Deglobalization and the reorganization of supply chains

Effects on regional inequalities in the EU

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A massive wave of globalization since the 1970s is coming to an end

Globalization has slowed down since 2008

- Natural supply chain disruptions.
- Geopolitical tensions and armed conflicts.
- Revealing vulnerabilities from (in)direct exposure to the world.

Political blocks implemented measures to

- reduce dependence on third countries,
- incentivize domestic production.

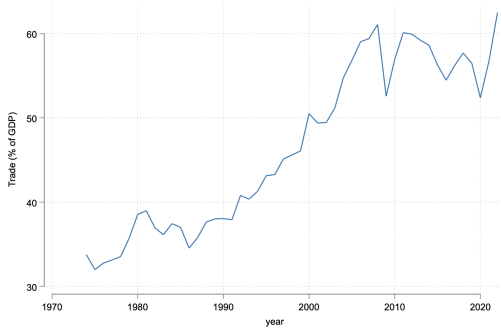


Figure: World trade-to-GDP (%), World Bank.

Protectionist measures have been rising since 2008

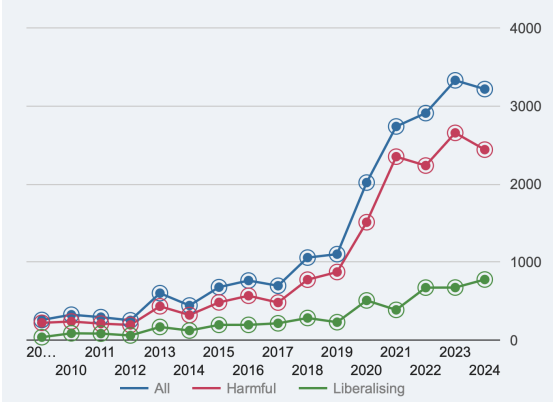


Figure: Yearly new interventions, Global Trade Alert.

USA: Investment and Jobs Act (2021), CHIPS and Science Act (2022), Defence Production Act (2022), Inflation Reduction Act (2022).

EU: Open Strategic Autonomy (2013-...), Recovery and Resilience Facility (2021), relaxation of EU state aid rules (2022), RePowerEU (2023), EU Chips Act (2023), Green Deal, Blue Deal.

Individual countries: Industrial Policy (France, Germany, ...), security (Art 346 TFEU).

Sub-national regions: European Semiconductor Regions Alliance (2023), 27 regions from 12 EU Member States.

This paper

Evaluate a toolbox of protectionist policies

- Trade, industrial, and public policy.
- Different levels of decision making (supranational vs local).

Develop a general equilibrium framework to evaluate these policies

- Multi-sector, multi-region, with input-output linkages within/across regions.
- Monopolistic competition, industry-level economies of scale, and public goods.
- Local/EU governments setting policies, raise taxes and provide subsidies to fund these.

Quantify their impact on EU welfare and that of its regions

- 235 EU NUTS2 regions + ROW, 55 sectors and IO linkages within/across regions.

Preview of results

EU welfare effects

- Trade policy: negative welfare effects.
- Industrial, public policy: positive effects.

Channels that affect welfare

- Classical gains from trade effects are small.
- Economies of scale contribute positively to welfare under each policy.
- Input-output linkages dominate under each policy.

Regional heterogeneity

- Small aggregate effects obfuscate massive variation across regions.
- Within countries, some regions can be top winners and others top losers under same policy.
- A region can win under one policy and lose in another.

Related literature

General equilibrium: Eaton Kortum (2002), Acemoglu et al. (2012), Caliendo Parro (2015), Caliendo et al. (2019), Carvalho et al. (2021), Galle et al. (2023), Baqaee Farhi (2020, 2024).

Policies: Grossman (1985), Neumark Simpson (2014), Liu (2019), Campolmi et al. (2022), Lashkaripour Lugovskyy (2023), Juhasz et al. (2023), Rubbo (2023).

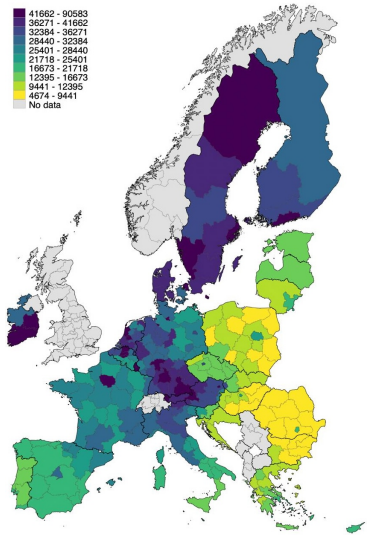
Economic geography: Marshall (1890), Krugman (1991), Caliendo et al. (2018), Fajgelbaum et al. (2019), Fajgelbaum Schaal (2020), Cruz Rossi-Hansberg (2021), Conte et al. (2022).

