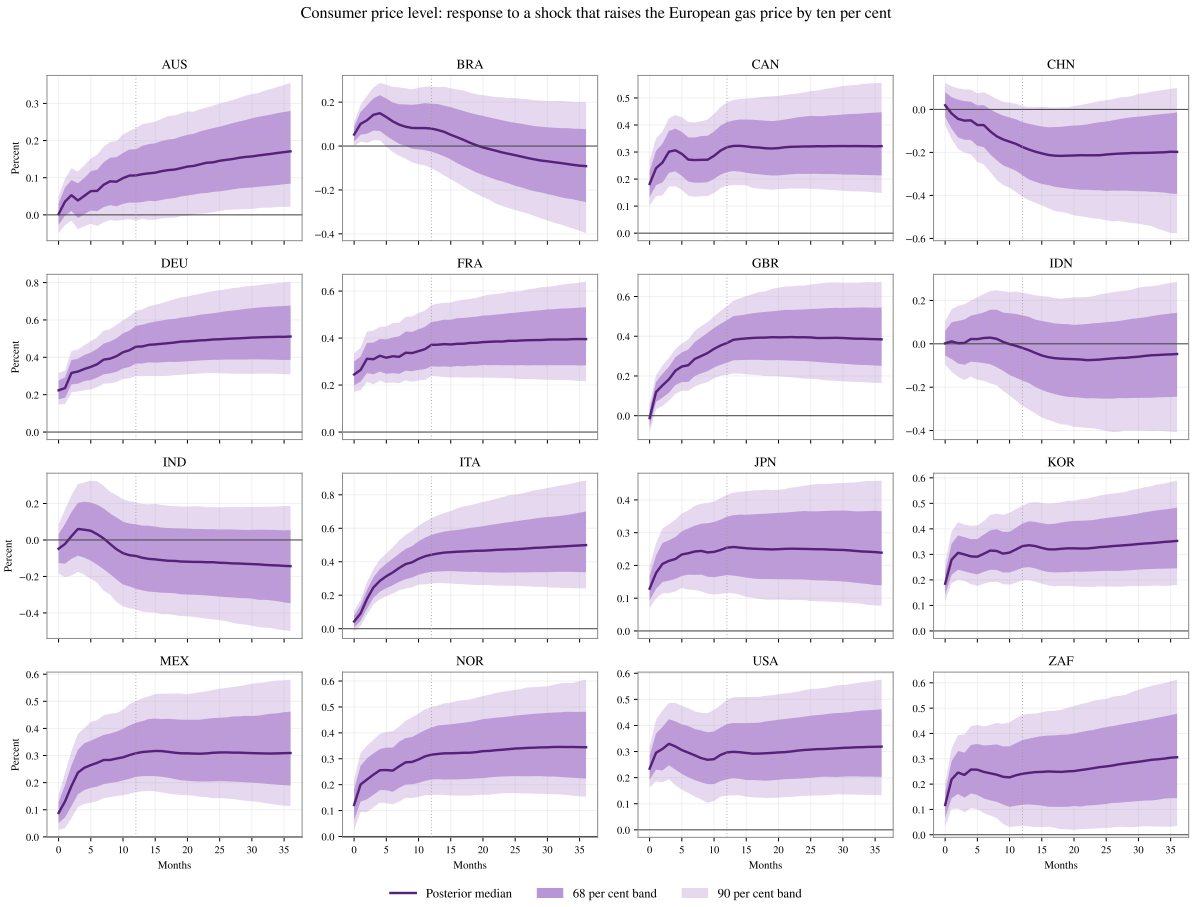


Notes: Posterior medians and 68 and 90 percent intervals from the country models in Figure 7. The dotted vertical line marks twelve months.

For these reasons we report the exposure regressions with and without Australia. As a net exporter, Australia does not affect the importer correlations. Among exporters, excluding it changes the correlation from -0.58 to -0.70 for industrial production, from 0.06 to -0.20 for consumer prices, and from 0.60 to 0.44 for the NEER. Since the exporter relationships depend on a single observation, the main text draws no conclusions from them.

