Decoupling Global Value Chains

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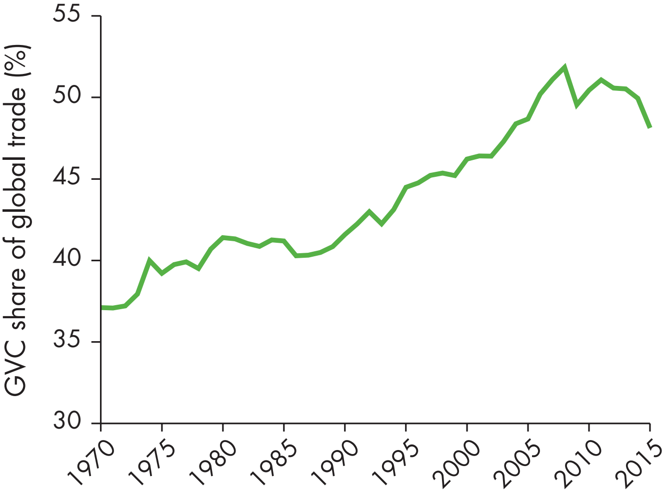
Motivation



Sources: The Economist (2019); WDR (2020), Fig. 1.2, based on Eora206 database, Borin and Mancini (2019), and Johnson and Noguera (2017).

Politicians consider barriers on input trade in GVCs

Political backlash of globalization (Antràs, 2021; Colantone et al., 2022)

- Brexit
- U.S.-China ‘trade war’

Focus on **trade in inputs**: Decoupling from/ Reshoring of/ Derisking in GVCs

- Trump’s steel tariffs
- Biden’s CHIPS Act
- . . .

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Supply chain disruptions e.g. due to Covid-19 pandemic and Russian war on Ukraine contributed to the critical stance on GVCs

Can it pay off to **decouple from GVCs to reduce spillovers** from foreign shocks?

This talk

1. General Methodology
   - Model
   - Data

2. Welfare Effects
   - Costs of Decoupling GVCs

     Effect Decomposition: Opening the Black Box
   - Spillovers of a Foreign Shock

3. Firm Heterogeneity

Model

Quantitative trade model à la Eaton and Kortum (2002) with: ▸ details

- Trade between J countries ($i \to j$) in S sectors ($r \to s$) featuring **input-output linkages** as in Caliendo and Parro (2015)

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  - Key: Different trade costs on intermediate inputs vs. final goods within sectors (e.g. in chemicals: fertilizer vs. lubricant vs. shampoo)

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  - Key: Different trade costs on intermediate inputs vs. final goods within sectors (e.g. in chemicals: fertilizer vs. lubricant vs. shampoo)
  - Allows the model to exactly match all entries of international input-output tables
- Variable **intersectoral labor mobility**: None/ perfect/ imperfect (Roy, 1951)

Equilibrium in changes

Multilateral resistance:

full equilibrium

$$\hat{\Omega}_{is} = \sum_j \sum_u \frac{X_{ijsu}}{R_{is}} \hat{K}_{ijsu} \frac{\hat{E}_{jsu}}{\hat{\mathbb{P}}_{jsu}}$$

$$\hat{\mathbb{P}}_{jsu} = \sum_i \frac{X_{ijsu}}{E_{jsu}} \hat{K}_{ijsu} \frac{\hat{R}_{is}}{\hat{\Omega}_{is}}$$

Revenues:

$$\hat{R}_{is} = \left(\hat{\delta}_{is}^{\varepsilon_s \gamma_{is}} \hat{\Omega}_{is} \prod_t \hat{\mathbb{P}}_{its}^{\gamma_{its} \frac{\varepsilon_s}{\varepsilon_t}} \right)^{\frac{1}{1+\varepsilon_s \gamma_{is}}} \left(\frac{\hat{R}_{is}}{\hat{w}_i} \right)^{\frac{\varepsilon_s \gamma_{is}}{1+\varepsilon_s \gamma_{is}} \frac{\varphi - 1}{\varphi}}$$

Welfare (real consumption):

$$\hat{C}_i = \prod_r \left(\hat{E}_{ir(S+1)} / \hat{\mathbb{P}}_{ir(S+1)}^{\frac{1}{\varepsilon_r}} \right)^{\alpha_{ir}},$$

where $\hat{E}_{jsu} = \hat{R}_{ju}$ (intermediate demand), $\hat{E}_{js(S+1)} = \hat{w}_j = \frac{\sum_r \gamma_{jr} R_{jr} \hat{R}_{jr}}{\sum_r \gamma_{jr} R_{jr}}$ (final demand).

Data and parametrization

World Input-Output Database (WIOD; Timmer et al., 2015)

- 43 countries + artificial 'Rest of World' (ROW), 56 industries
- Trade shares by use category π_{ijru}:

		Country 1		Country 2		Final Consumption		
		Industry 1	Industry 2	Industry 1	Industry 2	Country 1	Country 2	Output
Country 1	Industry 1							
	Industry 2							
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Value Added								

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Parametrization:

- Sectoral trade elasticities ε_r from Felbermayr et al. (2022)
- Labor supply elasticity (governing intersectoral mobility): 1.5 as Galle et al. (2022)