Supply chains: Johnson Noguera (2012), Koopman et al. (2014), Grossman Rossi-Hansberg (2008), Baldwin Venables (2013), Antras Chor (2013), Alfaro et al. (2019), Antras De Gortari (2020), Eppinger et al. (2021), Bonadio et al. (2021).

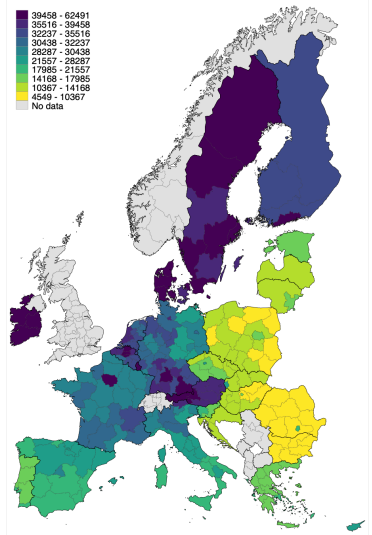
Our approach: Policy toolbox for economies with EES, IO linkages, public goods and multi-layer governments

EU regional heterogeneity and budget

Economic activity is highly dispersed across EU regions (NUTS2, 2017)

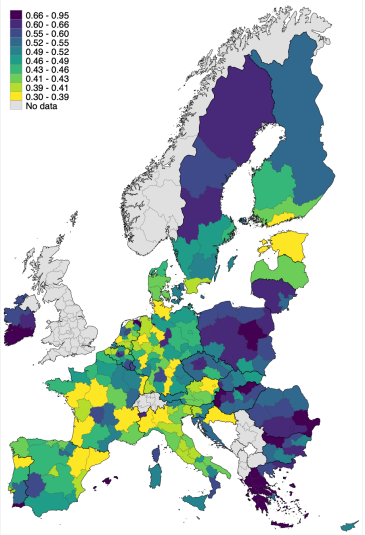


Gross value added per capita.

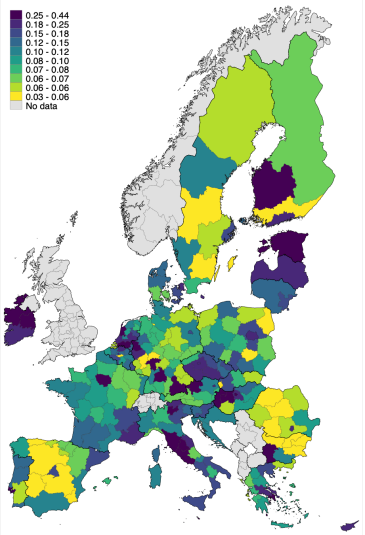


Gross National Income per capita.

As well as specialization patterns (NUTS2, 2017)



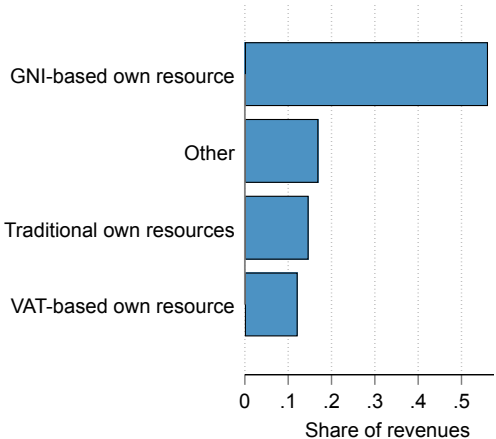
Krugman Specialization Index (value added).



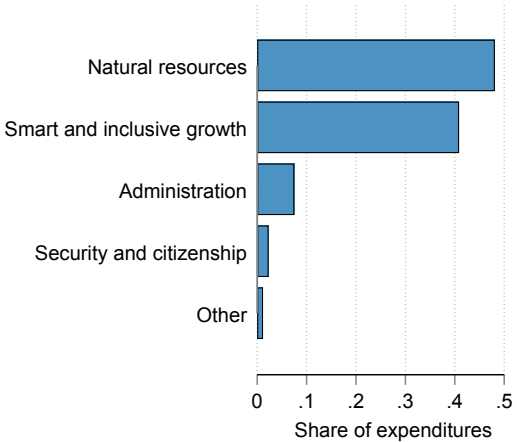
Import penetration ratio (manufacturing).

EU budget: revenues and expenditures

Long-term: Multi-annual Financial Framework (MFF) (e.g. 2014-2020).
Yearly: must be balanced (TFEU Art 310).

