Gas Prices and the Macroeconomy

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Objective

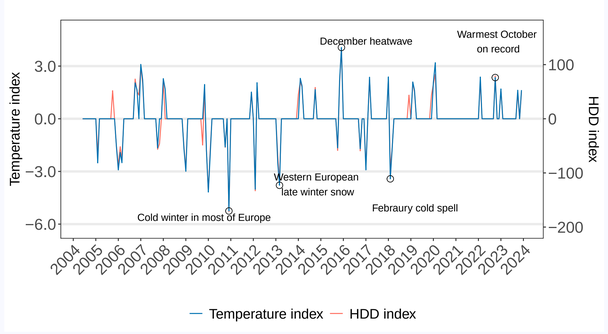
Goal: understand how natural gas shocks propagate through energy markets and the macroeconomy.

- Document *key features* of natural gas markets in the Euro Area and the United States.
- Identify gas demand and supply *shocks* in both regions.
- Estimate short-run demand and supply *elasticities*.
- Trace *transmission* to gas markets, macro, and sectoral outcomes.
- Explain *regional differences* between the Euro Area and the United States.

Key challenge: gas prices are endogenous ⇒ construct instruments.

Demand instrument: temperature-driven heating demand

Idea: exploit exogenous temperature variation to proxy for heating demand. The instrument is based on large, unexpected deviations of temperature from its seasonal norm.



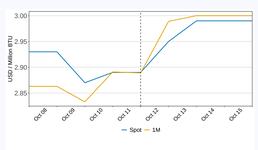
Gas demand proxy series for Euro Area

Supply instrument: high-frequency price surprises

Idea: exploit high-frequency gas-price movements around market-relevant supply events.

Flow supply

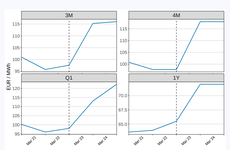
Current physical availability; PC of spot and 1-month futures price changes.



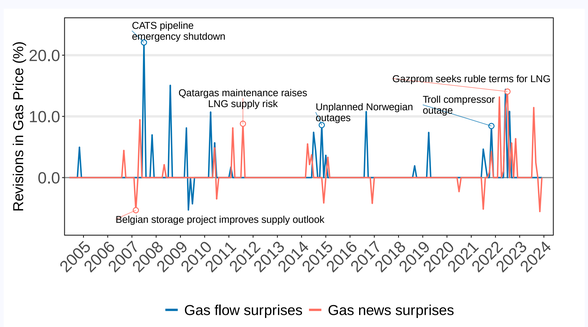
Flow event (US): Texas Eastern force majeure, 2017M10.

Supply news (EA only)

Longer-term energy-security news; PC of 2-month to 1-year futures price changes.



News event (EA): Gazprom demands ruble payments, 2022M3.



EA supply surprises: ΔTTF futures around gas news

Econometric modeling

- Structural VAR:

$$B_0 y_t = B_1 y_{t-1} + \cdots + B_p y_{t-p} + w_t,$$

with gas-market variables (price, supply, consumption, inventories), macro variables (inflation, industrial production), and oil price.

- For each shock j, the corresponding instrument satisfies:

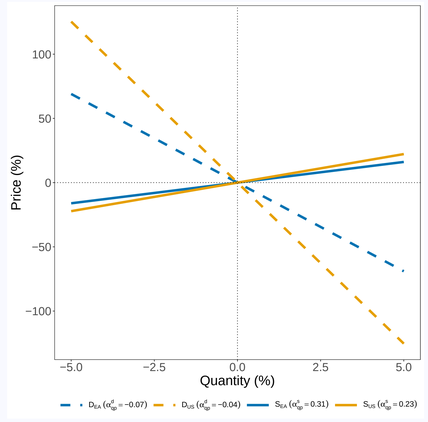
$$\mathbb{E}[z_{j,t} w_{j,t}] \neq 0, \qquad \mathbb{E}[z_{j,t} w_{-j,t}] = 0.$$

- Recover demand and supply elasticities following Baumeister and Hamilton (2024):

$$b'_{0,j} = \left[(B_0^{-1})_{\cdot j}\right]' \boldsymbol{\Sigma}_u^{-1}.$$

- Orthogonalize shocks by minimizing the distance from the initially identified system; test robustness to invertibility; estimate reduced-form parameters using Bayesian shrinkage.

