

Trade Conflicts' Impact on Innovation

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Motivation: Trade Decoupling



Decoupling: Example



How to Measure the Welfare Effects Decouple?

- Most used trade models: isomorphic, summarize gains from trade by $G \propto (\pi_{ij})^{\frac{1}{\varepsilon}}$ (Arkolakis et al., 2012).
- These models assume **fixed** technology: is that reasonable?
- We build a detailed *dynamic* multi-sector multi-region model, in which innovative ideas diffuse between countries as a by-product of trade;
- We solve the model recursively, fit for *forward-looking* policy experiments;
- We calibrate and estimate the effects of decoupling.

Preliminaries

- We start from the standard GTAP model and incorporate:
 - Ricardian trade (Eaton and Kortum, 2002);
 - Bertrand competition (Bernard et al., 2003);
 - Idea diffusion and trade (Buera and Oberfield, 2020);
 - Multisector idea diffusion through (**our contribution**)

Preliminaries

- Time is discrete and indexed by $t \in \mathcal{T}$.
- There are $d \in \mathcal{D}$ regions.
- In every region, multiple industries $i \in \mathcal{I}$.
- Dynamic model is characterized by a sequence of static equilibria.

International Trade

- Cost of unit input bundles are:

$$c_{s,t}^i = \left[\Psi_{s,t}^{i,f} (pf_{s,t}^i)^{1-\sigma_i} + \Psi_{s,t}^{i,m} (pm_{s,t}^i)^{1-\sigma_i} \right]^{\frac{1}{1-\sigma_i}}$$

- Landed costs are:

$$x_{sd,t}^i(\omega) = \frac{tm_{sd,t}^i \cdot \tau_{sd,t}^i \cdot c_{s,t}^i}{z_{s,t}^i(\omega)} \equiv \frac{\tilde{x}_{sd,t}^i}{z_{s,t}^i(\omega)}$$

- Firms engage in Bertrand competition as in Bernard et al., 2003. Landed prices satisfy:

$$p_{d,t}^i(\omega) = \min \left\{ \underbrace{\frac{\sigma}{\sigma-1} \frac{\tilde{x}_{sd,t}^i}{z_{1s,t}^i(\omega)}}_{\text{optimal monopolist price}}, \underbrace{\frac{\tilde{x}_{sd,t}^i}{z_{2s,t}^i(\omega)}}_{\text{MC of 2nd most productive firm from } s}, \min_{n \neq s} \underbrace{\frac{\tilde{x}_{nd,t}^i}{z_{1n,t}^i(\omega)}}_{\text{MC of most productive firm from other countries}} \right\}$$

International Trade

- **Assumption 1:** We follow the canonical Eaton and Kortum (2002) assumption that and take $z_{s,t}^i(\omega)$ to be the realization of an i.i.d. random variable with Fréchet distribution:

$$F_{s,t}^i(z) = \exp\{-\lambda_{s,t}^i z^{-\theta_i}\}$$

- Given that assumption, we can calculate closed form solution for trade shares

$$\pi_{sd,t}^i = Pr\left(\frac{\tilde{x}_{sd,t}^i}{z_{s,t}^i(\omega)} < \min_{(n \neq s)} \left\{ \frac{\tilde{x}_{nd,t}^i}{z_{n,t}^i(\omega)} \right\}\right) = \frac{\lambda_{s,t}^i (\tilde{x}_{sd,t}^i)^{-\theta}}{\sum_{n \in \mathcal{D}} \lambda_{n,t}^i (\tilde{x}_{nd,t}^i)^{-\theta}}$$

- And prices:

$$p_{d,t}^i = \Gamma_1 \cdot \left(\sum_{n \in \mathcal{D}} \lambda_{n,t}^i (\tilde{x}_{nd,t}^i)^{-\theta} \right)^{-\frac{1}{\theta_i}}$$