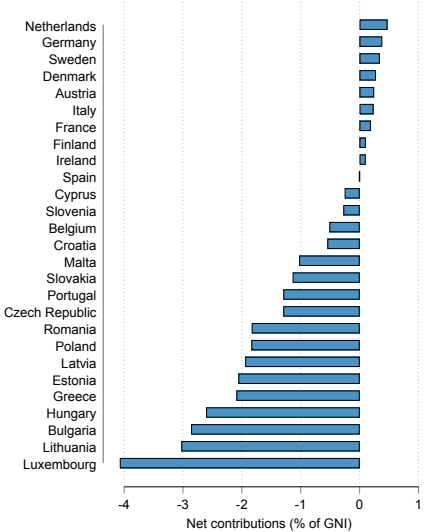


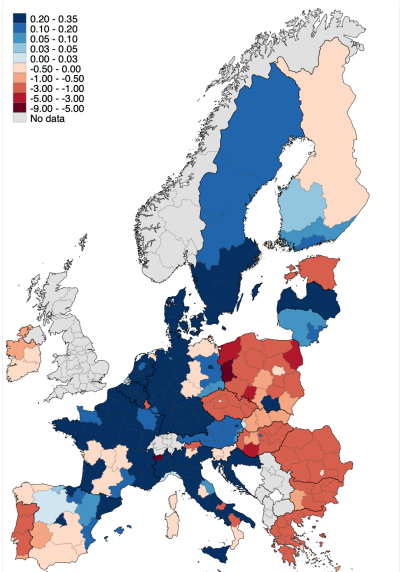
Revenues (2017) 139 billion euro.



Expenditures (2017) 137 billion euro.

EU budget: net contributors and net recipients





Note: Regional contribution is region i's GNI share in total EU payments minus regional receipts (European Commission EU regional policy allocation database).

Quantitative framework

Preferences

Households in region j maximize

$$U_j(C_j, G_j) = C_j^{\eta_j} G_j^{1-\eta_j}$$

with $C_j = \prod_{s=1}^{S} \left(Q_j^s\right)^{\alpha_j^s}$, where Q_j^s is an aggregator for sector s goods in region j:

$$\underbrace{Q_j^s = \left(\sum_{i=1}^{N} (Q_{ij}^s)^{\frac{\sigma^s - 1}{\sigma^s}} \right)^{\frac{\sigma^s}{\sigma^s - 1}}}_{\text{across regions}} \qquad \underbrace{Q_{ij}^s = \left[\int_{\omega} q_{ij}^s(\omega)^{\frac{\theta^s - 1}{\theta^s}} d\omega \right]^{\frac{\theta^s}{\theta^s - 1}}}_{\text{across varieties}}$$

Demand for variety ω in region j for sector s goods produced in region i is:

$$q_{ij}^s(\omega) = \left(\frac{p_{ij}^s(\omega)}{P_{ij}^s} \right)^{-\theta^s} \left(\frac{P_{ij}^s}{P_j^s} \right)^{-\sigma^s} Q_j^s$$

E.g. demand for cars across countries (Fra/Ger) and brands (Peugeot/Renault/BMW/Audi).

Income

Sources of income

- Inelastic labor L_j with wage w_j (perfectly mobile across sectors within regions).
- Capital K_j with rental rate r_j (idem: land, structures, buildings).
- Net foreign income from capital owned by HH at home.

Gross National Income in region j

$$I_j = \underbrace{w_j L_j + r_j K_j}_{\text{domestic value added}} \underbrace{- T_j^{LOC} - \phi_j T^{EU}}_{\text{taxes}} + \underbrace{\chi_j \sum_{i=1}^{N} r_i K_i - r_j K_j}_{\text{net foreign income}}$$

$\chi_j = \frac{r_j K_j}{\sum_i r_i K_i}$ is j's share of the international portfolio, and ϕ_j is region j's GNI share in the EU.

Production

Production: Sector s in region i produces a continuum of varieties ω with CRS technology

$$q_i^s(\omega) = Z_i^s \left[(L_i^s)^{\gamma_i} (K_i^s)^{1-\gamma_i} \right]^{1-\beta_i^s} \prod_{r=1}^{S} \left[\left(Q_i^r \right)^{\rho_i^{rs}} \right]^{\beta_i^s}$$

where Q_i^r is a CES composite bundle of intermediates.

Costs and prices

$$c_i^s(\omega) = \Upsilon_i^s \left[w_i^{\gamma_i} r_i^{1-\gamma_i} \right]^{1-\beta_i^s} \prod_{r=1}^{S} \left[\left(P_i^r \right)^{\rho_i^{rs}} \right]^{\beta_i^s}$$

$$p_{ij}^s(\omega) = \frac{\theta^s}{\theta^s - 1} \frac{c_i^s \tau_i^s \kappa_{ij}^s}{Z_i}$$

τ_i^s: net tax wedge ($\tau_i^s = 1 + \tilde{\tau}_i^s$); $\kappa_{ij}^s = (1 + t_{ij}^s) d_{ij}^s$: trade costs, tariffs t_{ij}^s and iceberg costs d_{ij}^s.