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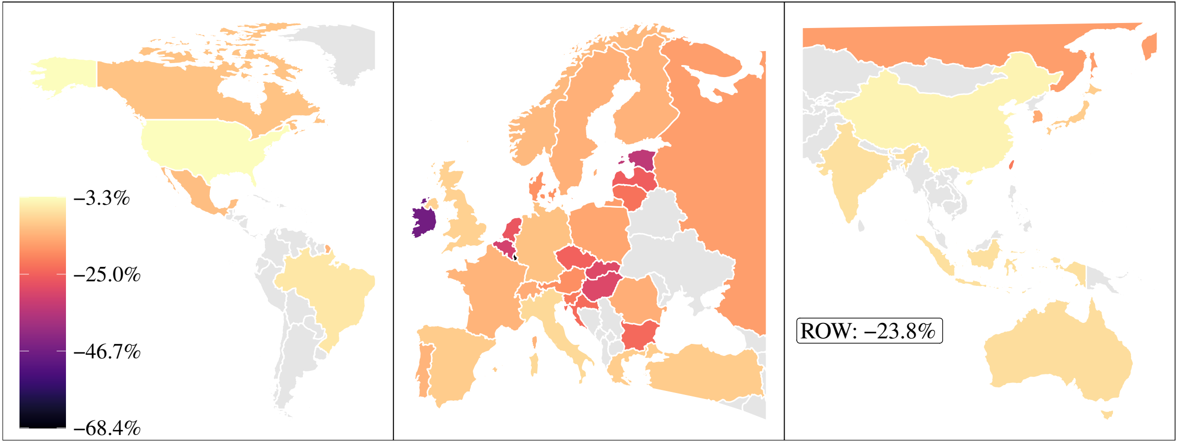
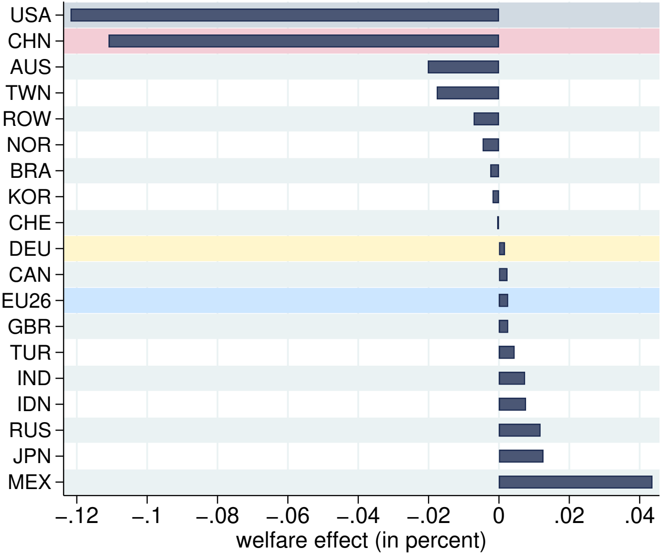
Welfare Costs of Decoupling: A world without GVCs

- Prohibitive barriers to *international* trade in *intermediate inputs*
- Welfare effects of shutting down GVCs:

▸ vs. final goods



Unilateral U.S. decoupling of GVCs from China



▸ Scenarios

Welfare Effect Decomposition: Opening the Black Box

What explains the welfare effects? **Why** does MEX (DEU) gain from U.S.-CHN decoupling?

We gain insights by a **decomposition exercise**:

- **Neumann power series expansion** of the **first-order approximation** of the non-linear model
- Under the assumption of intersectoral immobility, the Neumann power series **converges** to a **unique equilibrium** (Bifulco et al., 2022)

definitions

High correlation of the first-order approximation with full non-linear perfect mobility welfare effects: 0.89

Welfare Effect Decomposition: 12 Effects

$$d \log C_\ell = \sum_r \frac{\gamma_{\ell r} R_{\ell r}}{\sum_t \gamma_{\ell t} R_{\ell t}} \frac{1}{1 + \varepsilon_r \gamma_{\ell r}} \left(d \log \Omega_{\ell r} + \varepsilon_r \sum_t \frac{\gamma_{\ell tr}}{\varepsilon_t} d \log \mathbb{P}_{\ell tr} \right) + \sum_r \frac{\alpha_{\ell r}}{\varepsilon_r} d \log \mathbb{P}_{\ell r(S+1)}$$

$$d \log \Omega_{is} = \sum_j \sum_{u=1}^{S} \frac{X_{ijsu}}{R_{is}} \left(d \log K_{ijsu} + d \log E_{jsu} - d \log \mathbb{P}_{jsu} \right)$$

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Income effects (via Ω_{is}):

- Direct
- Trade diversion
- Exporter/Importer spillovers

Cost effects (via $\mathbb{P}_{jsu}, s \leq S$):

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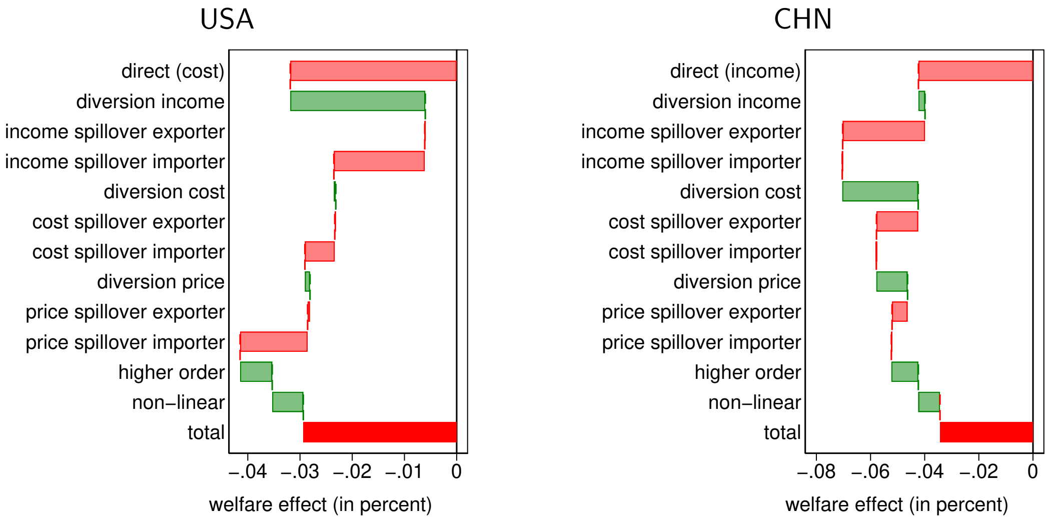
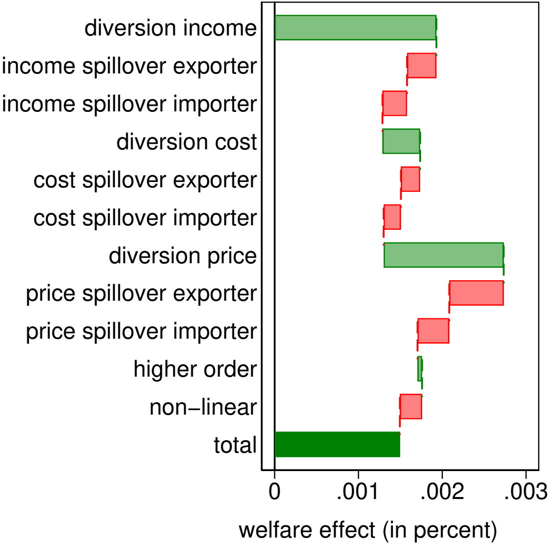
U.S.-CHN Decoupling (10%): Decomposition of Effects on U.S. and CHN



