EUROPEAN CENTRAL BANK

EUROSYSTEM

Inputs in distress: Geoeconomic fragmentation and firms' sourcing

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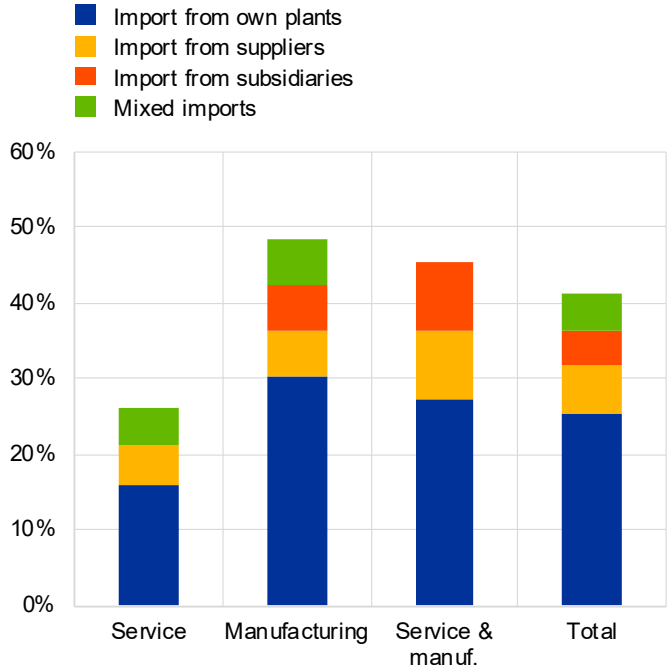
Growing attention to dependencies on foreign inputs

- Large shocks have rocked international supply chains of essential goods: Covid-19, Russian invasion
- Mounting geopolitical tensions and risks of trade fragmentation
  - How disruptive would sudden stop in supply of foreign critical inputs be for Europe?

Business surveys point to China as source of vulnerability

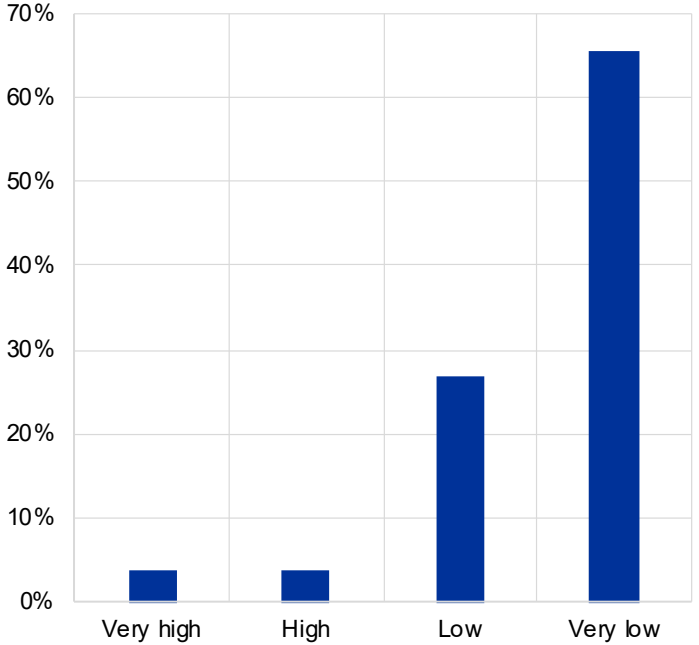
Exposure of large euro area firms to Chinese critical inputs

(percentage)



Substitutability of Chinese critical inputs

(percentage)



Source: ECB CTS, Attinasi et al. (2023b) and authors. Notes: Responses to the questions "In case these inputs were suddenly no longer available, how easy would it be to substitute them with inputs originating elsewhere?" The percentages of responses refer only to those firms that reported sourcing critical inputs which depended (entirely or heavily) on supply from China.

This paper: supply risk assessment based on micro data

Firm-level balance sheet and customs data of 5 EU countries, Belgium, France, Italy, Slovenia and Spain – or BFISS – to quantify value-added impact of hypothetical cut in supply of foreign critical inputs (FCIs) from China-aligned countries

1. Identify FCIs + China-aligned countries

2. Stylised facts on firms importing FCIs

3. Tractable (production function-based) partial equilibrium model to simulate effect of FCI supply cut

Key takeaways

- (Short-term) impact of geoeconomic fragmentation-like FCI supply cut can be substantial
- Impact varies significantly across countries, regions, sectors and firms, driven by heterogeneous exposure of firms
- Relying on macro rather than micro data may bias results
- Cross-country collaboration on micro data shows potential!