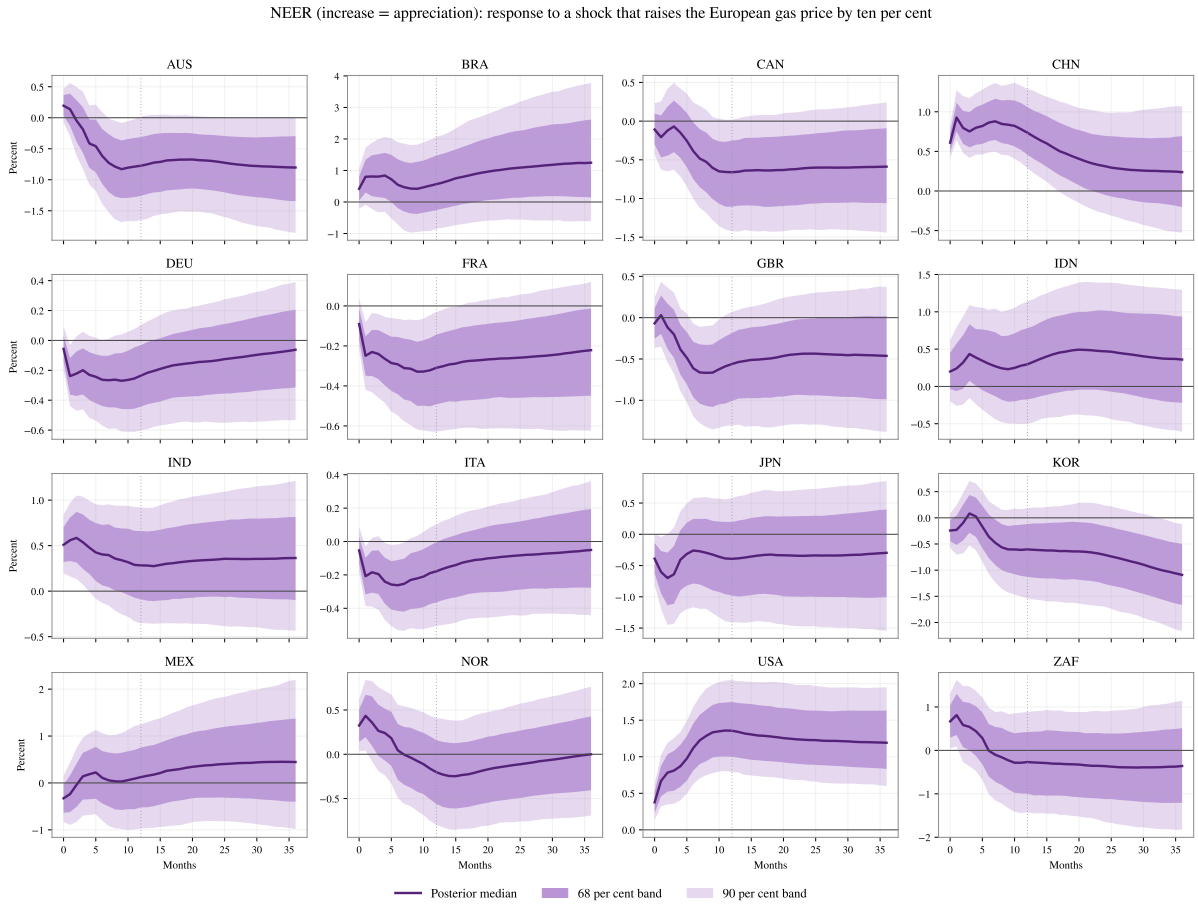
G.3. Alternative exposure measures

FIGURE A.23. Consumer prices: full response paths



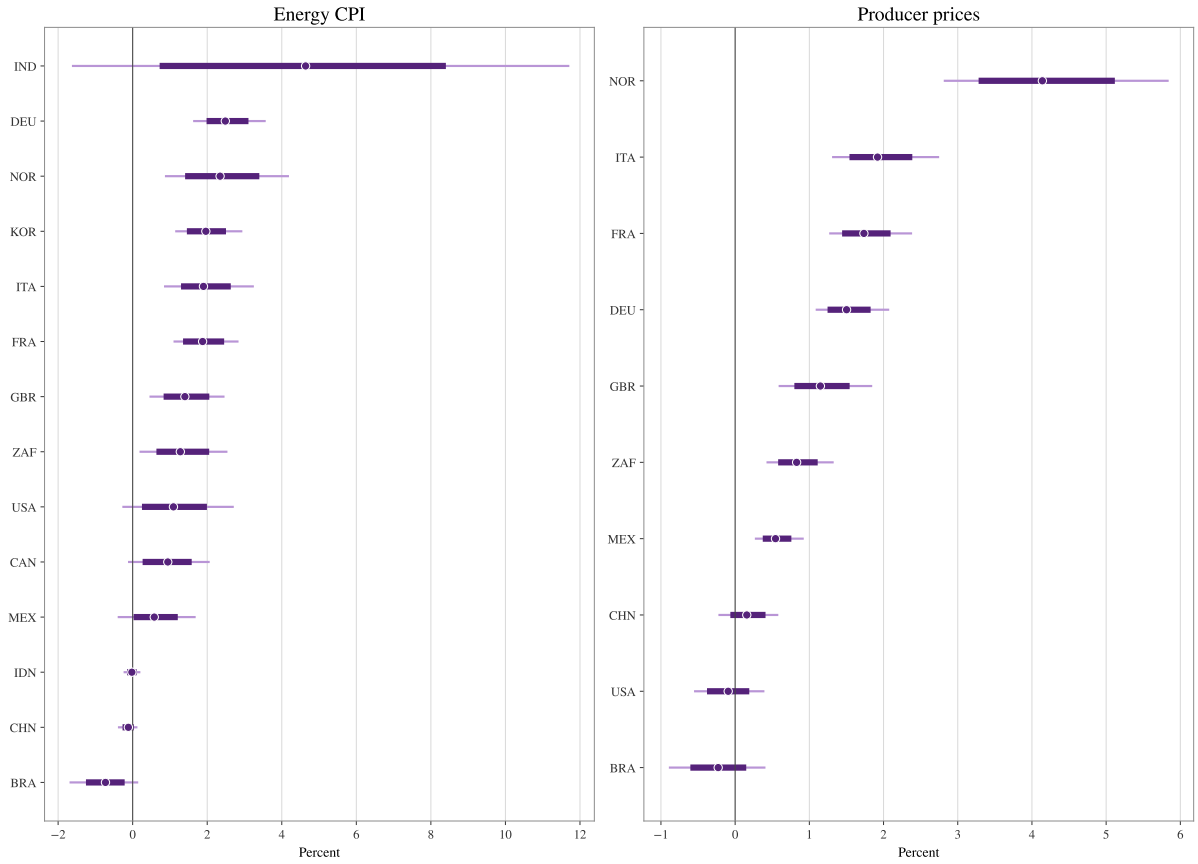
Notes: See the note to Figure A.22.