Assumptions

- We follow a literature on idea diffusion (Jovanovic and Rob, 1989, Alvarez et al., 2013, Buera and Oberfield, 2020).
- **Assumption 2** - New ideas are a transformation of two rv:

$$\underbrace{z}_{\text{productivity of new idea}} = \underbrace{o}_{\text{original insight}} \times \left(\underbrace{z'}_{\text{derived insight}} \right)^{\beta}$$

$$Pr(O < o) = 1 - \alpha_t o^{-\theta} \quad Pr(Z' < z') = G_{d,t}^i(z'), \quad \beta \in [0, 1)$$

- Therefore, domestic technological frontiers evolve according to:

$$F_{d,t+\Delta}^i(z) = \underbrace{F_{d,t}^i(z)}_{Pr\{\text{productivity} < z \text{ at } t\}} \times \underbrace{\left(1 - \int_t^{t+\Delta} \int \alpha_{\tau} z^{-\theta_i}(z')^{\beta\theta} dG_{d,\tau}^i(z') d\tau \right)}_{Pr\{\text{no better draws in } (t, t+\Delta)\}}$$

Main theoretical contribution

- **Assumption 3** - managers learn from their suppliers, proportional to sourcing decisions:

$$G_{d,t}^i(z') \equiv \sum_{j \in \mathcal{I}} \underbrace{\eta_{d,t-1}^{ij}}_{\text{intermediate cost share}} \sum_{s \in \mathcal{D}} \underbrace{H_{sd,t-1}^{ij}(z')}_{\text{distribution conditional on source}=s}$$

Proposition (Recursive Law of Motion in a Multi-Sector Framework)

Given Assumptions 1-3, in the multi-sector multi-region economy described in the previous section, the country-sector-specific technology parameter evolves according to the following process:

$$\Delta \lambda_{d,t}^i = \alpha_t \Gamma(1 - \beta) \sum_{j \in \mathcal{I}} \eta_{d,t-1}^{ij} \sum_{s \in \mathcal{D}} (\pi_{sd,t-1}^{ij})^{1-\beta} (\lambda_{s,t-1}^j)^\beta$$

Intuition: Within Sector

- To develop intuition, consider a simple 2-country (home and foreign), 2-sector model ($i, -i$). In each sector:

$$\begin{aligned} \Delta \lambda_h^i &\propto \eta^i [(\pi_h^{i,i})^{1-\beta} (\lambda_h^i)^\beta + (1 - \pi_h^{i,i})^{1-\beta} (\lambda_f^i)^\beta] \\ &+ (1 - \eta_d^i) [(\pi_h^{i,-i})^{1-\beta} (\lambda_h^{-i})^\beta + (1 - \pi_h^{i,-i})^{1-\beta} (\lambda_f^{-i})^\beta] \end{aligned}$$

- If a Planner were to choose $\pi_h^{i,i}$ to maximize diffusion, this optimal points would contrast with the Free Trade allocation:

$$\left(\frac{\eta^i \pi_h^{i,i}}{\eta^i (1 - \pi_h^{i,i})} \right)^{\text{Planner}} = \frac{\lambda_h^i}{\lambda_f^i}, \quad \left(\frac{\eta^i \pi_h^{i,i}}{\eta^i (1 - \pi_h^{i,i})} \right)^{\text{Free Trade}} = \frac{\lambda_h^i (x_h^i)^{-\theta}}{\lambda_f^i (\tau \cdot x_f^i)^{-\theta}}$$

- Free trade puts higher weight on source with the cheapest landed cost.

Intuition: Within Sector

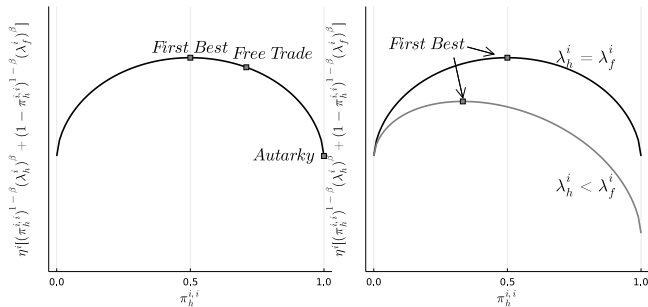


Figure: Within sector idea diffusion functions in a two-by-two economy. The left panel shows the optimal, free trade, and autarky points along the ideas diffusion function when countries are fully symmetric ($\lambda_h^i = \lambda_f^i$). The right panel plots the functions and planner's solutions for the cases when countries have identical productivities $\lambda_h^i = \lambda_f^i$ and the home country is less productive $\lambda_h^i < \lambda_f^i$.