Related literature

1. Mapping exposures of countries / single-country firms
   - Examples: European Commission (2021), Arjona et al. (2023), Baur and Flach (2023), ESCB-IRC (2023), Méjean and Rousseau (2024), Buysse et al. (2024), Balteanu et al. (2024)
   - Highlight dependencies, no analysis of shock impacts

2. Impact of geoeconomic fragmentation scenarios
   - Examples: Eppinger et al. (2021), Goes and Bekkers (2022), Chepeliev et al. (2022), Giametti et al. (2022), Attinasi et al. (2023), Borin et al. (2023), Campos et al. (2023), Febelmayr et al. (2023), Javorcik et al. (2024)
   - Mostly GE models, no granular shocks and outcomes

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Firm-level evidence on foreign critical inputs

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Identification of FCIs

Classify imported goods at HS6 level as “foreign critical inputs” based on intrinsic characteristics and/or criteria of foreign dependency:

1. Inputs listed as Advanced Technology Products by US Census Bureau
2. Inputs and raw materials crucial for green transition (ESCB-IRC, 2024)
3. Inputs and capital goods marked by high extra-EU dependencies according to Commission (Arjona et al., 2023)

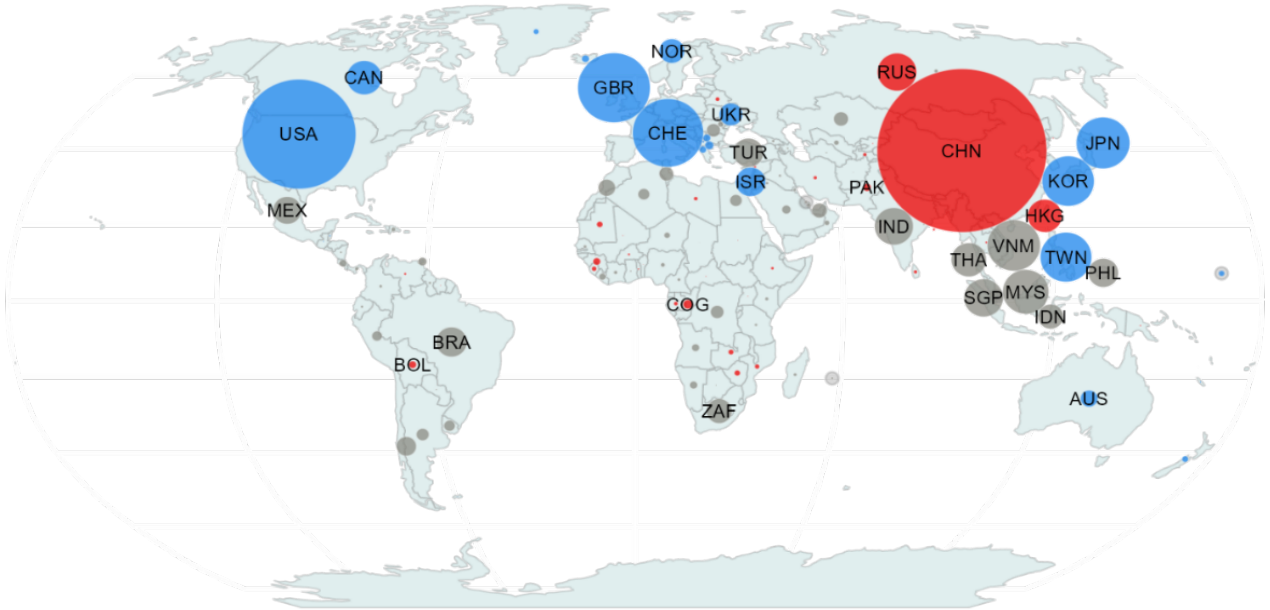
➢ Baseline list includes 667 HS6 product codes

Identification of China-aligned countries

Assign countries to blocs based on geopolitical index by den Besten et al. (2023). If index > 0.75, country is considered "China-aligned"

Extra-EU Import Share of FCIs by Country and Partner Alignment

(percentage)



5 stylised facts on FCI importers

Match FCI list with BFISS firm-level import and balance sheet data: 34k FCI importers in manufacturing; 20k from China-aligned countries

1. FCI importers account for sizeable share of economy
   - 70% of BFISS manufacturing VA; 55% for firms importing FCIs from China-aligned countries
2. Share of exposed firms is higher for large firms + large exposed firms account for most of total exposed VA
   - Top 1% largest exposed firms account for 70-96% of total exposed VA
3. FCIs account for modest share of total firm purchases
   - 6% on average, but 1% at median (lower for FCIs from China-aligned countries)
4. Diversification of FCI sourcing is limited, but large importers are less vulnerable
   - Only 10% of firms buy same FCI from at least 2 to 3 countries
5. FCI importers are larger and more productive, within same industry
   - Higher employment, turnover, VA/employee, even among extra-EU importers

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Simulation of FCI supply disruption

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Production function approach à la Bachmann et al. (2022)