FIGURE A.24. Nominal effective exchange rates: full response paths



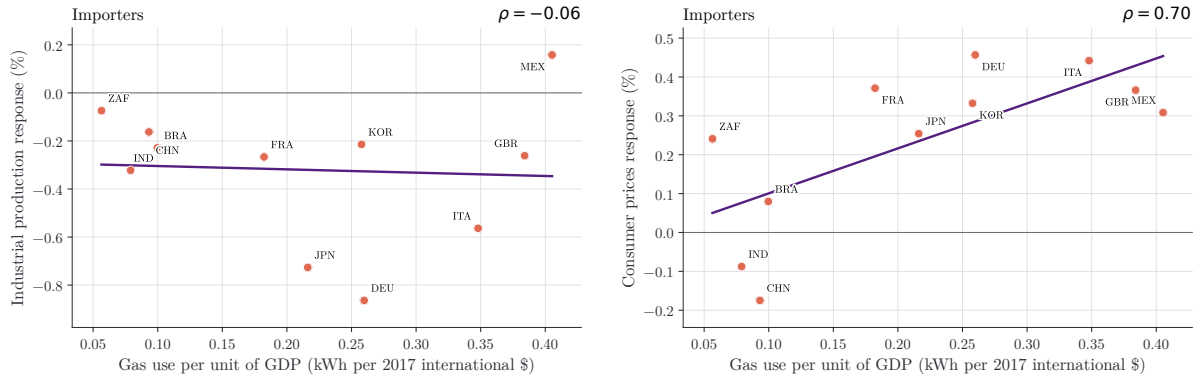
Notes: See the note to Figure A.22. An increase is an appreciation.