Free parameters increase with the number of sectors

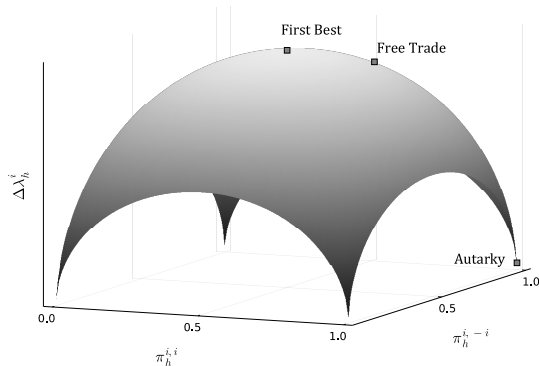


Figure: Idea diffusion function in a two-by-two economy. If countries and sectors are identical and $\eta^i = 1/2$, Planner's, Free Trade, and Autarky allocations are as represented in this figure. The marginal contribution of each sector to total diffusion are as shown in the left panel of Figure 1

Scenarios

- We split the world into a U.S. bloc and a China bloc.
- Trade costs increase between blocs but not within blocs.
- Two scenarios:
 - Full decouple (increase iceberg trade costs by 150%)
 - Tariff decouple (increase tariffs by 36%, cf. Colantone and Stanig, 2018)
- Simulate dynamic model after policy changes for 2021-2040.
- Calculate effects as $\hat{x} = \sum_{t=p}^T (x'_t - x_t) / \sum_{t=p}^T x_t$

Country Groups

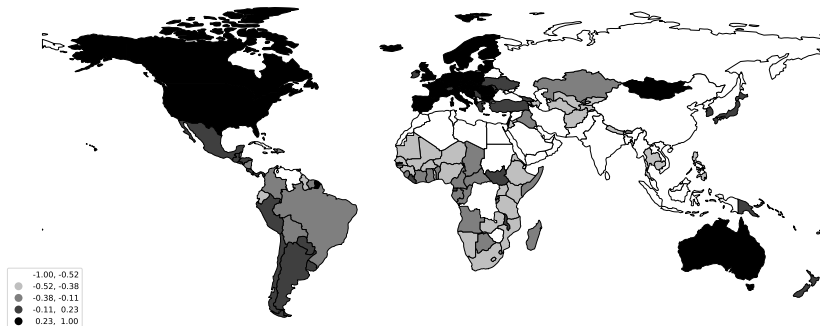


Figure: Differential Foreign Policy Similarity Index. Values are normalized such that 1 represents maximum relative similarity with the U.S. and -1 represents maximum relative similarity with China. The map shows the difference between pairwise similarity indices $\kappa_{i,US} - \kappa_{i,China}$. For more details, see Håge (2011).

Data

- Trade and Input Output Production Data: 2014 GTAP Database (GTAP10A)
- Exogenous path of labor endowments in both high-skilled and unskilled labor: $\{L_{d,t}^i\}_{t \in \mathcal{T}, i \in \{h,u\}} \forall d \in \mathcal{D}$, IMF and UN data.
- 10 regions: China, India, Russia, Rest of China bloc; U.S., Latin America, European Union, Other Developed, Rest of U.S. bloc.
- 6 sectors: Electronic Equipment; Heavy manufacturing; Light manufacturing; Other Services; Primary Sector; Business services.