Each firm *i* produces output Y_i with following technology:

$$Y_i = A_i K_i^{\alpha_s} L_i^{\beta_s} M_i^{1-\alpha_s-\beta_s}$$

Intermediate goods and services M_i are combined in firm-specific way:

$$M_i = \left[\gamma_i^{\frac{1}{\sigma}} E_i^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} X_i^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{1-\sigma}}$$

γ_i : firm's share of expenditure on FCIs E_i
X_i : bundle of non-FCI intermediates
σ : elasticity of substitution between FCIs and other intermediates

Production function approach à la Bachmann et al. (2022)

Assume firm-specific shock ε_i reduces availability of FCIs. It can be shown that:

$$\Delta va_i = (1-\alpha_s-\beta_s)\left[\frac{\left(\gamma_i^{\frac{1}{\sigma}}(1-\varepsilon_i)^{\frac{\sigma-1}{\sigma}}+(1-\gamma_i)^{\frac{1}{\sigma}}\left(\frac{1-\gamma_i}{\gamma_i}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}}{\left(\gamma_i^{\frac{1}{\sigma}}+(1-\gamma_i)^{\frac{1}{\sigma}}\left(\frac{1-\gamma_i}{\gamma_i}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{1-\sigma}}}-1\right]$$

Firm-level impact can be aggregated using VA weights in relevant sample (aggregate, region, sector):

$$\Delta va = \sum_i \Delta va_i \times \omega_i^{va}$$

Useful partial equilibrium model, with its limitations

Advantages…

- Calibration with micro data that exist for many countries and tend to be available to researchers
- Computationally very fast
- Very granular and flexible

…but also caveats

- Partial equilibrium: prices and non-FCI factors of production held constant
- Abstraction from indirect exposure: no propagation through domestic network (cf. Dhyne et al., 2021)
- Abstraction from adjustment through alternative (domestic) suppliers: no information on domestic availability of FCIs

Model calibration

Firm-specific shock to FCI imports: $\varepsilon_i = \text{China-aligned share}_i \times \delta$

- China−aligned share$_i$ is firm's exposure, from customs data
- Baseline: $\delta = 0.5$, captures severity of disruption and ease of substitution between FCIs from China-aligned and other countries
  - 100% cut in FCI supply, but 50% substituted with FCIs from elsewhere
  - 50% cut in FCI supply, no substitution

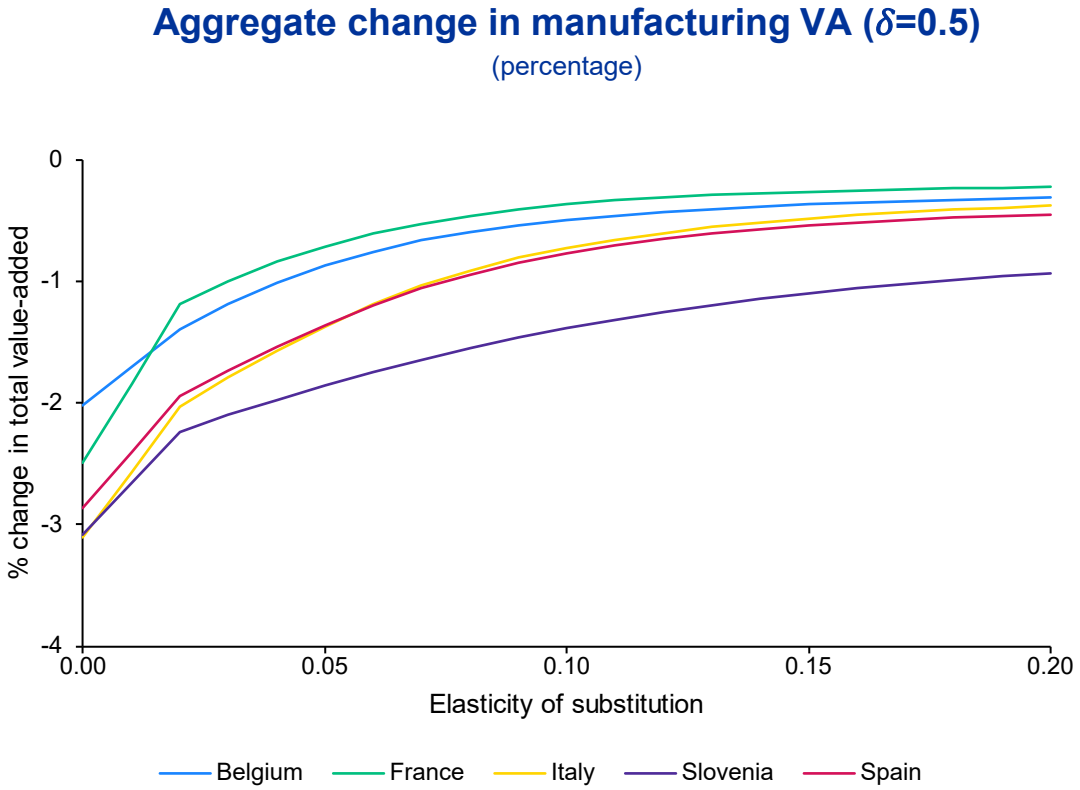
Calibration of other parameters:

