

# The Dynamics of Trade Fragmentation: a Network Approach.

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The views expressed in this presentation are those of the authors and **do not** necessarily represent the views of the Bank of Spain and the Eurosystem.

## **Trade fragmentation is among the main threats to economic outlook.**

- / Sanctions on Russia as a major driver of the EU economy in the recent period.
- / Trade decoupling from China could have even grimmer consequences.

### **What consequences should we expect?**

- / Propagation even if only a small fraction of firms are directly exposed.
- / Time as a key factor: much more difficult to substitute suppliers in the short run.
- / Differences by types of goods: (non-durable) intermediate or capital goods.
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## Dynamic Network Approach: multiplier effects and trade rerouting

- / **Trade elasticities** increase over time.
  - Easiness to substitute suppliers reduces misallocation.
  - Head and Mayer (2014), Fontagné et al. (2022), Boehm et al. (2023)
- / Trade disruption affects price of (imported) **investment goods**.
  - Negative capital contribution piles up over time.
  - Intertemporal substitution: delay investments to periods with higher elasticities
  - Vom Lehn and Winberry (2022), Foerster et al. (2022)
- / **Anticipation** response to trade fragmentation.
  - Stock-piling of investment goods from opposite bloc prior to trade fragmentation
  - Khan and Khederlarian (2021)
- / Consumption: households discount less severe future costs.
- / **Implications:** different time profile (Attinasi et al. (2023), Baqaee et al. (2023))

## Dynamic multi-sector, multi-country model with intermediate inputs and investment goods networks.

- / Sectors and households source their intermediate inputs or consumption goods from other sectors and countries.
- / Sectors also use other sectors' output for their investment bundles.

### Scenarios

- / Simulate scenarios of moderate (*Back to 90s*) or severe (*Cold War*) trade fragmentation.
  - // 3 geopolitical blocs: Western, Eastern and Neutral countries.
  - // Introduce iceberg cost to trade between blocs.
- / Sudden (*Cold turkey*) or anticipated shock.

# Model

# Production Side

## Dynamic model with production and investment networks.

Firms produce with  $((KL)E)MS$  structure.

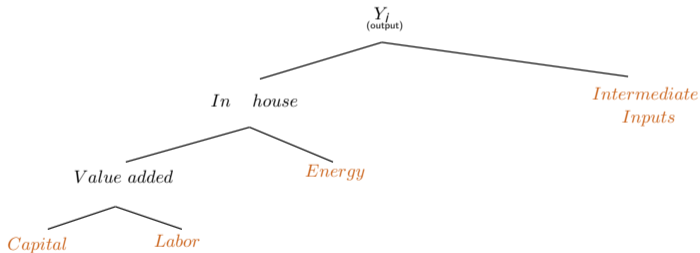
1. Value added:

Capital and labor

2. Energy

3. Material and services from other firms

Aggregated under CES





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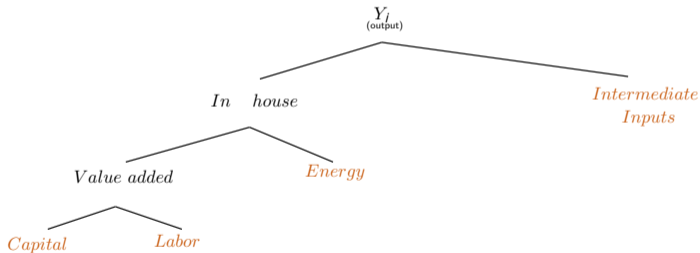
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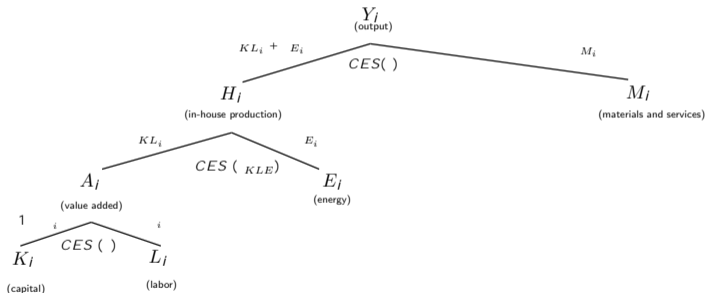
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# Production Side

Firms combine output from other sectors to produce:

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2. Intermediate Inputs bundle,  $M_i$

