ECB FORUM ON CENTRAL BANKING

30 June-2 July 2025

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IDENTIFYING MACROECONOMIC SHOCKS USING FIRM-LEVEL DATA: MATERIAL SHORTAGES IN THE GERMAN MANUFACTURING SECTOR

EUROPEAN CENTRAL BANK

EUROSYSTEM

Motivation

- Identification, quantification, causal interpretation of (macro) shocks is challenging

→ **Bottom-up approach**: Use firm-level data to infer about macro developments

- Construct **external instrument** based on firm-level data and apply it to identify an **input material shock** in the German manufacturing sector

Constructing the IV

- Exploit qualitative information on firms' forecast errors, demand situation and production impediments from the ifo business survey to identify firms hit by a material shock

- **Quarterly**: Production impediments

"Our domestic production is currently constrained by […] lack of raw materials or pre materials […]"

- **Monthly:** Firms' expected and realized output, prices and current demand situation

"**Plans and expectations** for next 3 months:
"Our production activity/ prices are expected to increase/ decrease/ remain about the same"

Review trends in month t:
"*Compared to t-1, our prices/ production activity increased/ decreased/ did not change"*

- Aggregate monthly (x_t^i) to quarterly frequency (x_T^i)

$$1. \quad x_t^i = \begin{cases} -1 & \text{if decrease} \\ 0 & \text{if no change} \\ 1 & \text{if increase} \end{cases} \qquad \forall\, x, i.$$

$$2. \quad x_T^i = \sum_{k=0}^{2} x_{t+k}^i = \begin{cases} \text{decrease} & \text{if } x_T^i < 0 \\ \text{no change} & \text{if } x_T^i = 0 \\ \text{increase} & \text{if } x_T^i > 0 \end{cases} \qquad \forall\, x, i.$$

Figure 1: Temporal aggregation scheme

Intuition

- Isolate the **exogenous share** of firms unexpectedly hit by material constraints
- **Control group**: Account for general forecasting errors and economy-wide shocks

→ *Assumption*: Absent material constraints, firms do not differ structurally

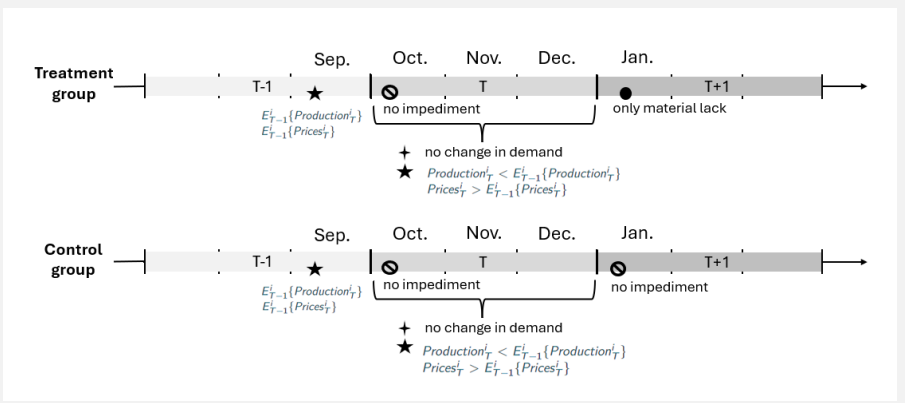

Figure 2: Timing of identification constraints identification of a tightening shock at the firm level

Constructing the shock series

1. Share of firms unexpectedly hit by a material shock for each subsector (*s*)

$$sh_{t,s,treat.}^{tight.} = \frac{weighted\ \#firms\ sign\ \&\ impediment\ restrictions\ satisfied}{weighted\ \#firms\ impediment\ restrictions\ satisfied}$$

2. Aggregate sector-level treatment and control group series to manufacturing level

$$sh_{t,treat.}^{tight.} = \sum_{s=1}^{N} sh_{t,s,treat.} \frac{GVA_s}{GVA}, \qquad sh_{t,contr.}^{tight.} = \sum_{s=1}^{N} sh_{t,s,contr.} \frac{GVA_s}{GVA}$$

3. Final tightening shock series

$$iv_t^{tight.} = sh_{t,treat.}^{tight.} - sh_{t,contr.}^{tight.}$$

Shock validation

- Remove auto-correlation akin to Miranda-Agrippino and Ricco (2023)
- Granger causality tests for variable selection