FIGURE A.25. Energy consumer prices and producer prices across countries



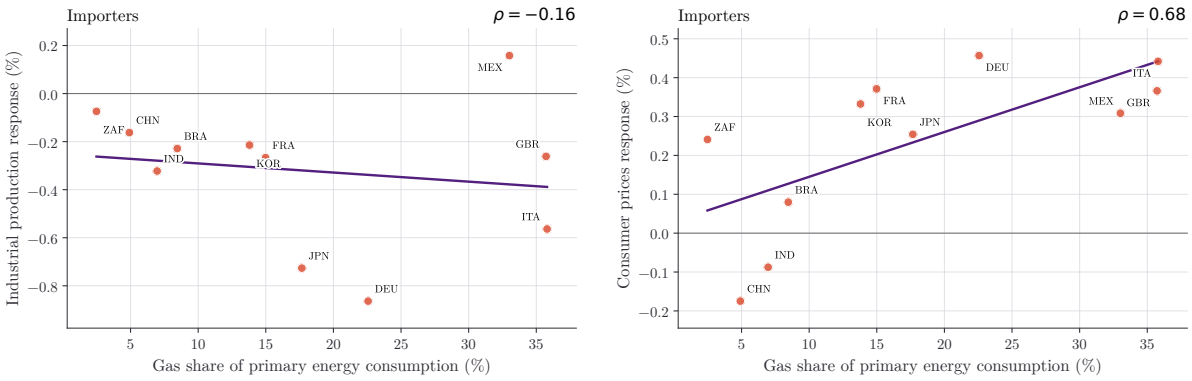
Notes: Responses at twelve months when the energy CPI or the PPI replaces headline consumer prices in the country models. Dots are posterior medians; thick and thin bars are 68 and 90 percent intervals. As in Figure 7, Turkey is not shown, nor are countries whose Robust-F falls below ten.

FIGURE A.26. Gas use per unit of GDP and country responses



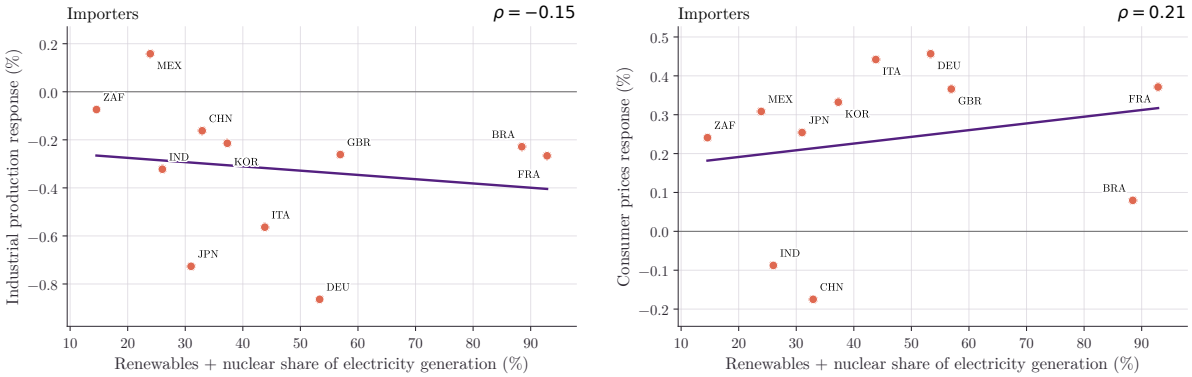
Notes: The eleven importers of Figure 8. Each dot is a country's response at twelve months, plotted against its gas use per unit of GDP before the events; lines are least-squares fits.