U.S.-CHN Decoupling (10%): Decomposition of Effects on DEU



Welfare effects on Germany:

- No direct effect

▸ MEX and TWN ▸ EU-CHN decoupling

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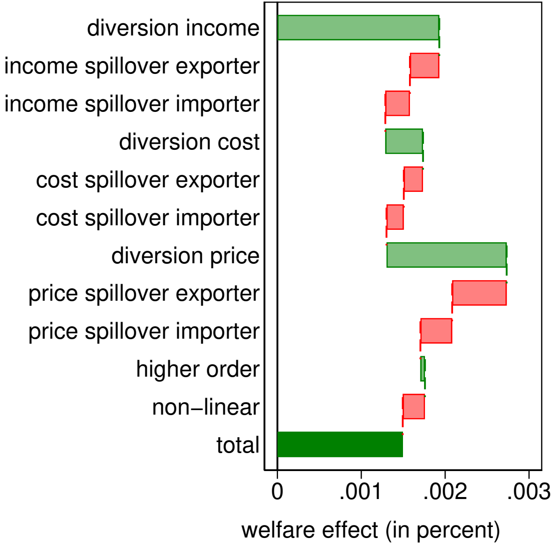

Welfare effects on Germany:

- No direct effect
- Similarly important: diverted U.S. demand (income) and diverted Chinese (cost and price)
- But: Gains mitigated by spillovers of shrinking U.S. and CHN economies

MEX and TWN EU-CHN decoupling

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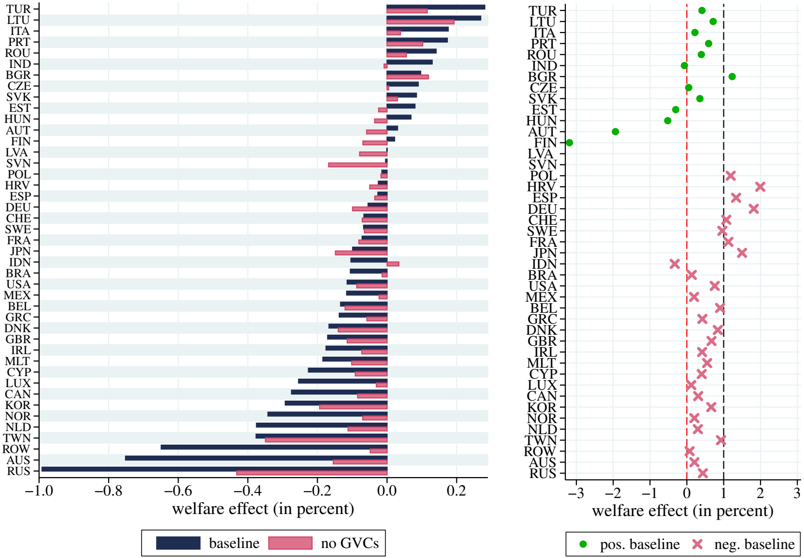
Spillovers of a Foreign Shock: Covid-19 in China, with vs. w/o GVCs



Covid shock

Foreign spillovers: Comparing costs and benefits

How do welfare losses of decoupling compare to mitigation effects?

- For U.S. vs. China? – Does not pay off

US decoupling

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▸ US decoupling
▸ country by country

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Short-run effects? Shocks in one country **too small?**

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Short-run effects? Shocks in one country **too small?**

Further scenarios: ▸ more scenarios

- Short-run trade elasticities (Boehm et al., 2020) and immobile labor ▸ short-run effects
- Shocking all foreign countries simultaneously ▸ global shocks
- Both combined!

Robust finding: Direct welfare losses from decoupling $\gg$ any mitigation effects

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Firm Heterogeneity

Firm heterogeneity, entry and exit, reallocation

- Important (Melitz, 2003), but often ignored in quantitative trade policy analyses
- **Big challenges:** Data requirements; corner solutions in multi-sector Melitz models

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Extended model:

- **Firm heterogeneity** for Germany, perfectly competitive firms in other countries
- **Nested CES preferences** (Kucheryavyy et al., 2023) to avoid corner solutions

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Calibration using German micro data:

- Estimation of **total factor productivity** (TFP, following Wooldridge, 2009)
- **Calibration** of productivity cut-offs and entrants using productivity distributions and numbers of active firms by trading link (Fauth et al., 2024) details
- Estimation of sectoral elasticities (Blank et al., 2022; Jung, 2023)

Firm Heterogeneity Results: Effects of U.S.-China Decoupling

Effects on Germany:

- Homogenous firms: $+\ 0.057\%$
- Heterogeneous firms: $+\ 0.067\%$

Differences are small, but more favorable with heterogeneous firms

Conclusions

Contributions:

- Quantify the costs of barriers to input trade in global value chains (GVCs) and benefits due to mitigating negative spillovers
- Decompose welfare effects to understand underlying channels
- Account for firm heterogeneity in multi-sector model calibrated using new German micro data

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Key findings:

- Decoupling from GVCs causes substantial welfare losses, which dominate any gains from mitigating spillovers of adverse shocks (even some magnification!)
- Decomposition: Germany gains from both China and the U.S. trade diversion
- Firm heterogeneity: Major challenges resolved, quantitative differences small