Results: gas demand and supply elasticities

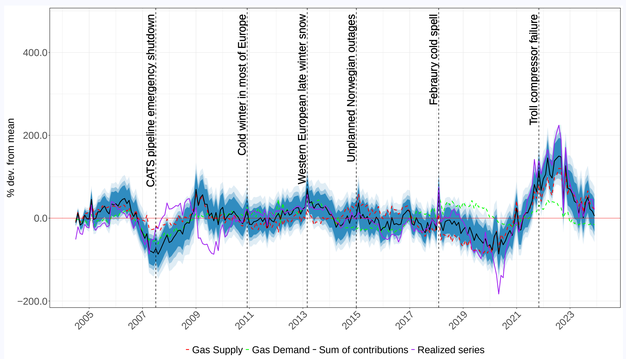


- **Euro Area**: Demand elasticity = −0.07, Supply elasticity = 0.31.
- **United States**: Demand elasticity = −0.04, Supply elasticity = 0.23.

Demand is less elastic ⟹ supply shocks have larger price effects.

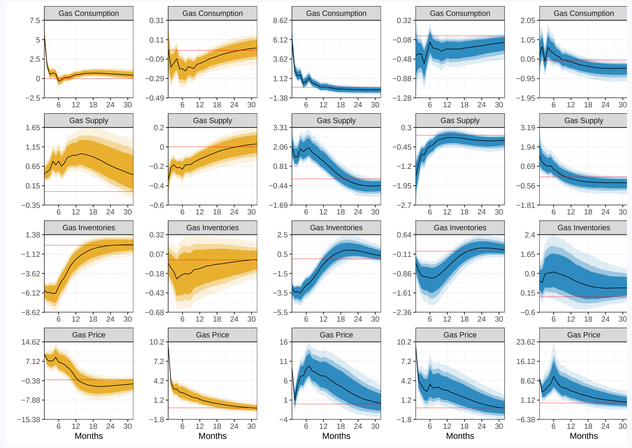
Results: FEVD and historical decomposition

Region	Shock	h=1	h=6	h=12	h=18	h=24
Euro Area	Flow supply	58.0	36.9	31.9	30.6	29.8
Euro Area	Flow demand	14.1	15.5	20.8	22.8	23.3
United States	Flow supply	75.5	39.3	31.6	30.2	28.9
United States	Flow demand	12.2	17.8	17.7	18.2	19.1



Identified shocks account for a large share of gas price fluctuations, particularly during major supply disruptions.

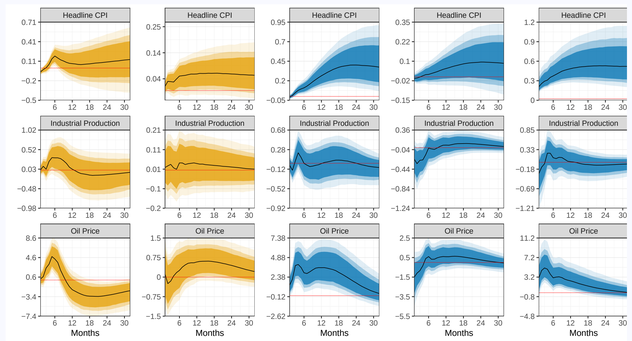
Results: gas-market transmission (10% ΔP)



U.S. demand | U.S. supply | EA demand | EA supply | EA news

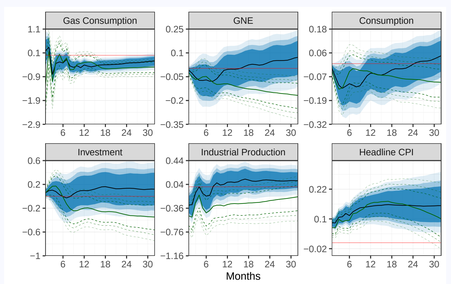
- Results align with standard theoretical predictions;
- Small reduction in supplied quantities sufficient to generate large price increase;
- Supply news shock triggers storage accumulation.