External economies of scale

Sector prices for goods s from i to j

$$P_{ij}^s = \frac{\theta^s}{\theta^s - 1} \frac{c_i^s \tau_i^s \kappa_{ij}^s}{Z_i^s} M_i^{s\,-\frac{1}{\theta^s - 1}}$$

where M_i^s is the endogenous mass of firms in sector s in region i.

Sector-level economies of scale are

$$-\frac{\partial \ln P_{ij}^s}{\partial \ln M_i^s} = \frac{1}{\theta^s - 1} = \mu^s$$

where μ^s is the markup rate ($1 + \mu^s = \frac{\theta^s}{\theta^s - 1}$).

The mass of firms is pinned down by a free entry condition

$$\underbrace{c_i^s f^s}_{\text{entry costs}} = \frac{1}{\theta^s} \underbrace{\frac{Y_i^s}{M_i^s}}_{\text{output per firm}}$$

where f^s is a fixed cost of entry and Y_i^s is total sector output.

Local governments in each region i

Industrial policy
Raise *ad valorem* taxes T_i^s and provide subsidies S_i^s on production to sector s.

$$\bar{T}_i = \sum_{s=1}^{S} (T_i^s - S_i^s) = \sum_{s=1}^{S} Y_i^s c_i^s \tilde{\tau}_i^s$$

Public policy
Total public goods consumption by the government is $\bar{G}_i = \sum_s P_i^s G_i^s$.

Can run unbalanced budgets
Its budget constraint is given by $T_i^{LOC} + \bar{T}_i + B_i = \bar{G}_i$, where B_i is the local budget deficit.

The supranational government

Collects taxes from regions as GNI contributions $T^{EU} = \sum_{i \in EU} \phi_i T^{EU}$.

Sets trade policy t_{ij}^s and collects tariff revenues R_i.

Taxes and redistributes money to local governments running imbalances B_i.

Runs a balanced budget

$$\sum_{i \in EU} \phi_i T^{EU} + \sum_{i \in EU} R_i - \sum_{i \in EU} B_i = 0$$

A region can be **net recipient or net contributor** of supranational funds:

$$\phi_i T^{EU} - B_i \gtrless 0$$

Trade and gravity

Value of trade flows from region i to j in goods from sector s are:

$$X_{ij}^s = \left(\frac{1}{\theta^s}\right)^{-\frac{1-\sigma^s}{\theta^s-1}} \left(\frac{\theta^s}{\theta^s-1}\right)^{1-\sigma^s} (\kappa_{ij}^s)^{1-\sigma^s} (Z_i^s)^{\gamma_i^s(\sigma^s-1)} \left(\frac{Y_i^s}{(c_i^s\tau_i^s)^{\theta^s} f^s}\right)^{-\frac{1-\sigma^s}{\theta^s-1}} X_j^s (P_j^s)^{\sigma^s-1}$$

Expenditure shares are:

$$\lambda_{ij}^s = \frac{X_{ij}^s}{X_j^s} = \frac{(\kappa_{ij}^s)^{1-\sigma^s} (Z_i^s)^{\gamma_i^s(\sigma^s-1)} \left(\frac{Y_i^s}{(c_i^s\tau_i^s)^{\theta^s} f^s}\right)^{-\frac{1-\sigma^s}{\theta^s-1}}}{\left[\sum_{i=1}^N (\kappa_{ij}^s)^{1-\sigma^s} (Z_i^s)^{\gamma_i^s(\sigma^s-1)} \left(\frac{Y_i^s}{(c_i^s\tau_i^s)^{\theta^s} f^s}\right)^{-\frac{1-\sigma^s}{\theta^s-1}}\right]}$$

Solving the model: exact hat algebra

Firms costs

$$\hat{c}_j^s = \hat{w}_j^{1-\beta_j^s} \prod_{r=1}^{S} \left(\hat{P}_j^r \right)^{\beta_j^r \rho_j^{rs}}$$

Input prices

$$\hat{P}_j^r = \left[\sum_{i=1}^{N} \lambda_{ij}^r \hat{\kappa}_{ij}^{r\,1-\sigma^r} \hat{Z}_j^{r\,\gamma_j^r(\sigma^r-1)} \left(\frac{\hat{Y}_i^s}{(\hat{c}_i^s \hat{\tau}_i^s)^{\theta^s}} \right)^{-\frac{1-\sigma^s}{\theta^s-1}} \right]^{\frac{1}{1-\sigma^s}} \tag{1}$$

Import shares

$$\lambda_{ij}^{s'} = \lambda_{ij}^s \hat{\kappa}_{ij}^{s\,1-\sigma^s} \hat{Z}_i^{s\,\gamma_i^s(\sigma^s-1)} \left(\frac{\hat{Y}_i^s}{(\hat{c}_i^s \hat{\tau}_i^s)^{\theta^s}} \right)^{-\frac{1-\sigma^s}{\theta^s-1}} \hat{P}_j^{s\,\sigma^s-1} \tag{2}$$