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Preferences

Two-tier utility for consumers in country $j \in \{1, ..., J\}$

- Cobb-Douglas over sector $s \in \{1, ..., S\}$ compound goods C_{js}

$$C_j = \prod_{s=1}^{S} C_{js}^{\alpha_{js}}, \quad \text{where} \quad \sum_{s=1}^{S} \alpha_{js} = 1,$$

- CES across varieties $\omega \in [0, 1]$ within each sector s

$$C_{js} = \left[\int_0^1 x_{js}(\omega)^{\frac{\sigma_s - 1}{\sigma_s}} \, d\omega \right]^{\frac{\sigma_s}{\sigma_s - 1}}$$

- Individual demands $x_{js}(\omega)$, elasticity of substitution $\sigma_s > 1$

Mobility

Workers are **immobile across countries**

We consider three scenarios for **intersectoral labor mobility**:

1. Immobility: Sectoral employment L_{js} is exogenous
2. Perfect mobility: L_{js} adjusts such that nominal wages equalize across sectors
3. Imperfect mobility with heterogeneous workers: Roy (1951) self-selection into industries as in Lagakos and Waugh (2013) or Galle et al. (2022):
   If worker Ω in country j decides to work in sector s, labor supply there increases by $\delta_{js}(\Omega)$ efficiency units

Imperfect intersectoral mobility

Individual worker productivities $\delta_{js}(\Omega)$ for all sectors drawn from **Fréchet distributions** (with mean δ_{js} and shape parameter φ)

$$\Pr\left[\delta_{js}(\Omega) \leq \delta\right] = e^{-\frac{\delta_{js}^{\varphi}}{\Gamma\left(1-\frac{1}{\varphi}\right)^{\varphi}}\delta^{-\varphi}}$$

Workers choose the sector where they obtain the highest wage income, with w_{js} being the wage per efficiency unit

$$L_{js} = L_j \frac{\delta_{js}^{\varphi} w_{js}^{\varphi}}{\sum_{r=1}^{S} \delta_{jr}^{\varphi} w_{jr}^{\varphi}}$$

Higher wages attract lower-skilled workers and **expected wages per capita equalize across sectors**

$$w_j = \left(\sum_{s=1}^{S} \delta_{js}^{\varphi} w_{js}^{\varphi}\right)^{\frac{1}{\varphi}}$$

Production

Goods markets are **perfectly competitive**, implying price offers:

$$p_{ijru}(\omega) = \frac{c_{ir}\tau_{ijru}}{z_{ir}(\omega)},$$

which depend on:

- A Cobb-Douglas combination of labor costs and **intermediate input** costs (from potentially all sectors)

$$c_{ir} \propto w_{ir}^{\gamma_{ir}} \prod_{s=1}^{S} P_{is}^{\gamma_{isr}}, \quad \text{where } \gamma_{ir}, \gamma_{irs} \in [0,1], \gamma_{ir} + \sum_{r=1}^{S} \gamma_{irs} = 1$$

- **Trade costs** τ_{ijru} between countries i and j of goods produced in sector r and purchased by **use category** $u \in \{1, \ldots, S+1\}$, which can be one of the S sectors using the variety as an intermediate input or it can be final demand.
- A **variety-specific productivity** $z_{ir}(\omega)$ drawn from **Fréchet distributions** with mean T_{ir} and shape parameter $\varepsilon_r > \sigma_r - 1$

Trade and prices

Consumers and firms source each variety from the cheapest supplier:

$$p_{jru}(\omega) \equiv \min_i \; p_{ijru}(\omega)$$

Due to use-specific trade costs, this gives rise to

- a set of **use-specific CES price indices**

$$P_{jru} = \Gamma \left(\frac{\varepsilon_r + 1 - \sigma_r}{\varepsilon_r} \right)^{\frac{1}{1-\sigma_r}} \left[\sum_{i=1}^{J} T_{ir} \left(c_{ir} \tau_{ijru} \right)^{-\varepsilon_r} \right]^{-1/\varepsilon_r}$$

- and use-specific **import shares** (gravity-type equations)

$$\pi_{ijru} = \frac{T_{ir} \left[\tau_{ijru} c_{ir} \right]^{-\varepsilon_r}}{\sum_{k=1}^{J} T_{kr} \left[\tau_{kjru} c_{kr} \right]^{-\varepsilon_r}}$$

Full equilibrium in changes

Price index: $$\hat{P}_{jru} = \left[\sum_{i=1}^{J} \pi_{ijru} \left(\hat{c}_{ir}\hat{\tau}_{ijru}\right)^{-\varepsilon_r}\right]^{-1/\varepsilon_r}$$

Goods market clearing: $$\hat{R}_{ir} = \frac{1}{R_{ir}} \sum_{j=1}^{J} \sum_{u=1}^{S+1} \hat{\pi}_{ijru}\pi_{ijru}E'_{jru}, \quad \text{where}$$

Expenditures: $$E'_{jru} = \gamma_{jru}\hat{R}_{ju}R_{ju} \; \forall u \leq S, \quad E'_{jr(S+1)} = \alpha_{jr}\left(\sum_{s=1}^{S} \gamma_{js}\hat{R}_{js}R_{js}\right),$$

Trade shares (gravity): $$\hat{\pi}_{ijru} = \frac{\left(\hat{c}_{ir}\hat{\tau}_{ijru}\right)^{-\varepsilon_r}}{\sum_{k=1}^{J} \pi_{kjru}\left(\hat{c}_{kr}\hat{\tau}_{kjru}\right)^{-\varepsilon_r}},$$

Costs: $$\hat{c}_{js} = \hat{w}_{js}^{\gamma_{js}} \prod_{r=1}^{S} \hat{P}_{jrs}^{\gamma_{jrs}},$$

Labor market clearing: $$\hat{w}_{js} = \left(\hat{R}_{js}\right)^{\frac{1}{\varphi}} \left(\frac{\sum_{s=1}^{S} \gamma_{js}\hat{R}_{js}R_{js}}{\sum_{s=1}^{S} \gamma_{js}R_{js}}\right)^{\frac{\varphi-1}{\varphi}} \Big/ \hat{\delta}_{js}.$$

Welfare Effect Decomposition: Neumann Power Series

- In log-linearized form, our model can be expressed as a system of linear equations:

$$x = b + Ax, \tag{1}$$

  where x is a fixed point vector (endogenous welfare changes), A is a square matrix of exogenous variables, and b is an exogenous vector.