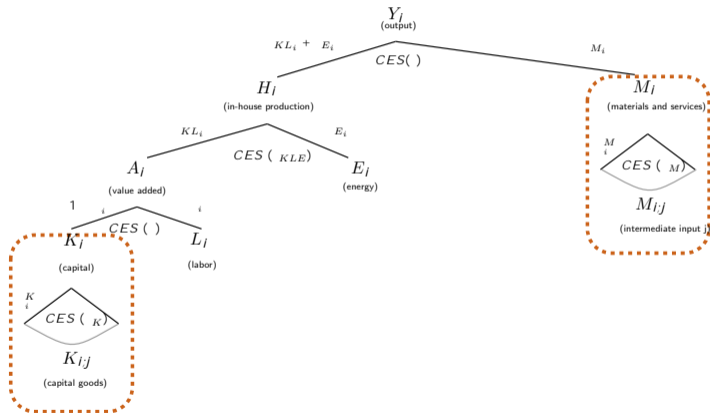
Weight matrices,  $\frac{K}{i}$  and  $\frac{M}{i}$

CES with elasticities,  $K$  and  $M$

Firms combine different local varieties of each sector:

Importance of each local variety,  $\frac{K}{i,j}$  and  $\frac{M}{i,j}$

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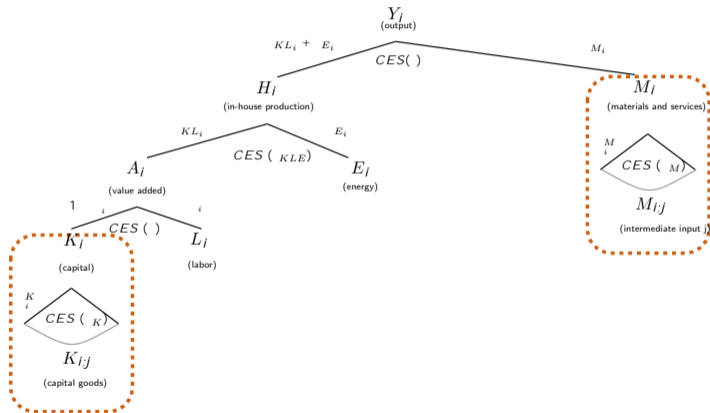
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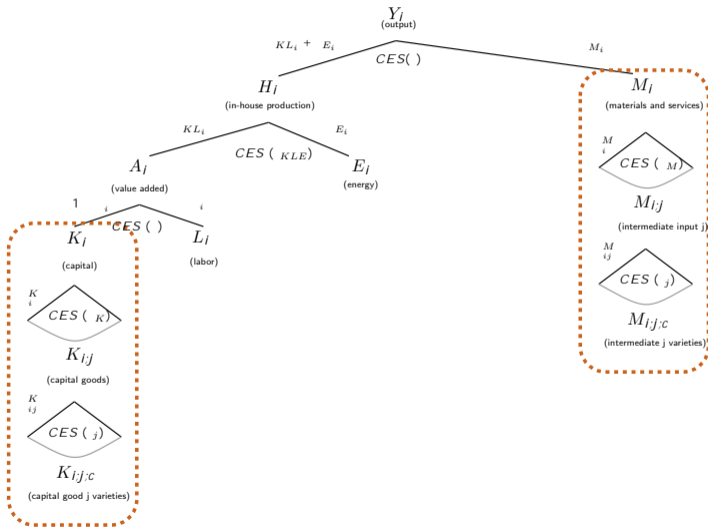
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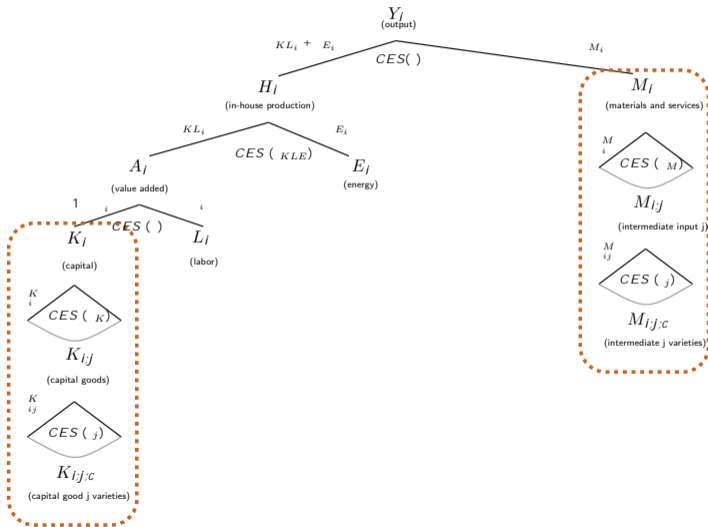
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## Production Side: Investment

Each sector accumulates each of the capital goods for the following period. The process of capital accumulation is

$$K_{ijc;t+1} = (1 - \delta_j) K_{ijc;t} + I_{ijc;t} - \frac{\zeta}{2} \left( \frac{K_{ijc;t+1}}{K_{ijc;t}} - 1 \right)^2 \quad (1)$$

where  $\delta_j$  is the rate of depreciation of good  $j$ . Firms face convex adjustment cost to change their level of capital.