FIGURE A.27. Gas share of primary energy and country responses



Notes: The eleven importers of Figure 8. Each dot is a country's response at twelve months, plotted against the gas share of its primary energy before the events; lines are least-squares fits.

FIGURE A.28. Non-fossil electricity generation and country responses



Notes: The eleven importers of Figure 8. Each dot is a country's response at twelve months, plotted against the share of electricity generated by renewables and nuclear over the full sample; lines are least-squares fits.

H. Counterfactual Oil Price Stabilization

This exercise combines the gas shock with separately identified oil shocks to approximately offset the oil-price response. It assesses whether oil-price spillovers account for the global activity and price responses.

Let $\theta_h^{g,o}$ denote the oil-price response to the gas shock and $\theta_h^{j,o}$ its response to oil shock j. For each candidate oil shock, the loading minimizes the sum of squared oil-price responses over horizons zero to 36:

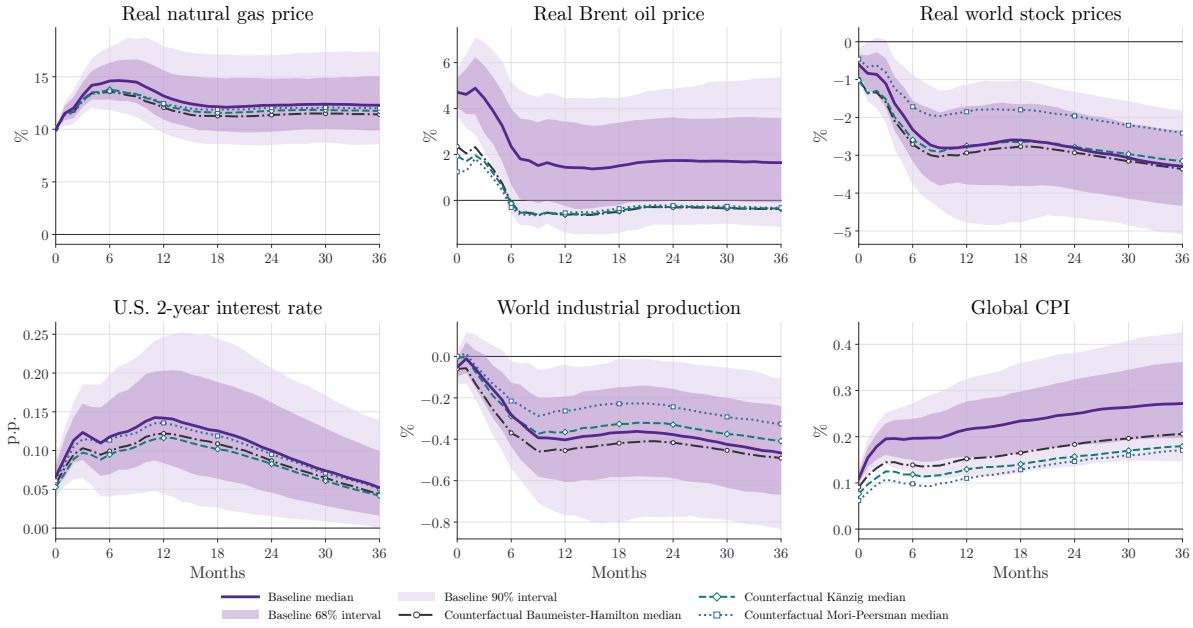
$$s_j^* = \arg\min_s \sum_{h=0}^{36} \left(\theta_h^{g,o} + s\theta_h^{j,o}\right)^2. \tag{9}$$

The corresponding response of outcome y is

$$\theta_{h,y}^{\mathrm{cf},j} = \theta_{h,y}^{g} + s_j^* \theta_{h,y}^{j}. \tag{10}$$