Total gross output

$$Y_i^{s'} = \underbrace{\sum_{r=1}^{S} \sum_{i=1}^{N} \frac{\lambda_{ij}^{s'}}{1+t_{ij}^{s'}} \beta_j^r \rho_j^{sr} Y_j^{r'}}_{\text{intermediates}} + \underbrace{\sum_{j=1}^{N} \frac{\lambda_{ij}^{s'}}{1+t_{ij}^{s'}} \alpha_i^s I_j' + \hat{P}_i^s \hat{G}_i^s \left(P_i^s G_i^s \right)}_{\text{final goods}}$$

Decomposing welfare channels

Decomposing the welfare effects of policies

Change in welfare for region j is given by:

$$\hat{W}_j = \left(\frac{\hat{I}_j}{\hat{P}_j}\right)^{\eta_j} \left(\hat{G}_j\right)^{1-\eta_j}$$

$$d\log W_j = \underbrace{\eta_j \left[\left(\frac{w_j L_j}{I_j} - 1\right) d\log w_j + \chi_j \sum_{i=1}^{N} \frac{r_i K_i}{I_j} d\log w_i - \phi_j \frac{\mathrm{d}T^{EU}}{I_j}\right.}_{\text{Income}}$$

$$\underbrace{\left. - \sum_{s=1}^{S}\sum_{r=1}^{s} \alpha_j^s \tilde{\psi}_j^{rs} \frac{d\log \lambda_{jj}^r}{\sigma^r - 1} - \sum_{s=1}^{S}\sum_{r=1}^{S} \alpha_j^s \tilde{\psi}_j^{rs} d\log\left(\frac{\tau_j^r}{Z_j^r}\right) + \sum_{s=1}^{S}\sum_{r=1}^{S} \alpha_j^s \mu^r \tilde{\psi}_j^{rs} \left(d\log Y_j^r - d\log \bar{Y}_j\right)\right]}_{\text{Price index}}$$

$$\underbrace{+ (1-\eta_j)\left[\sum_{s=1}^{S} \delta_j^s d\log G_j^s\right]}_{\text{Public goods}}$$

Welfare effects: Where do policies enter the model?

Policies Trade policy: t_{ij}^s (inside λ_{ij}^r). Industrial policy: τ_j^r. Public policy: G_j^r (inside Y_j^r).

$$
\begin{aligned}
d\log W_j = \quad & \eta_j \left[\left(\frac{w_j L_j}{I_j} - 1 \right) d\log w_j + \chi_j \sum_{i=1}^{N} \frac{r_i K_i}{I_j} d\log w_i - \phi_j \frac{\mathrm{d}\, T^{EU}}{I_j} - \right. \\
& - \sum_{s=1}^{S} \sum_{r=1}^{s} \alpha_j^s \tilde{\psi}_j^{rs} \frac{d\log \lambda_{jj}^r}{\sigma^r - 1} - \sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \tilde{\psi}_j^{rs} d\log \left(\frac{\tau_j^r}{Z_j^r} \right) + \sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \mu^r \tilde{\psi}_j^{rs} \left(d\log Y_j^r - d\log \bar{Y}_j \right) \Bigg] \\
& + (1 - \eta_j) \left[\sum_{s=1}^{S} \delta_j^s d\log G_j^s \right]
\end{aligned}
$$

Welfare effects: Model channels

$$
\begin{aligned}
d\log W_j = \quad & \eta_j \left[\left(\frac{w_j L_j}{I_j} - 1 \right) d\log w_j + \chi_j \sum_{i=1}^{N} \frac{r_i K_i}{I_j} d\log w_i - \phi_j \frac{\mathrm{d}T^{EU}}{I_j} \right. \\
& \underbrace{- \sum_{s=1}^{S} \sum_{r=1}^{s} \alpha_j^s \tilde{\psi}_j^{rs} \frac{d\log \lambda_{jj}^r}{\sigma^r - 1}}_{\text{Gains from trade}} \underbrace{- \sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \tilde{\psi}_j^{rs} d\log \left(\frac{\tau_j^r}{Z_j^r} \right)}_{\text{Productivity}} + \underbrace{\sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \mu^r \tilde{\psi}_j^{rs} \left(d\log Y_j^r - d\log \bar{Y}_j \right)}_{\text{External economies of scale}} \\
& \left. + (1 - \eta_j) \left[\sum_{s=1}^{S} \delta_j^s d\log G_j^s \right] \right]
\end{aligned}
$$

Economies of scale

- If $\mu^s = 0$, there are no EES. All effects are on the firm intensive margin.
- If $\mu^s > 0$, increase in demand triggers firm entry, lowering prices.