- γ_i from customs and balance sheet data
- $1 - \alpha_s - \beta_s$ from OECD STAN

Central role of elasticity of substitution σ

- Ranges from 0 (Leontief) to 1 (Cobb-Douglas)
- Lower values (0 to 0.2) more plausible in short run (see e.g. Barrot and Sauvagnat, 2016; Atalay, 2017 and survey evidence)

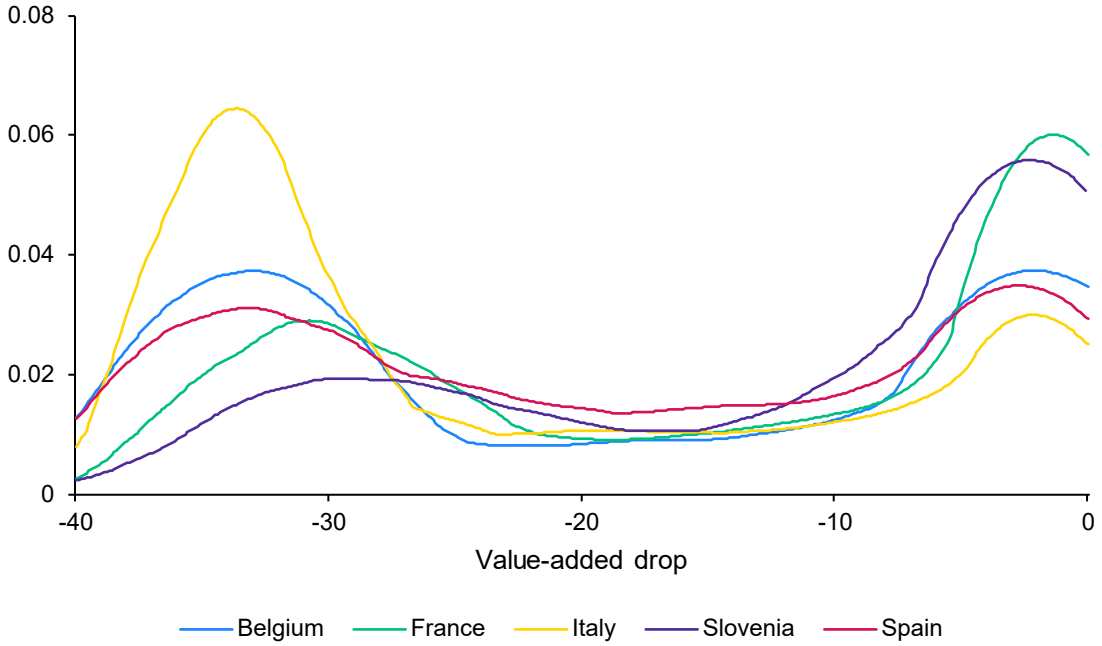
Baseline aggregate effects are sizeable



Firm-level effects are very heterogeneous

Distribution of changes in VA of exposed manufacturing firms (δ=0.5; σ=0)

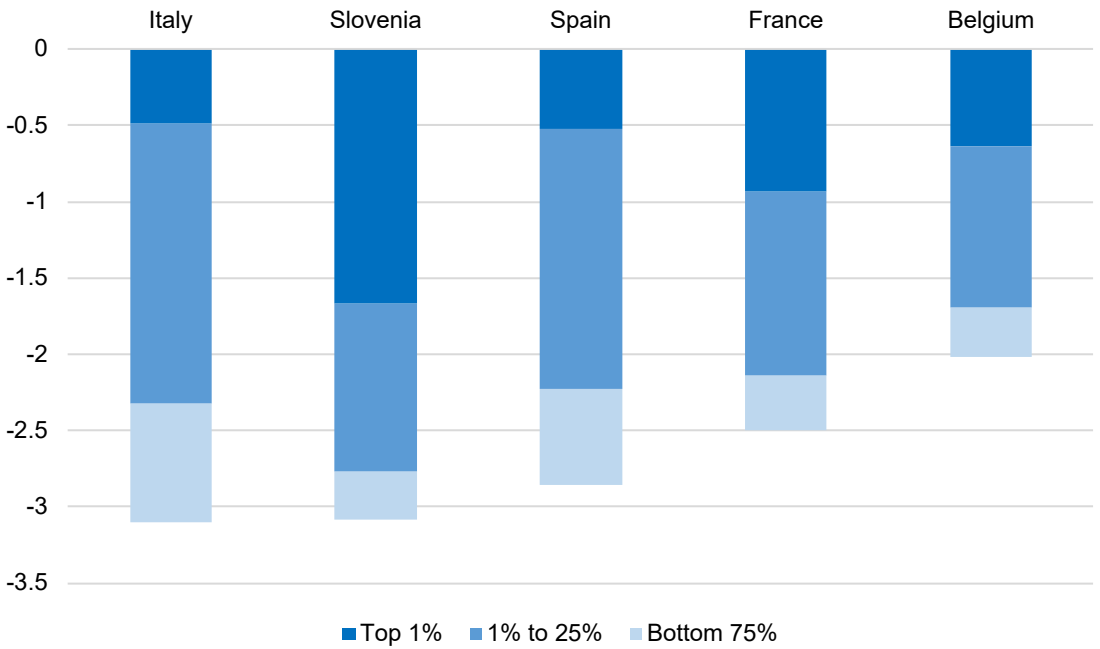
(percentage)