- Let $\rho(A)$ denote the spectral radius of A. If $\rho(A) < 1$, we can write eq. (1) as:

$$x = (I - A)^{-1} b = \sum_{k=0}^{\infty} A^k b = \underbrace{(I + A + A^2 + A^3 + \dots)}_{\text{Neumann series}} b.$$

- With labor immobility, we have $\rho(A) < 1$ (see Bifulco et al., 2022)
- It can be shown that the iterative method corresponds exactly to the n-th partial sum of the Neumann series:

$$x_{n+1} = b + Ax_n \quad \Rightarrow \quad x_n = \sum_{k=0}^{n-1} A^k b.$$

Equivalence between Neumann series and iterative method

The iterative method is given by:

$$x_{n+1} = b + Ax_n \tag{2}$$

ITERATION 0: Assume $x_0 = 0$ (i.e., calculate a 0^{th}-degree effect):

$$x_1 = b + Ax_0 = b. \quad (= 1^{st} \text{ term of Neumann series: } x_1 = A^0 b = b)$$

ITERATION 1: Substitute $x_1 = b$ into (2) to compute the next iteration:

$$x_2 = b+Ax_1 = b+Ab = (I+A)b. \quad (=2^{nd} \text{ term of Neumann series: } x_2 = A^0 b + A^1 b = (I + A)b\ )$$

ITERATION 2: Substitute $x_2 = (I + A)b$ into (2):

$$x_3 = b + Ax_2 = b + A(b + Ab) = b + Ab + A^2 b = (I + A + A^2)b.$$

This corresponds to the third partial sum of the Neumann series:

$$x_3 = A^0 b + A^1 b + A^2 b = (I + A + A^2)b.$$

By induction, for any $n \geq 1$, the n-th iterate of the method is given by:

$$x_n = \sum_{k=0}^{n-1} A^k b,$$

which corresponds exactly to the n-th partial sum of the Neumann series.

Variations of decoupling

Keep GVCs within the EU intact, decoupling all others

- EU countries lose much less (e.g. Germany -4.1% vs. -11.6%)
- Effects outside the EU barely change

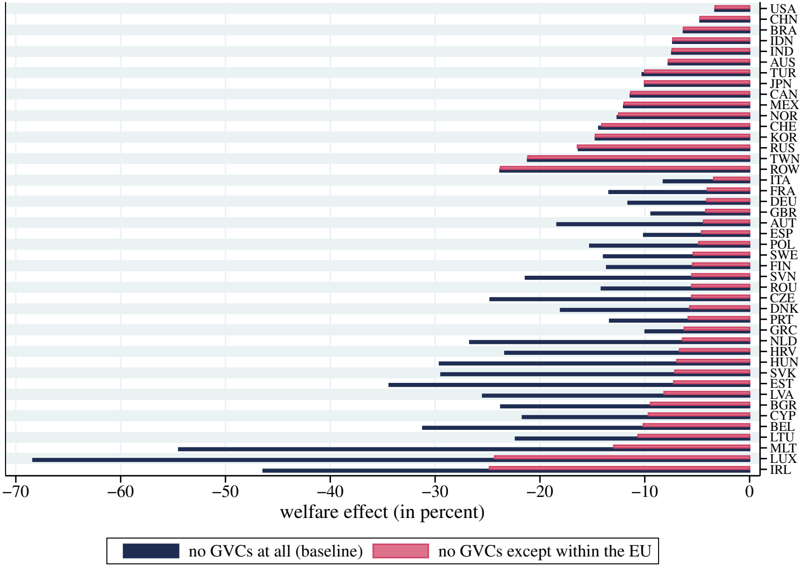
Partial decoupling: Stepwise increase in barriers

- Losses grow monotonically, at a *diminishing rate* (concavity); small losses beyond 100% barrier increase

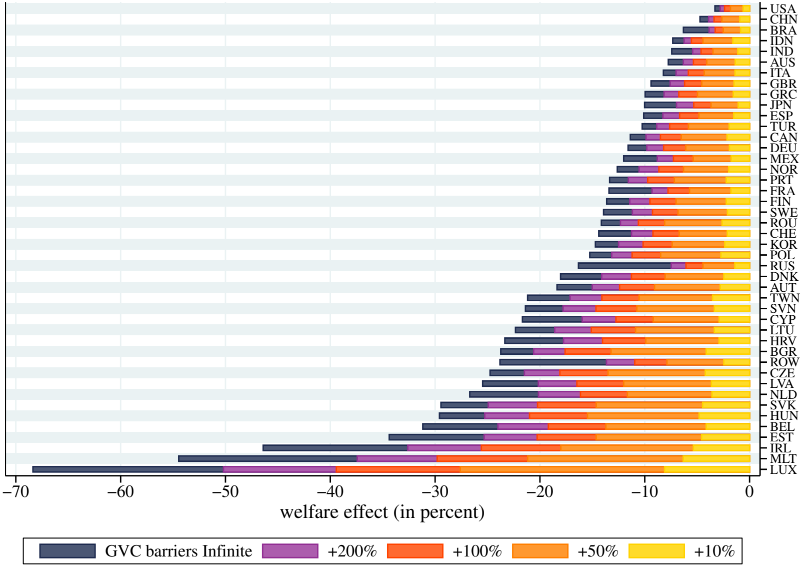
No GVCs vs. no final goods trade vs. autarky

- No GVCs generally worse than no final goods trade
- In most countries: Sum of effects exceeds loss from autarky