Welfare effects: Input-output linkages

$$
\begin{aligned}
d\log W_j = \quad & \eta_j \left[\left(\frac{w_j L_j}{I_j} - 1 \right) d\log w_j + \chi_j \sum_{i=1}^{N} \frac{r_i K_i}{I_j} d\log w_i - \phi_j \frac{\mathrm{d}\, T^{EU}}{I_j} \right. \\
& \underbrace{- \sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \tilde{\psi}_j^{rs} \frac{d\log \lambda_{jj}^r}{\sigma^r - 1}}_{\text{Gains from trade}} \underbrace{- \sum_{s=1}^{S} \sum_{r=1}^{S} \alpha_j^s \tilde{\psi}_j^{rs} d\log \left(\frac{\tau_j^r}{Z_j^r} \right)}_{\text{Productivity}} \\
& \underbrace{+ \sum_{r=1}^{S} \mu^r \tilde{\psi}_j^{rs} \left(\sum_{i=1}^{N} \sum_{k=1}^{S} \psi_{ji}^{rk} d\log F_i^k - \sum_{r=1}^{S} \frac{L_j^r}{L_j} \sum_{i=1}^{N} \sum_{k=1}^{S} \psi_{ji}^{rk} d\log F_i^k \right)}_{\text{External economies of scale}} \\
& \left. + d\log w_j + (1 - \eta_j) \left[\sum_{s=1}^{S} \delta_j^s d\log G_j^s \right] \right]
\end{aligned}
$$

Input-output multipliers: Prices of sector s in j

- High $\tilde{\psi}_j^{rs}$: r is an important supplier to $s \rightarrow \Delta$VA contributes more to price change in s.
- High ψ_{ji}^{rk}: k is an important customer of $r \rightarrow \Delta$FD triggers firm entry and lowers prices.

Welfare effects of policies

Data sources

Regional production, value added, consumption, value chains, net taxes

- MRIO data for RHOMOLO model (JRC at the European Commission).
- Regions: 235 EU regions, 18 RoW aggregate.
- Sectors: 55 sectors in each region.

EU transfers to NUTS2 regions

- Cohesion data on Open Data Platform of European Commission.
- Data for 2017, covers different programming periods (2007-2013, 2014-2020).
- Used to calculate initial values for B_i.

Model objects and data

Model object	Data
X_{ij}^{sr}	Intermediate goods matrix
Y_i^s	Gross output
$w_i L_i$	Value added: compensation of employees
$r_i K_i$	Value added: gross operating surplus
$\bar{T}_i^s$	Value added: net taxes on production
λ_{ij}^s	Expenditure shares, $\sum_r X_{ij}^{sr} / \sum_i \sum_r X_{ij}^{sr}$
β_j^r	IG cost share in production, $\sum_i \sum_s X_{ij}^{sr} / Y_j^r$
ρ_j^{sr}	Share of inputs bought from s, $\sum_i X_{ij}^{sr} / \sum_i \sum_s X_{ij}^{sr}$
α_i^s	Budget shares, $\frac{Y_i^s - \sum_j \sum_r \beta_j^r \rho_j^{sr} Y_j^r}{I_i}$
γ_i	$w_i L_i^s / Y_i^s$
δ_i^s	$1 - \gamma_i^s - \beta_i^s$
$\tilde{\tau}_j^r$	Net tax wedge, $\frac{\bar{T}_j^s}{\sum_i \sum_s X_{ij}^{sr} + w_j L_j + r_j K_j}$
μ^s	Scale elasticity, 0.09
σ^s	Trade elasticity, 5

Policy exercises

Exercise 1 – Trade policy

- 10% increase in tariffs for all manufacturing imports κ_{ij}^{s}.
- Raised by the supra-national government.

Exercise 2 – Industrial policy

- 10% increase to production subsidies in all manufacturing sectors τ_{i}^{s}.
- Provided by each local government to its own sectors.

Exercise 3 – Public policy

- 10% increase in final demand for manufacturing sectors G_{i}^{s}.
- Provided by each local government to its own sectors.

Aggregate welfare effects

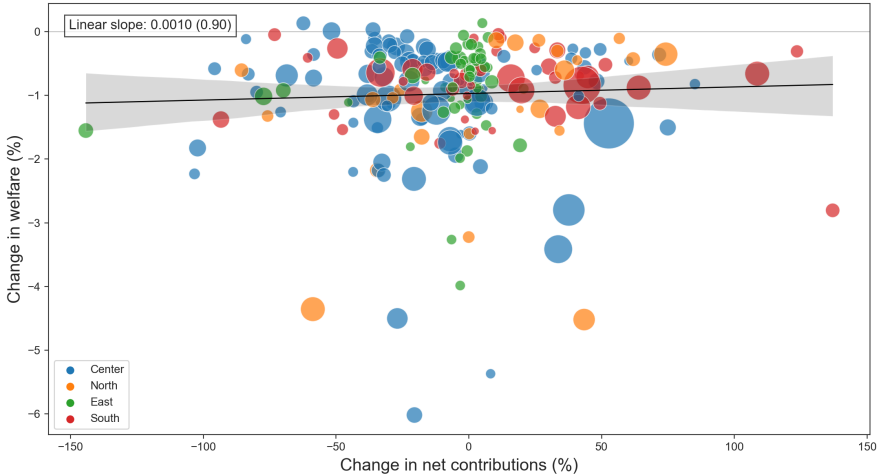
EU $\hat{W}(\%)$	ACR	ACR + EES	Full	Stdev(Full)
Trade policy	-0.16	-0.11	-0.27	0.49
Industrial policy	0.00	0.01	0.03	0.15
Public policy	-0.03	-0.03	0.01	0.08

Notes: EU aggregate welfare effects from GNI shares of regions: $\hat{W} = \sum_j \phi_j \hat{W}_j$.
Stdev is the standard deviation across regional outcomes.