Large firms drive aggregate effects

Decomposition of aggregate change in manufacturing VA by exposed firm size (δ=0.5; σ=0)

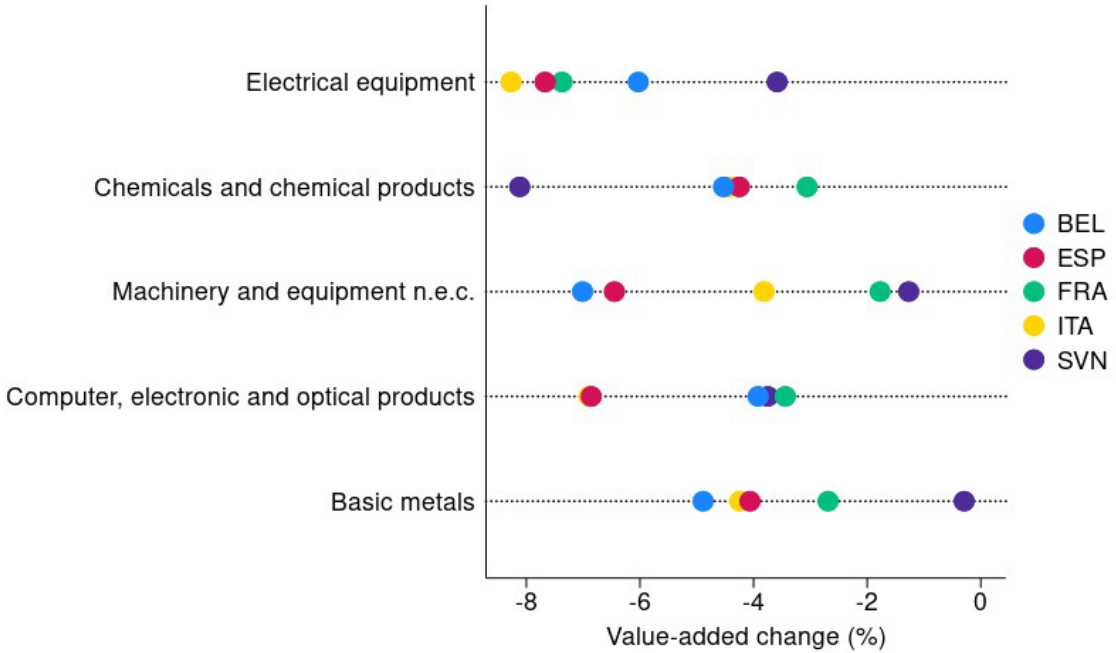
(percentage)



Impact varies significantly across different sectors…

Changes in VA of most exposed manufacturing sectors (δ=0.5; σ=0)

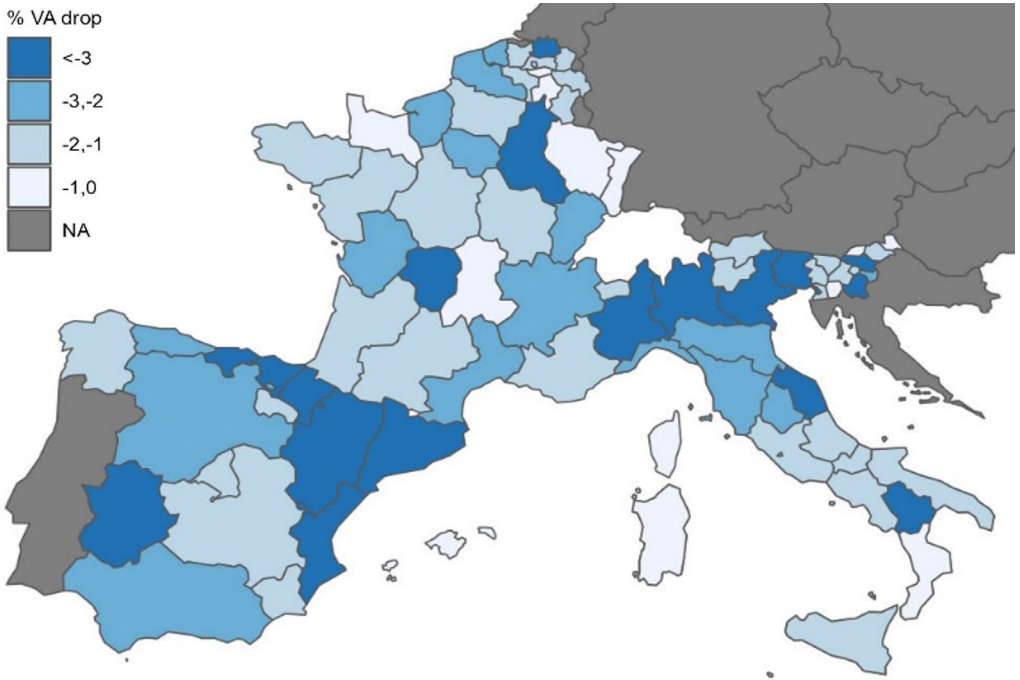
(percentage)