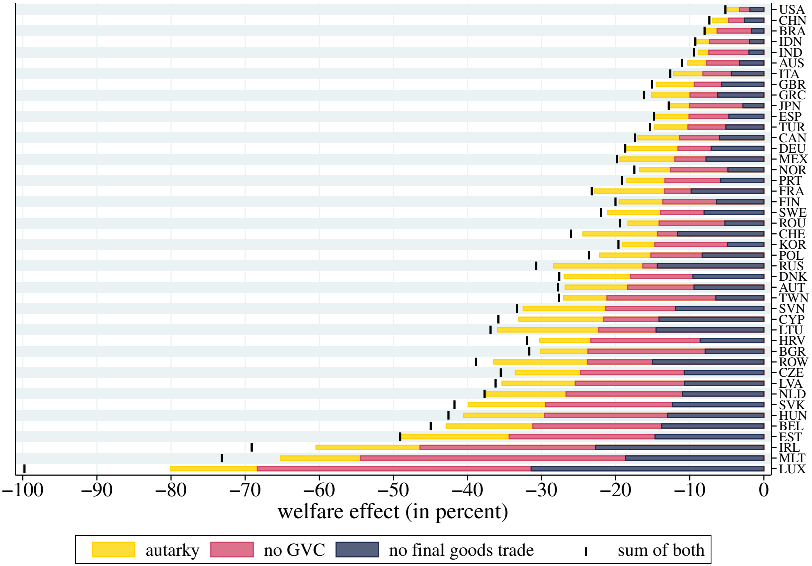
No GVCs vs. no GVCs except within EU



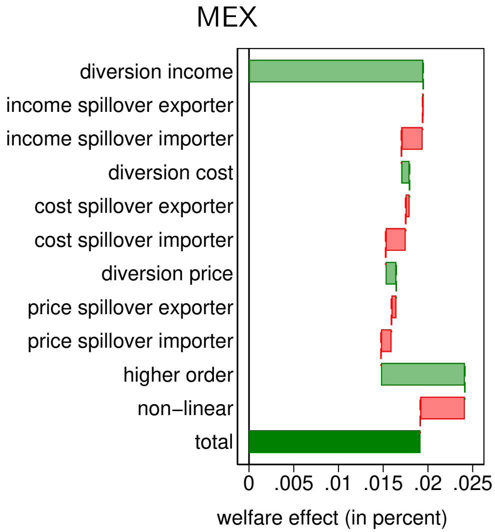
Partial decoupling: Stepwise increase in barriers

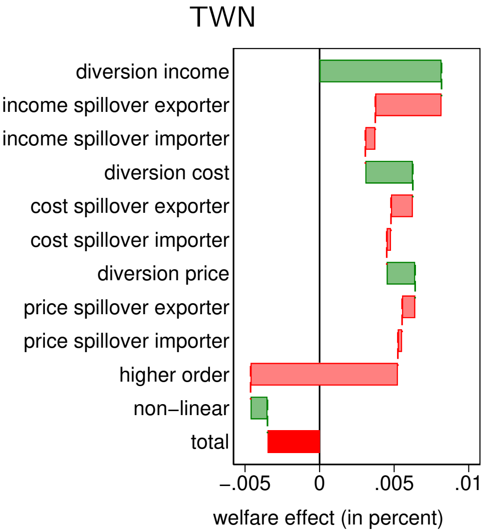


No GVCs vs. no final goods trade vs. autarky

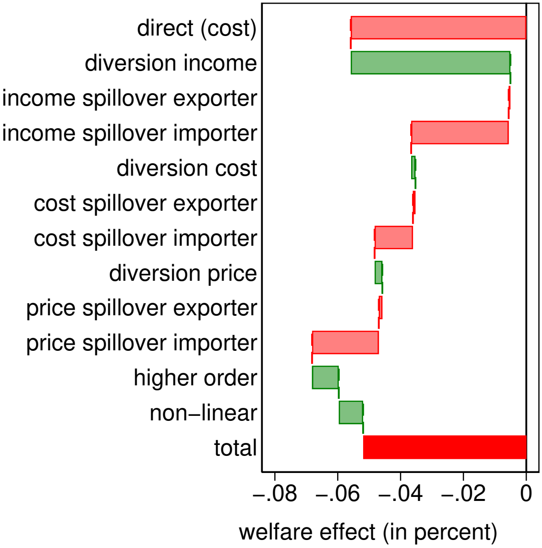


U.S.-CHN Decoupling (10%): Decomposition of effects on MEX, TWN





EU-CHN Decoupling (10%): Decomposition of effects on DEU



Backing out the Covid-19 shock in China

We estimate a large actual shock,. . .
The impact of Covid-19 on China in January–February 2020:

- **Sectoral output drop** due to Covid-19 in China estimated from AR(1) models using **time series** from Chinese official statistics in an **event study**
- Output declines by **around 30%**; large sectoral heterogeneity
- Conceptualize the output drop as the **'zeroth degree' effect** of the shock in China (similar to Allen et al., 2020)
- Use the model to **back out sectoral labor supply shocks**

. . . to simulate a counterfactual scenario:
A permanent negative supply shock confined to China
$\Rightarrow$ **International shock transmission only via trade and GVCs**

Estimating the Covid-19 impact in China

Data

- Bi-monthly sector-level time series from the Chinese National Bureau of Statistics (NBS): revenues deflated by sectoral producer price indices for 23 WIOD sectors in manufacturing and 17 WIOD sectors in services
- Remaining sectors (14% of Chinese output) captured by aggregate services production index