## Production Side: Investment

Firm  $i$  uses different capital goods from other sectors  $j$

$$K_i = \left( \sum_{j=1}^S K_{ij}^{\frac{\sigma_K - 1}{\sigma_K}} \right)^{\frac{\sigma_K}{\sigma_K - 1}} \quad (1)$$

where  $K_{ij}^K$  represents the importance of the investment good  $j$  for firm  $i$ .

Firms also combine different national varieties of each type of capital good

$$K_{ij} = \left( \sum_{h=1}^C \lambda_{ijh}^K K_{ijh}^{\frac{\xi_{j,t} - 1}{\xi_{j,t}}} \right)^{\frac{\xi_{j,t}}{\xi_{j,t} - 1}} \quad (2)$$

where  $\lambda_{ijh}^K$  represents the importance of the variety from country  $h$  of investment good  $j$  for firm  $i$ .



## Production Side: Investment

The investment input-output network allows us to express the cost of the capital bundle of firm  $i$  (that belongs  $c$ ) can be expressed by:

$$P_{i,j}^I = \left( \sum_{h=1}^C \lambda_{ijh}^K (\tau_h^c P_{jc})^{1-\xi_{j,t}} \right)^{\frac{1}{1-\sigma_K}} \quad P_i^I = \left( \sum_{j=1}^S K_{ij} P_{ij}^{I,K} \right)^{\frac{1}{1-\sigma_K}}$$

Source of gradual capital adjustment. sudden increase (decrease) in investment demand endogenously increases (decreases) the price of the investment bundle

## Nominal Variables

Trade decoupling increases the relative price of intermediate inputs and capital compared to labor.

Pin down nominal variables assuming wage rigidities.

Two cases:

- 1 *i* Nominal rigidities (i.e.  $\hat{W}_{i,t} = W_{i,t}$ )
- 2 *i* Partial backward adjustment (i.e.  $\hat{W}_{i,t} = 1/3 \pi_{i,t} + 1/3 \pi_{i,t-1}$ )

Nominal exchange rates adjust freely for trade balance.

# Data and Calibration

## Production parameters and trade information

- / Inter Country Input Output (ICIO), OECD, *year 2019*.
  - Complemented with Figaro (Eurostat)
- / 44 sectors and 66 countries.
- / Calibrate production shares for factors, energy and intermediate inputs.
  - $\alpha_i, \eta_i, M, M, E, E$

**Issue:** no data availability post Ukraine invasion.

- Trade decoupling from Russia has *already* taken place.

- 1 / Simulate trade decoupling between Russia and the West.
- 2 / Use predicted changes in trade flows to recompute IO matrices.

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# Data and Calibration

## Investment input-output matrix.

Open economy version of Vom Lehn and Winberry (2022) or Foerster et al. (2022)

Equivalent to standard intermediate inputs IO matrix for investment goods.

Combine two sources:

- 1 / **ICIO Database**: trade flows of investment goods from sector-country to country.
  - . *German vehicle manufacturing sector sells 100\$ as investment goods to Spain*
- 2 / **KLEMS Database**: sector-country investment in by type of assets (and depreciation rates).
  - . *Land transportation sector accounts for 70% investment in transportation equipment in Spain*

Need to create a **bridge file**: from NACE sectors to type of assets.

# Data and Calibration

## Trade Elasticities:

Fontagné et al. (2022), long-term sector-specific estimates.

- / Significantly lower elasticities in the short run:  $\xi_{i;t=1} = 0.75$
- / Assume that elasticities grow linearly between up to long-run values over 10 years.

## Other production elasticities:

- / Labor-capital elasticity  $\theta_{KL}=0.9$ ; the elasticity between intermediate inputs and in-house production  $\theta= 0.5$ ; Elasticity between intermediate inputs ( $\sigma_M$ ), energy sources ( $\sigma_E$ ) and capital goods ( $\sigma_K$ ) equal to 0.2. Household consumption across sectors  $\sigma_C = 0.9$ . Value-added and energy,  $\theta_{KLE} = 0.4$ .

Atalay (2017) and Baqaee and Farhi (2024)

# Trade Disruption

Trade disruption modelled as **increasing** the cost of trade among blocs.