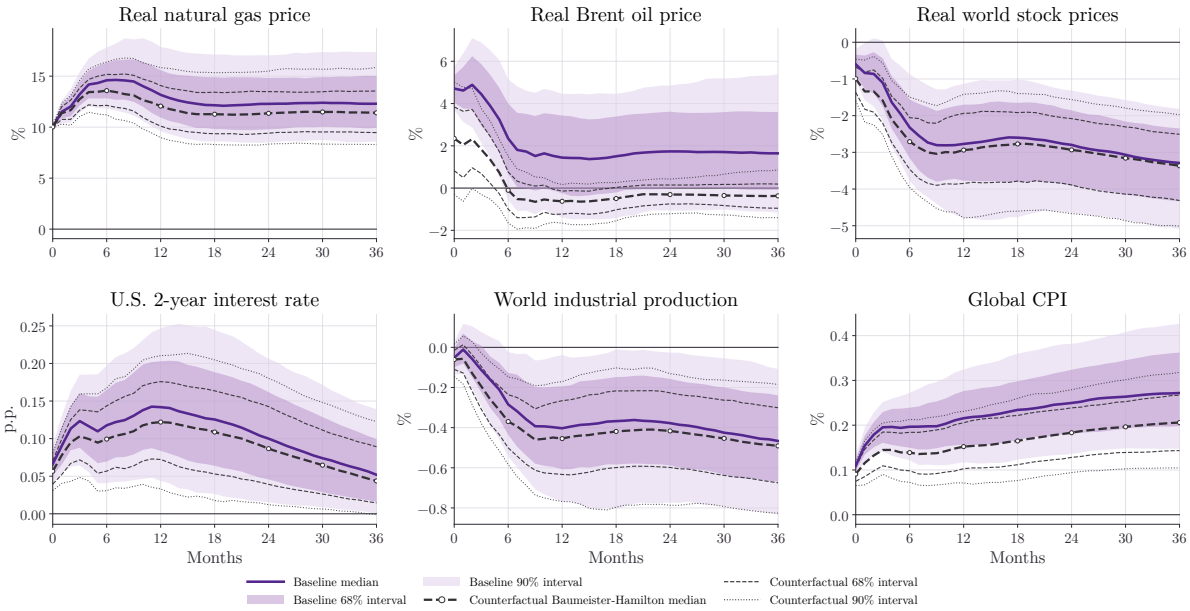
Following the time-series counterfactual logic of McKay and Wolf (2023), the exercise asks whether the effects of the gas shock persist when combined with an oil shock that approximately stabilizes the oil-price path. It does not describe a policy intervention that can control oil prices without cost.

FIGURE A.29. Oil-price stabilization: point estimates



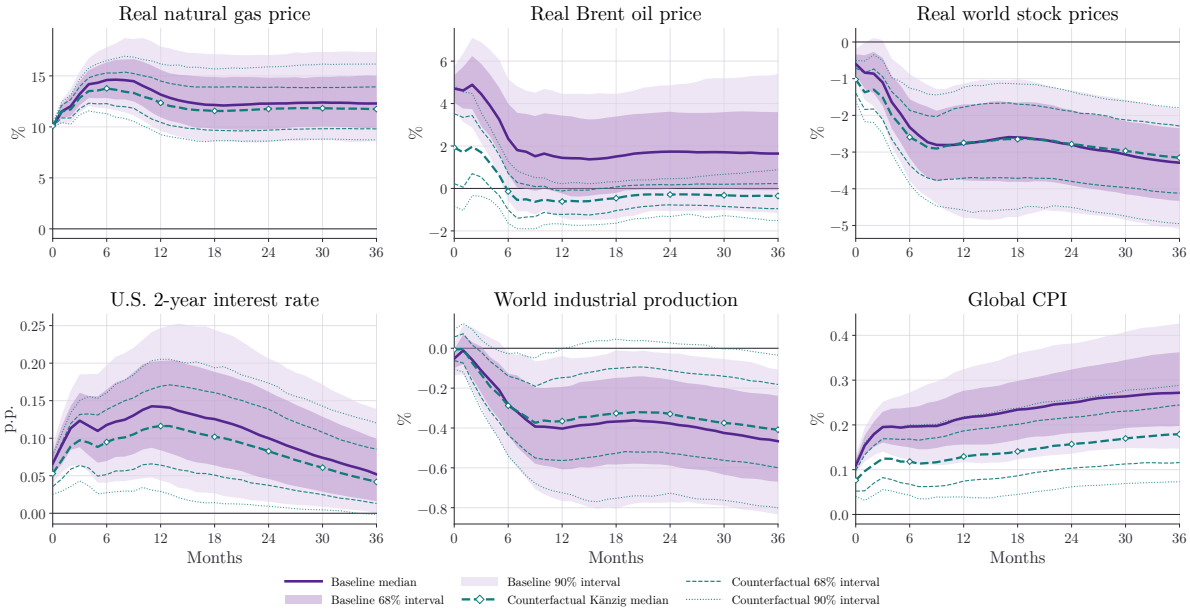
Notes: Baseline responses and counterfactual posterior medians in which the gas shock is combined with a Baumeister–Hamilton, Känzig, or Mori–Peersman oil supply shock, scaled to minimize the sum of squared oil-price responses over months 0–36, as in equation (9).