Estimation

- With $\Delta Y_{st} \equiv Y_{st} - Y_{s(t-6)}$, estimate AR(1) models:

$$\Delta Y_{st} = u_{st} \ , \qquad \text{with} \qquad u_{st} = \rho u_{s(t-1)} + e_{st}$$

  by sector on the pre-shock years 2017-2019
- Derive the Covid-19 impact in January–February 2020 as the difference between observed and predicted sectoral output:

$$\textit{Covid-19 impact}_{st} = \Delta Y_{st} - E[\Delta Y_{st}]$$

Data vs. AR(1) prediction for Chinese sectors

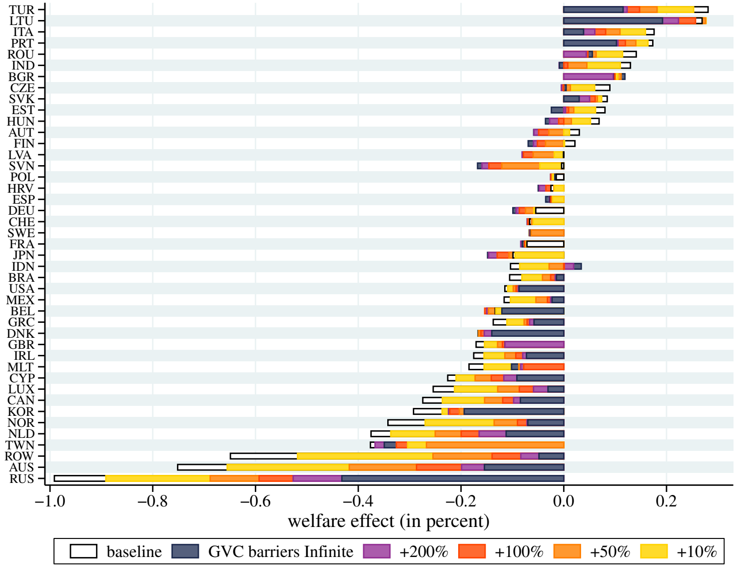
Data (green);
AR(1) model (blue);
predicted effect of
Covid-19 (red)

Variations: Global shock transmission with vs. without GVCs

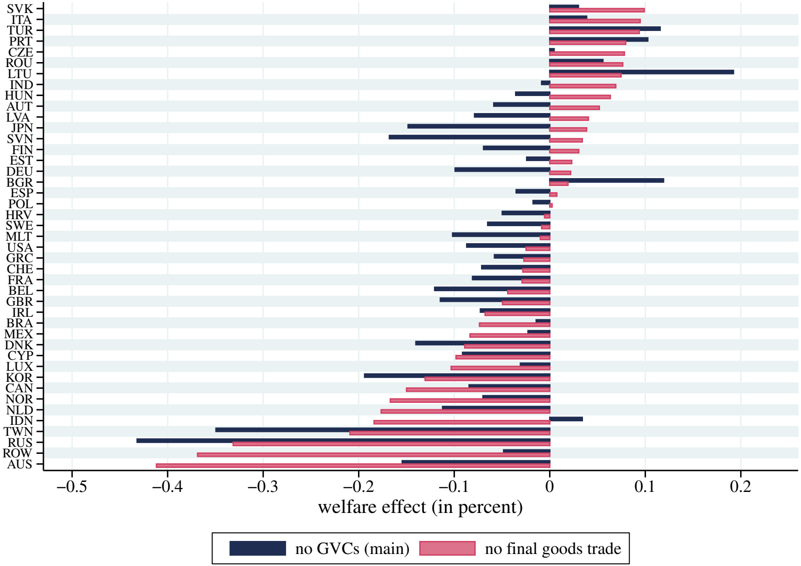
Sensitivity of spillovers after global decoupling:

- Largely monotonic adjustments for stepwise decoupling
- Very different results for shutting down final goods trade (vs. GVCs): 57% correlation of welfare effects across countries
- Decoupling only China: Smaller losses; high correlation
  $\Rightarrow$ Results mainly driven by GVCs directly involving China
- Varying intersectoral labor mobility: High correlation with baseline; greater cross-country dispersion for immobility

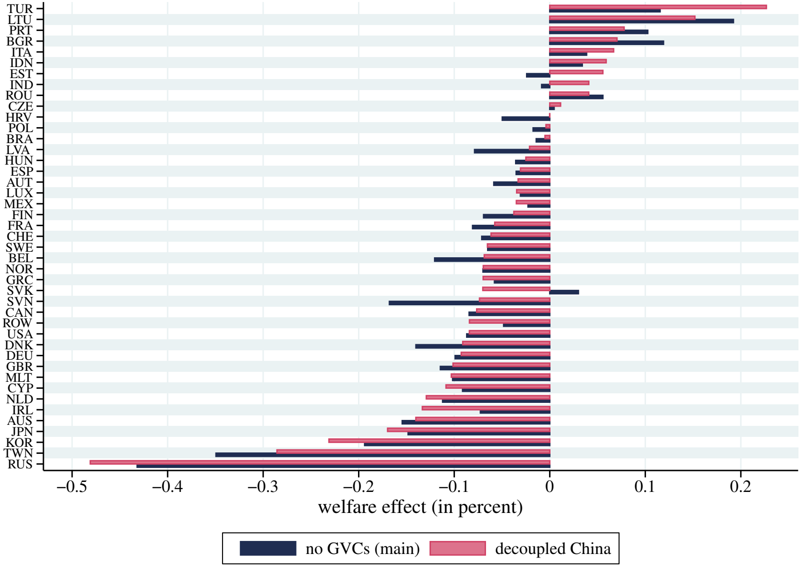
Shock transmission after partial decoupling



Shock transmission without final goods trade



Shock transmission after decoupling China



Shock transmission for varying intersectoral mobility

Shock transmission after U.S. decoupling

Effects of **unilateral U.S. decoupling** and **shock transmission after decoupling** on U.S. welfare in percent:

Scenario	Decoupling	Covid-19 shock (after decoupling)	Cumulative effect (decoupling+shock)	Difference to baseline
	(1)	(2)	(3)	(4)
Baseline		-0.11		
U.S. unilateral GVCs isolationism	-2.18	-0.13	-2.31	-2.20
U.S.–China one-way decoupling	-0.12	-0.09	-0.21	-0.10

- Unilateral decoupling has **almost no mitigating effect**
- Mitigation effects from decoupling **much smaller than direct welfare costs** of decoupling itself
- Same conclusion if China retaliates or U.S. and EU coordinate