…and across regions, due to specialisation/concentration

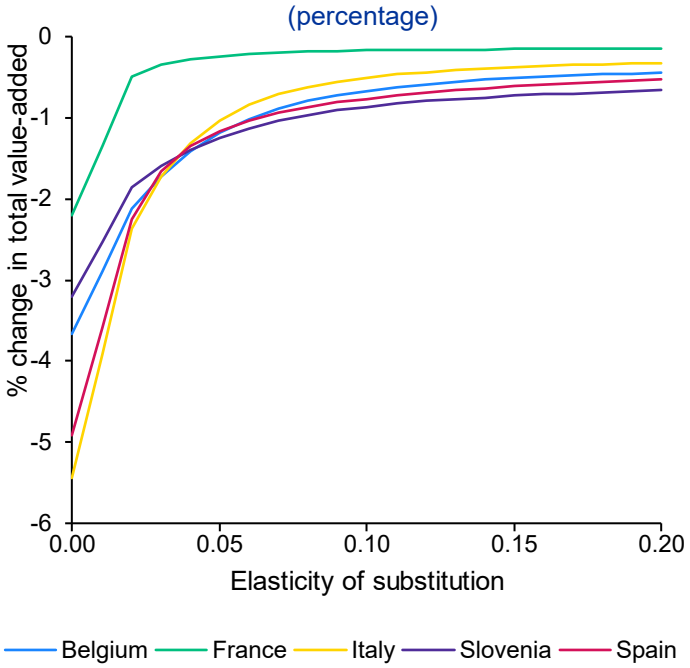
Changes in manufacturing VA by region (δ=0.5; σ=0)

(percentage)

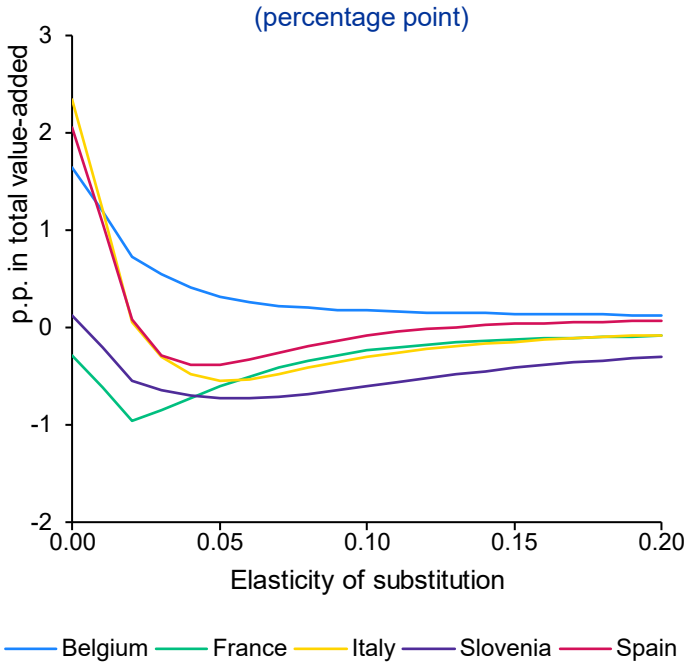


Using less granular data may bias simulated impact

Change in VA with sector data



Aggregation bias



Note: The chart reports the change in value added (in %) for a 50% cut in supply of FCIs, and the resulting percentage point bias. The sector-level data are at the NACE3 level.