Calibration: From the Literature

Table: Behavioral parameters

	θ_i	ε_i	σ_i
Primary (agriculture & natres)	10.09	0.146	0.27
Light manufacturing	4.60	-0.2	1.20
Heavy manufacturing	5.99	-0.26	1.26
Electronic Equipment	7.80	-0.26	1.26
Business services	2.80	-0.416	1.26
Other Services	2.90	-0.672	1.42
Source	Hertel et al., 2007	Comin et al., 2021	Hertel et al., 2007

Calibration of β : Simulated Method of Moments

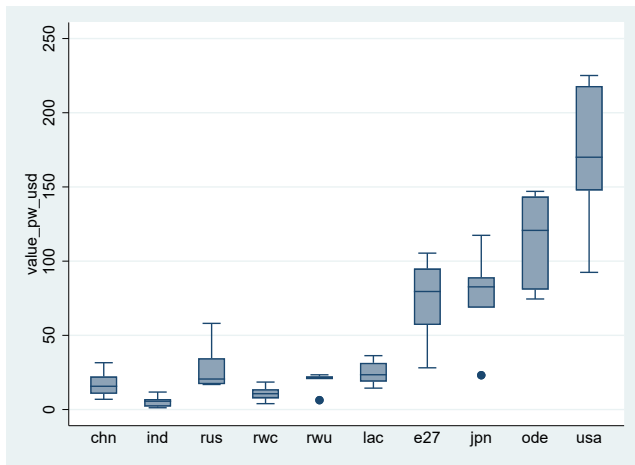
Table: Growth Rate of Real GDP using Different Values of β

β	Mean	St.Dev.	max	min
0.05	1.72	1.13	4.50	0.35
0.10	1.75	1.14	4.54	0.35
0.15	1.80	1.18	4.60	0.36
0.20	1.90	1.22	4.71	0.37
0.25	2.07	1.32	4.90	0.40
0.30	2.39	1.55	5.26	0.46
0.35	3.00	2.06	6.52	0.57
0.40	4.20	3.19	10.62	0.78
0.45	6.61	5.64	18.90	1.20
0.50	11.63	10.89	36.23	2.05
0.55	22.34	22.37	73.63	3.81
0.60	45.89	48.13	157.19	7.57
IMF past data	1.79	1.81	5.67	0.01
OECD SSP2 projections	3.28	2.08	8.14	1.36
<i>N</i>	10			

Calibration of λ

- Assumption: $\lambda_{d,t}^i \propto$ labor productivity.
- Combine SEA-WIOD and World Bank's Global Productivity Database for Value Added and Employment across different sectors.
- Covers x% of global GDP and y% of global labor force

Calibration of λ : Value Added per Worker, 2014



Baseline: Productivity Frontier

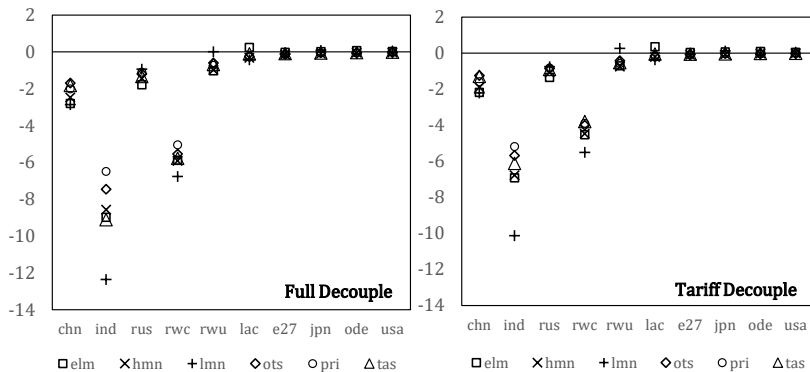


Figure: Cumulative Percentage Change in the Fréchet Distribution location parameter $\lambda_{d,t}^i$, after policy change, by 2040. *Full Decouple* increases iceberg trade costs $\tau_{sd,t}^i$ by 160 percentage points. *Tariff decouple* increases bilateral tariffs $tm_{sd,t}^i$, across groups, by 32 percentage points.