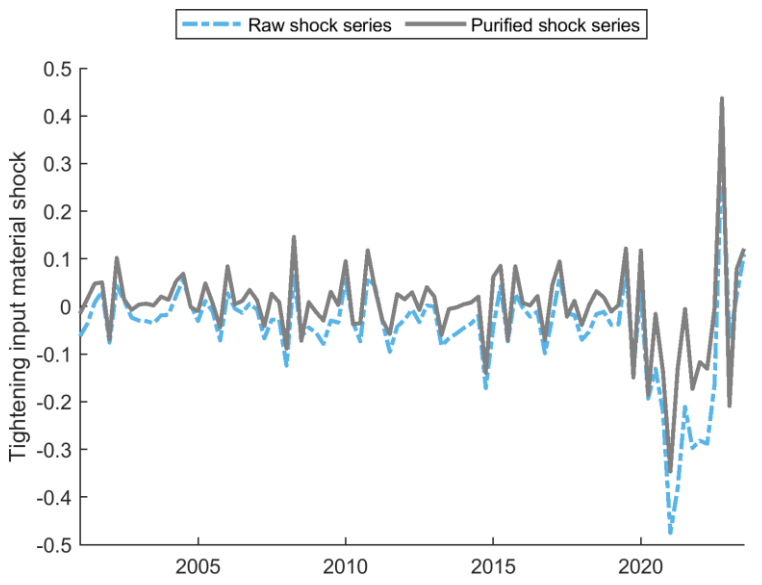

Figure 3: Series of tightening input material shock

Estimation & Discussion

- Quarterly **proxy VAR** akin to Mertens and Ravn (2013) and Stock and Watson (2012)

- Industrial production, Producer prices, GDP, Commodity price index (log difference)
- Share of firms reporting (among others) material input constraints

Relevance

- Material constraints affecting companies reflected in ifo survey
- **Excess forecast error** constructed to reflect input material constraints
- F-statistics >10

Exogeneity

- Shock unrelated to any other shock
- **Surprise element**: forecast error attributable to sudden material lack
- Accounting for **anticipation effects**
- Realizations do not affect firm-level expectations in previous quarter
- Origin of material lack negligible

Tightening shocks push inflation

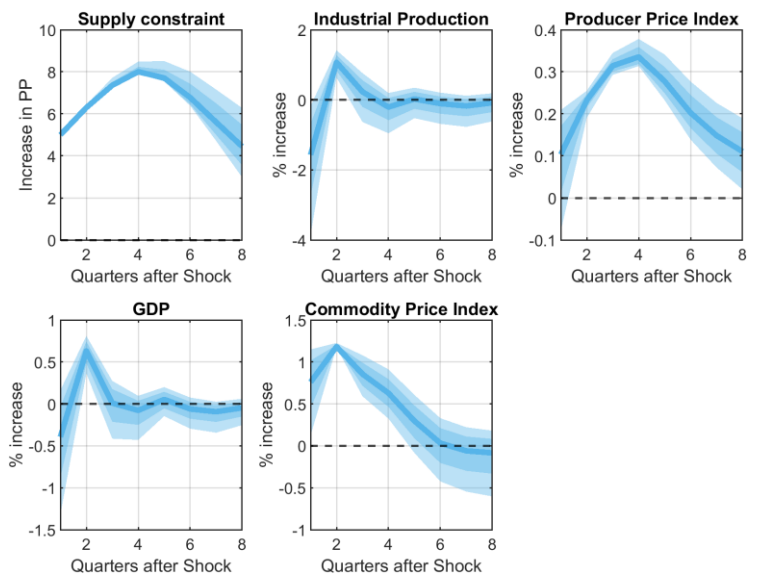

Figure 4: Impulse responses to a tightening input material shock

Decomposition of IRFs

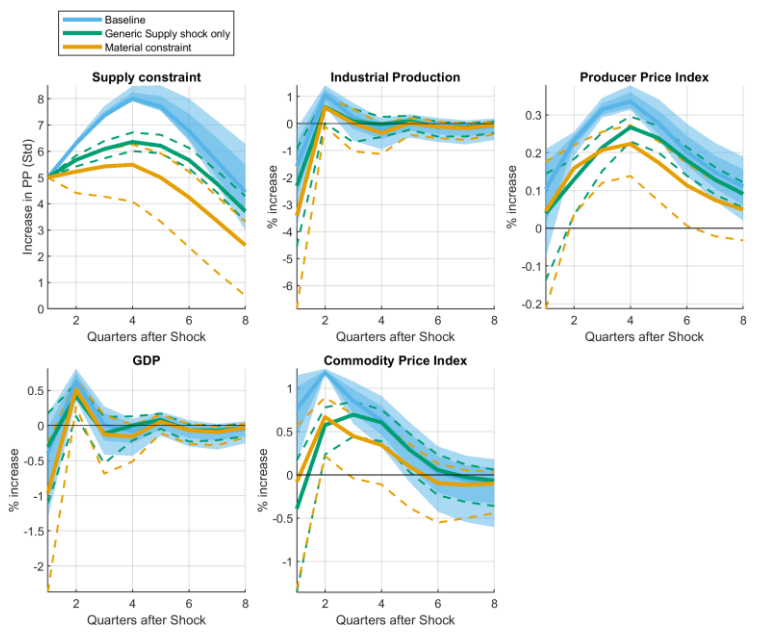

Figure 5: Impulse responses to the decomposed instrument

Sensitivity & Robustness

IV construction

- Naïve IV specification
- Timing assumption on expectation
- Less strict forecast error conditions

Model specification

- Local projections
- Extended variable set
- Sector level results
- Exclude Covid period
- Alternative prior, lag structure & constraint measure
- OLS results