Trade policy

Intuition: Imports drop. Reallocation to intra-EU suppliers, but at higher prices.

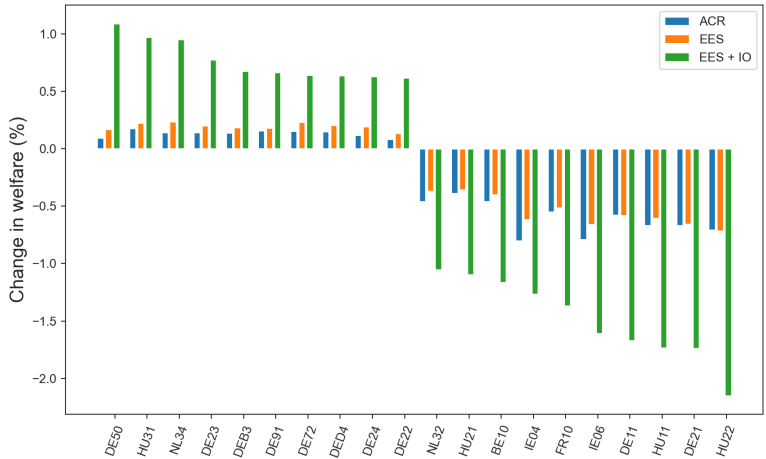
Welfare: Almost every region loses. Large variation in Center, less for South.



Trade policy

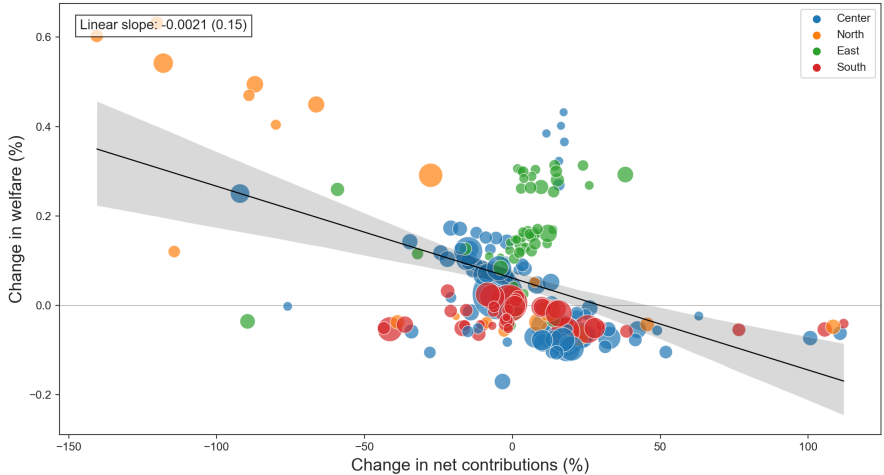
Massive heterogeneity in outcomes across regions

- Input-output linkages contribute most to welfare changes.
- Even within countries (e.g. DE, NL, HU) some regions are top winners, others top losers.



Industrial policy

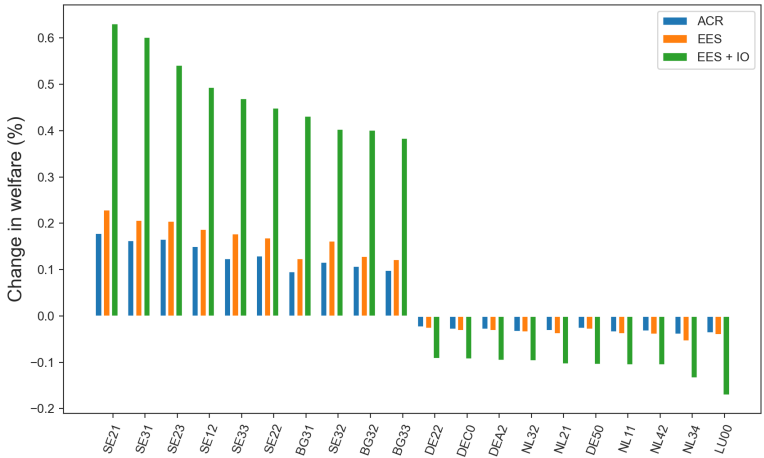
Intuition: Lower costs. Reallocation to intra-EU suppliers, at lower prices. No tariff revenues.
Welfare: Winners and losers, largest gains for North East.