Baseline: Real Income

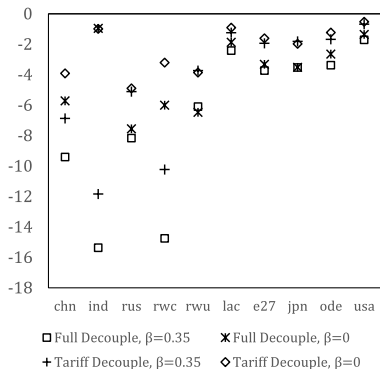


Figure: Cumulative Percentage Change in Real Income, after policy change, by 2040. *Full Decouple* increases iceberg trade costs $\tau_{sd,t}^i$ by 160 percentage points. *Tariff decouple* increases bilateral tariffs $tm_{sd,t}^i$, across groups, by 32 percentage points.

Multi-sector vs. Single-Sector Framework

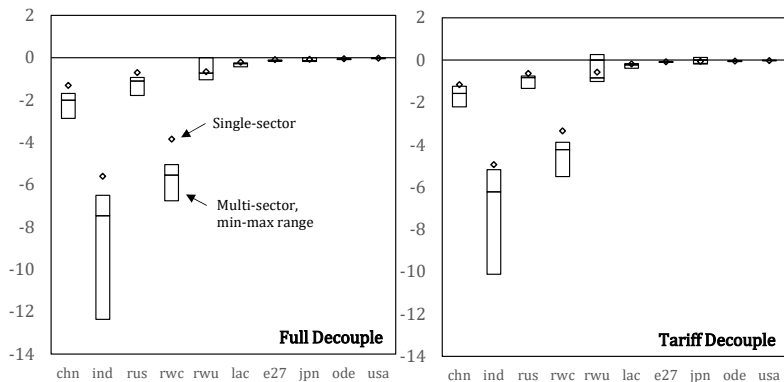


Figure: Multi-sector vs. Single-sector: Cumulative Percentage Change in the Fréchet Distribution location parameter $\lambda_{d,t}^i$, after policy change, by 2040.

Consequences of bloc membership

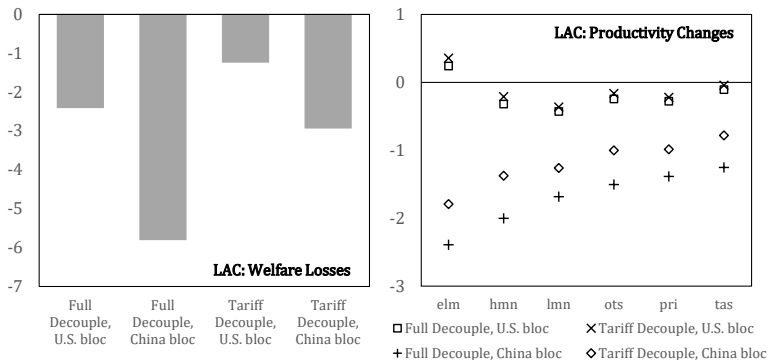


Figure: Left Panel: Cumulative Percentage Change in Real Income in LAC Region, by scenario. Right Panel: Cumulative Percentage Change of the Fréchet Distribution scale parameter $\lambda_{d,t}^i$ in LAC Region, by scenario.

Decoupling in a specific sector

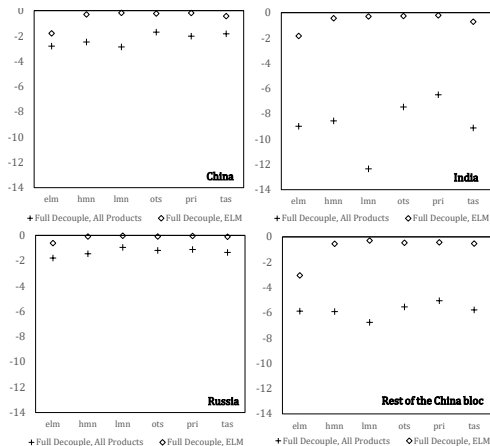


Figure: Cumulative Percentage Change of the Fréchet Distribution scale parameter $\lambda_{d,t}^i$, by scenario.

Conclusions

- Including an ideas diffusion mechanism can substantially increase welfare losses when modelling large scale trade conflicts.
- Multi-sector framework exacerbates diffusion inefficiencies; important for more realistic policy experiments.
- Dynamic costs of trade decoupling can be very large for developing countries.
- If decoupling happens in a restricted number of sectors, losses are limited.