- Remember $\Delta va_i = (1 - \alpha_s - \beta_s)\Delta m_i$ and $\Delta va = \sum_i \Delta va_i \times \omega_i^{va}$
- Size of bias depends on distributions of VA weights and of firm-level exposures

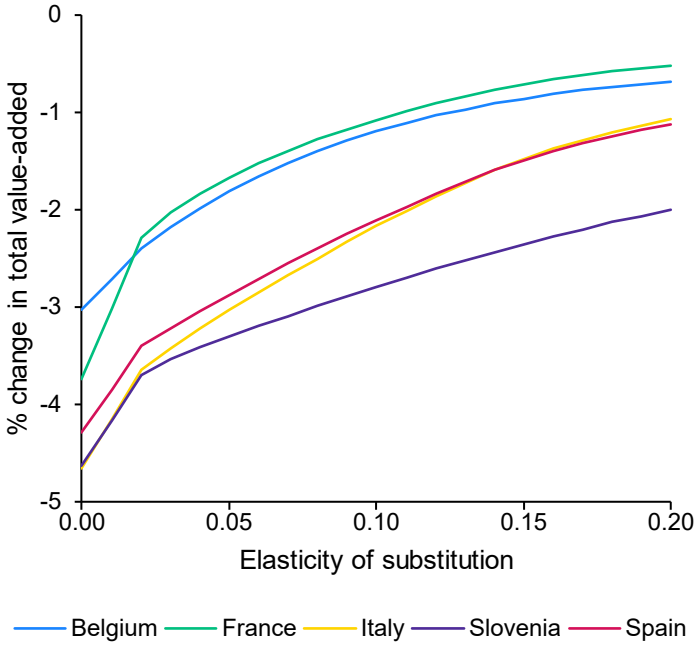
Conclusion

- Identify vulnerable inputs and use partial equilibrium model calibrated with micro data to simulate impact of potential supply disruptions coming from geoeconomic fragmentation
- Impact on manufacturing value added can be substantial, if there are strong complementarities in production
- Impact varies significantly across countries, regions, sectors and firms, driven by heterogeneous exposure of firms
- Relying on macro data rather than micro data may bias results
- Paper as first step towards "alliance to map global supply networks" (Pichler et al., 2023)

Impact with alternative shock severity

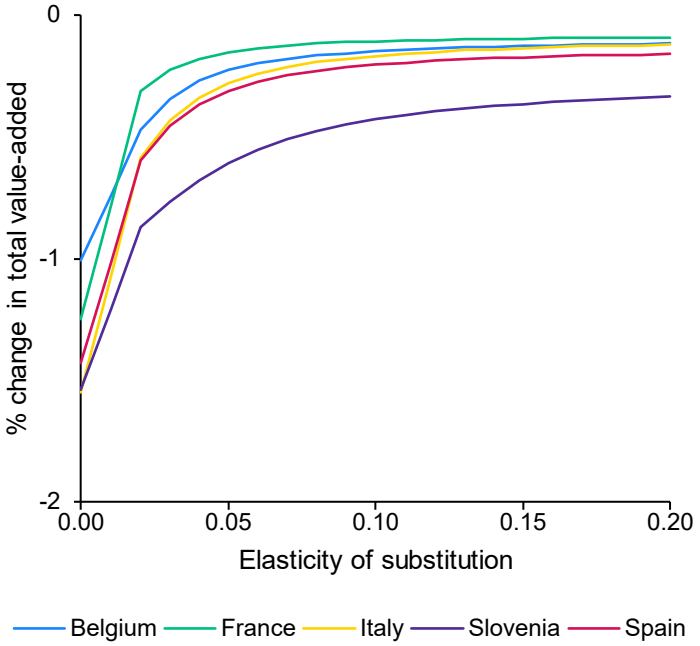
Aggregate change in manufacturing VA δ=0.75

(percentage)



Aggregate change in manufacturing VA δ=0.25

(percentage)