FIGURE A.30. Oil-price stabilization using the Baumeister–Hamilton shock



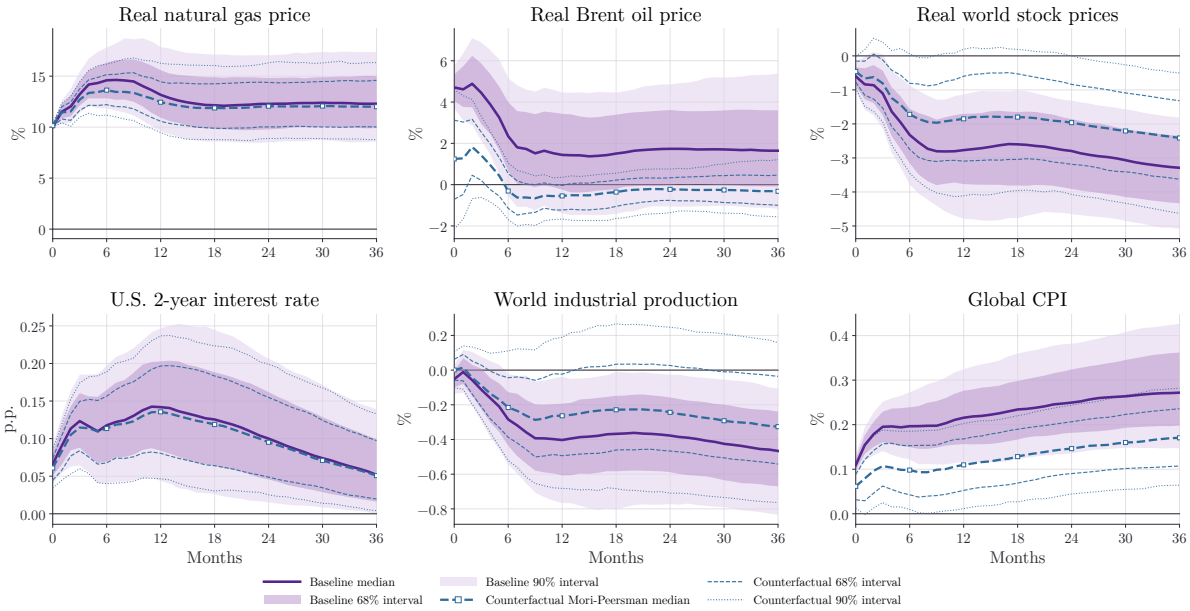
Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The dashed line shows the counterfactual median, and the thin dashed and dotted lines its 68 and 90 percent intervals.

FIGURE A.31. Oil-price stabilization using the Känzig shock



Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The dashed line shows the counterfactual median, and the thin dashed and dotted lines its 68 and 90 percent intervals.

FIGURE A.32. Oil-price stabilization using the Mori–Peersman shock



Notes: The solid line and shaded areas show the baseline median and 68 and 90 percent posterior intervals. The dashed line shows the counterfactual median, and the thin dashed and dotted lines its 68 and 90 percent intervals. The counterfactual uses the oil supply shock of Mori and Peersman (2026).