Results: macroeconomic transmission



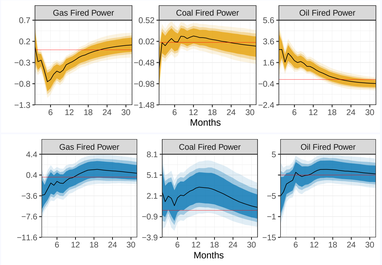
U.S. demand | U.S. supply | EA demand | EA supply | EA news

- **Inflation channel:** gas shocks pass through to electricity and broader energy prices; supply-news shocks further amplify inflation through expectations, uncertainty, and precautionary behavior.
- **Real-activity channel:** aggregate output effects are limited because sectoral losses are heterogeneous and cascading effects are weak.
- **Germany:** real effects are larger, consistent with stronger knock-on effects due to higher gas share and larger demand elasticity.

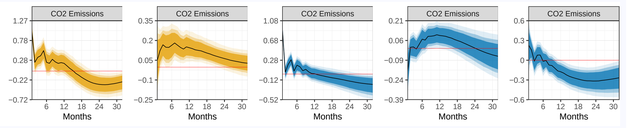


Germany (green) vs. EA (blue) responses to a gas supply shock.

Interfuel substitution and emissions



Power-generation responses to gas supply shocks.

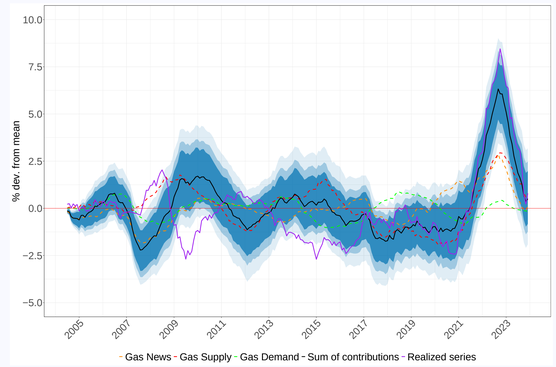


US demand | US supply | EA demand | EA supply | EA news

CO_2 emissions responses to natural gas shocks.

- Gas shocks trigger interfuel substitution in power generation.
- CO_2 emissions rise in the short to medium run through fuel substitution; only shocks expected to be persistent reduce emissions with a lag.

Inflation surge



- Gas supply shocks were a main driver of the post-pandemic EA inflation surge.

Additional results & robustness

Additional results:

- **Supply adjustment:** U.S. production and Euro Area net imports drive regional gas-supply responses.
- **Volatility:** news shocks raise financial volatility; flow shocks display no effect.
- **Energy prices (EA):** gas supply shocks transmit strongly to electricity and broader energy prices.
- **Sectoral prices (EA):** gas shocks pass through to core inflation, with stronger effects on goods than services.
- **Sectoral quantities (EA):** limited cascading across sectors helps explain muted aggregate real effects.

Robustness:

- **Instruments:** sample autocorrelation; background noise; Granger tests; correlation with other macro indicators; informationally robust instruments; demand instrument including summer months (US).
- **Identification:** posterior distribution of impact coefficients; first-stage strength; invertibility tests.
- **Estimation:** jackknife exercise; no orthogonalization; internal-instrument strategy; frequentist VAR-OLS; additional lags; extended estimation sample (US).