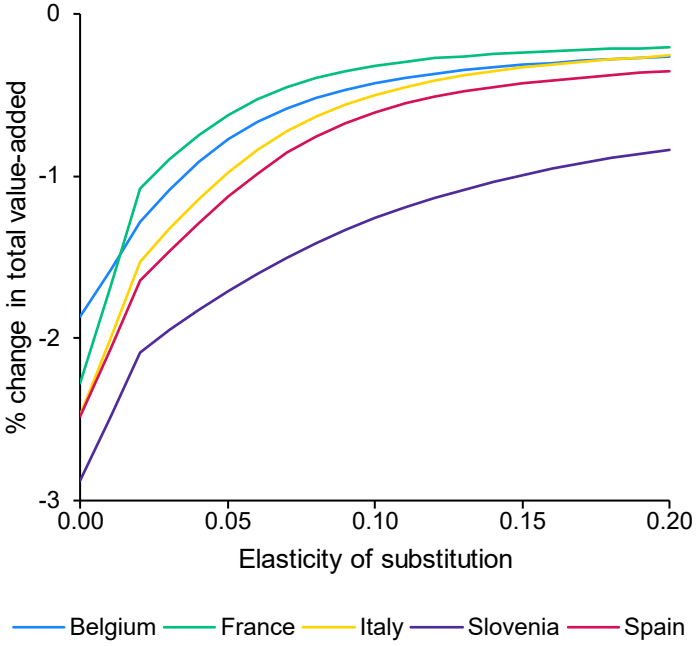


Notes: Includes only manufacturing firms

Impact with alternative FCI list or cut from China only

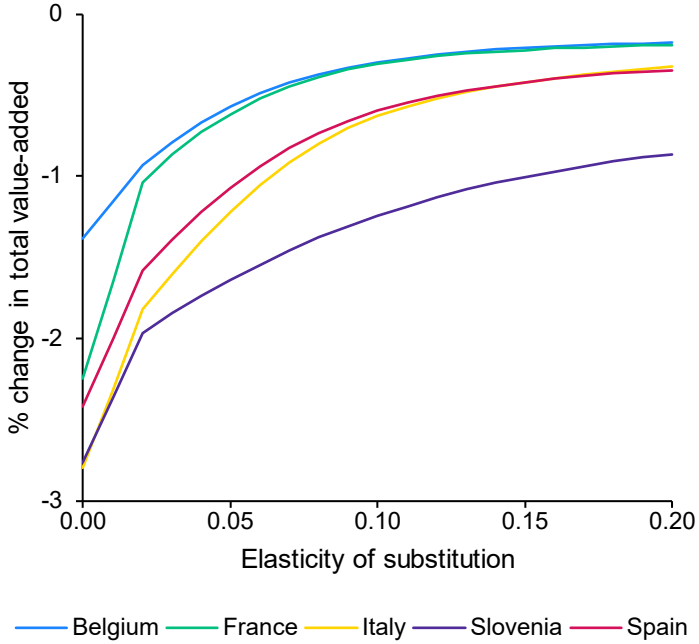
Restricted FCI list

(percentage)



Supply cut from China only

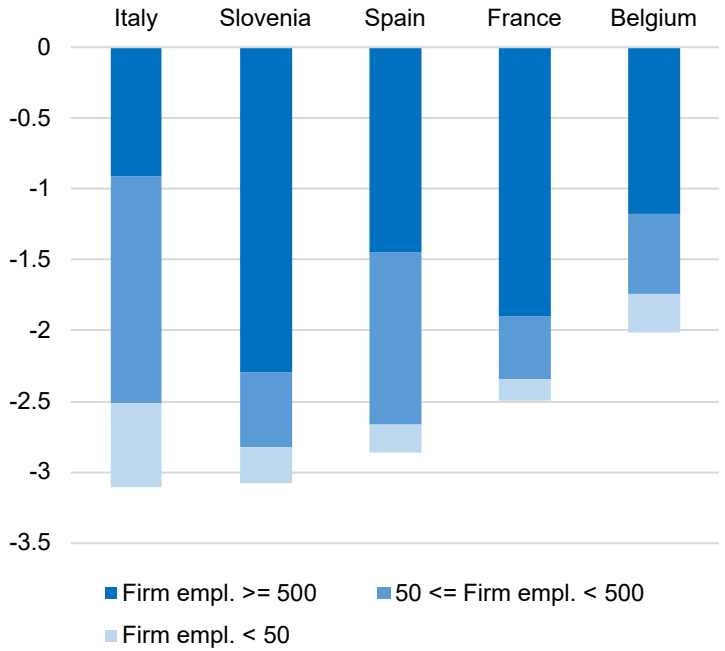
(percentage)



Decompositions of impact by firm employment or sector

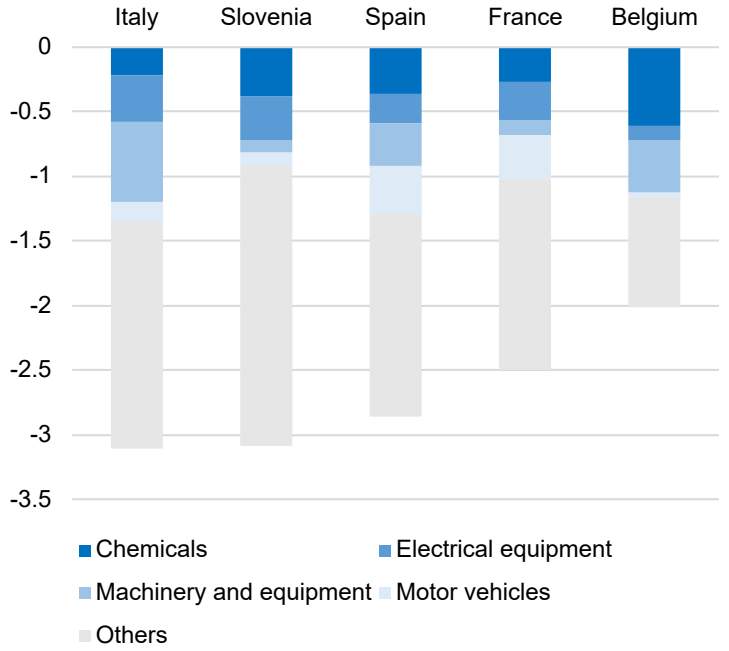
By exposed firms' employment size

(percentage)



By exposed firms' sector

(percentage)



Notes: Only the manufacturing sector is considered. We selected the 5 sectors contributing the most to the drop (average across the 5 countries).