Short-run shock transmission

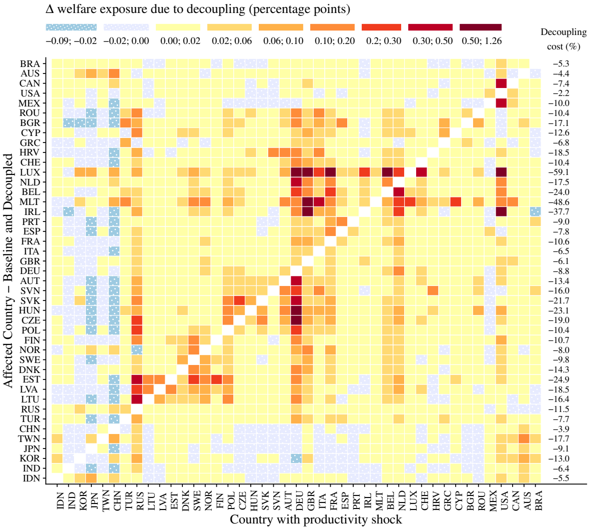
What about **short-run effects?**

- Muted adjustments $\Rightarrow$ Worse effects in the short run?
- Our model: **inter-sectoral labor mobility, now set to zero**
- Another key aspect: (much) **lower elasticities of substitution** across goods in consumption and production
  $\Rightarrow$ Sectoral trade elasticities **scaled down to mean -0.76**, the one-year horizon estimate from Boehm et al. (2020).

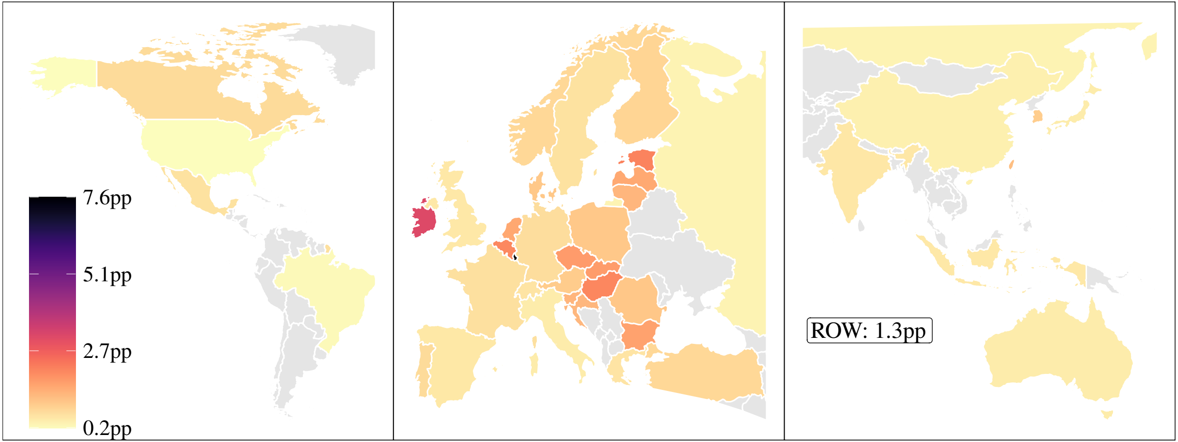
Focus on **U.S.–China** case:

- Short-term spillover from China shock: -0.25% of U.S. welfare
- (Long-run) U.S. welfare costs of one-way decoupling: -0.12%
- Spillover reduced by 0.06pp to -0.19% of U.S. welfare
- Plain comparison: Mitigation too small to warrant decoupling

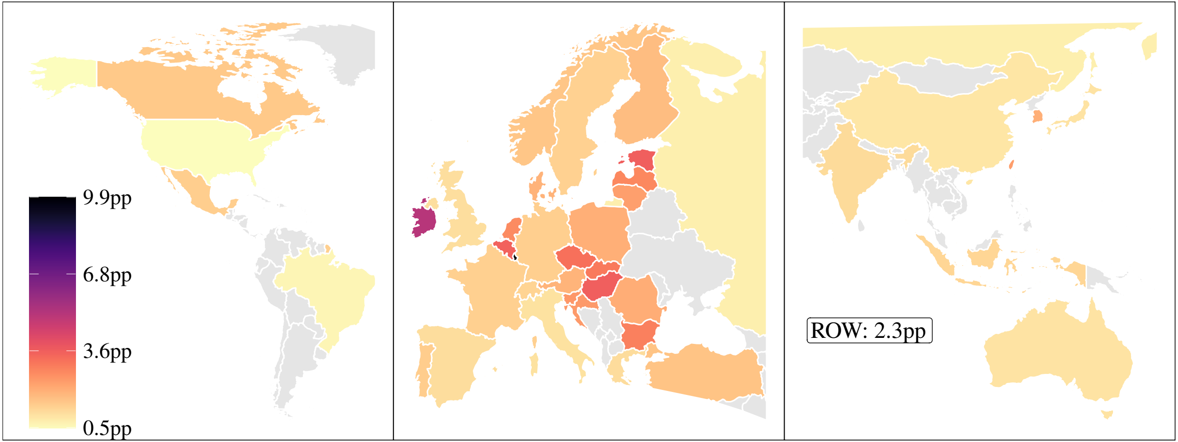
Uniform shocks by country – mitigation effects



Mitigation from unilateral decoupling, global shocks



Unilateral decoupling, global shocks, short run



Calibration of Heterogeneous Firms Model: Details

The number of active firms N_{ijs} is a share of all entrants N_{is}:

$$N_{ijs} = (1 - G_{is}(\theta_{ijs}))\, N_{is}$$

Zero profit cutoff θ_{ijs}:

$$\frac{\theta_{ijs}}{\tilde{\theta}_{ijs}(\theta_{ijs})} = \frac{N_{is} w_i f_{ijs}}{\frac{1}{\sigma_s} X_{ijs}}$$

and free entry:

$$\Leftrightarrow N_{is} = \frac{\frac{1}{\sigma_s} Y_{is}}{w_i f_{is}^e + w_i \sum_j (1 - G_{is}(\theta_{ijs}))\, f_{ijs}}$$

pin down the endogenous cutoffs θ_{ijs} and number of entrants N_{is}

- Obtain number of active firms by link N_{ijs} from AHS data
- Estimate productivity (TFP) θ to obtain sectoral distributions $G_{is}(\theta)$
- Approximate the left tail under assumption of log-normality (better fit than Pareto)

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