Industrial policy

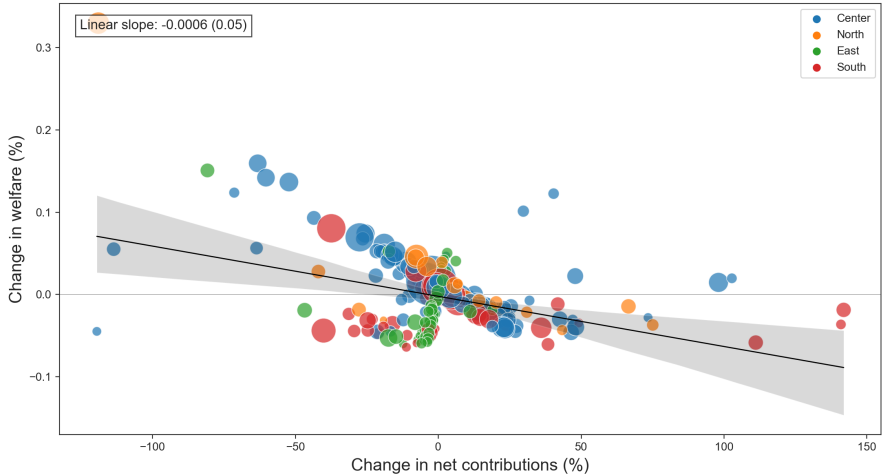
Massive heterogeneity in outcomes across regions

- Input-output linkages contribute most to welfare changes.



Public policy

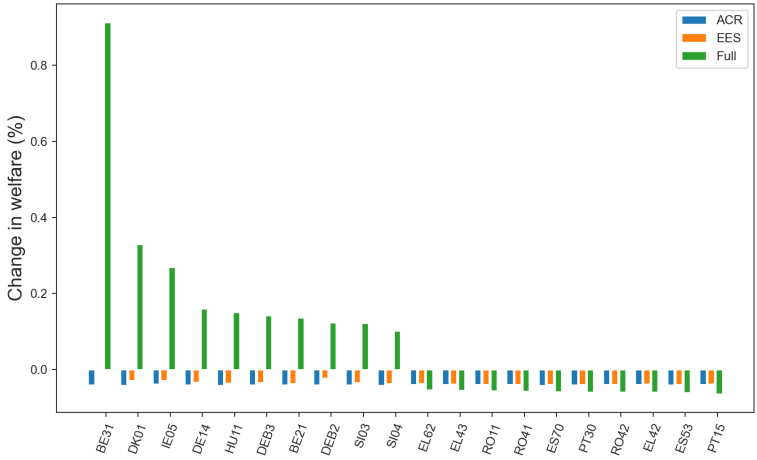
Intuition: Govt spending increases demand at a cost of higher taxes.
Welfare: winners and losers. Largest variance for Center.



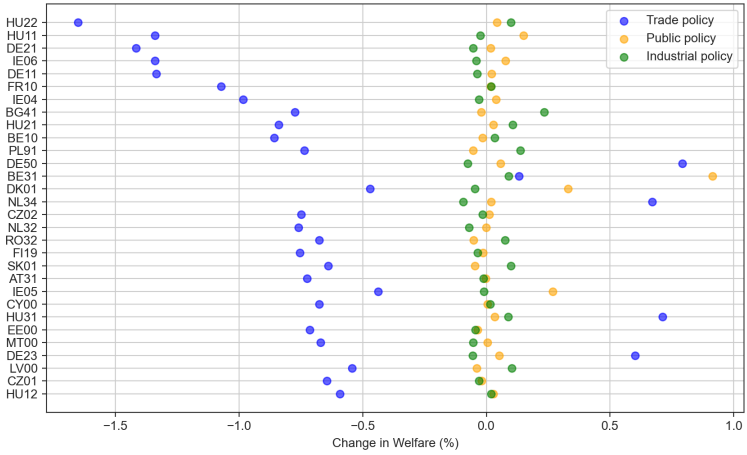
Public policy

Massive heterogeneity in outcomes across regions

- Input-output linkages contribute most to welfare changes (some with opposite effects).
- Losses are smaller and less dispersed.



Regions can win under one policy and lose in another



Top 30 gaps in welfare outcomes across policies.

Conclusion

What is the impact of a toolbox of protectionist policies on EU outcomes?

- Different policies to reduce dependence generate very different aggregate welfare effects.
- With massive variation across regions.
- Top winners and losers can occur within same country under same policy.
- Regions can win under one policy but lose under another.

Next steps: What is optimal policy?

- Subsidiarity and proportionality principles vs. externalities (e.g. subsidy shopping).
- Role for the EU government to coordinate scale economies?
- Need for EU-level industrial policy?

Thank you!

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