**Iceberg costs**, governments do not collect **tariff revenues**.

Applied for all trade between West-East, not with Neutral bloc.

- Intermediate, investment and consumption goods.

This exercise: **150%** iceberg cost.

*/* Roughly implies a return to Cold War trade levels

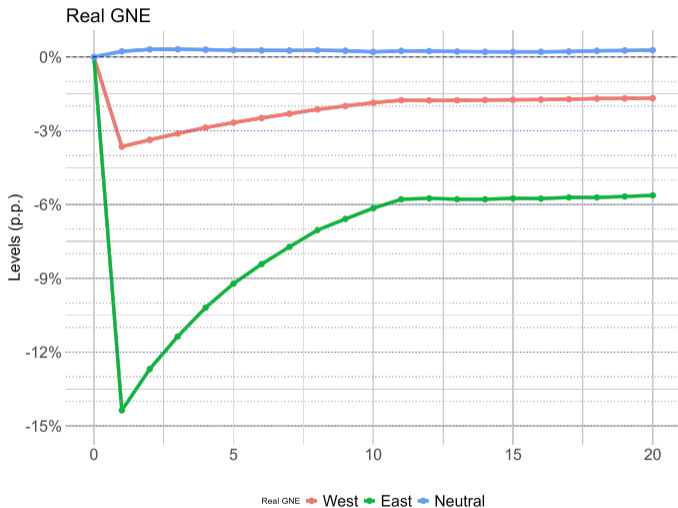
## Country Bloc Classification

<b>West</b>	<b>East</b>	<b>Neutral</b>
European Union	China	Rest of the world
United States	Hong Kong	
United Kingdom	Russia	
Canada		
Japan		
South Korea		
Norway		
Switzerland		
Australia		
New Zealand		
Israel		
Taiwan		

▶ Go to Trade Across Blocs



# Results



## Cold War scenario: Sudden Trade Disruption

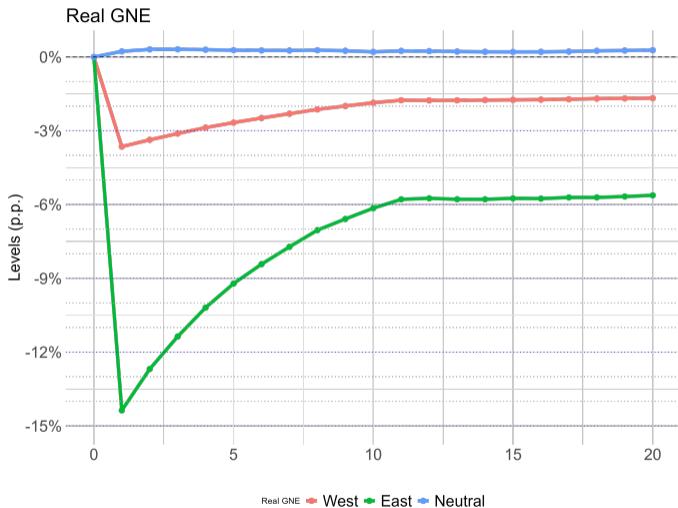
/ Long-term GNE losses in the West close to 1.6 p.p. **GDP**

/ Greater losses in the East.

/ Small gains for Neutral.

/ Within the West, Europe is relatively less exposed. **Russia**

/ Key: Short-term losses can be significantly higher.



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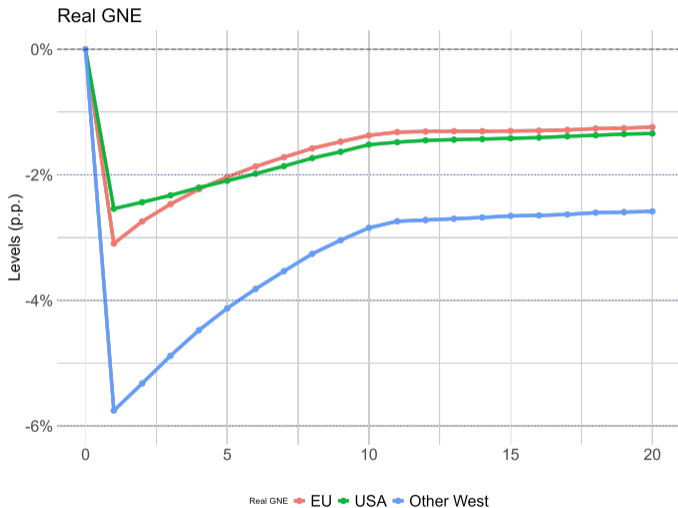
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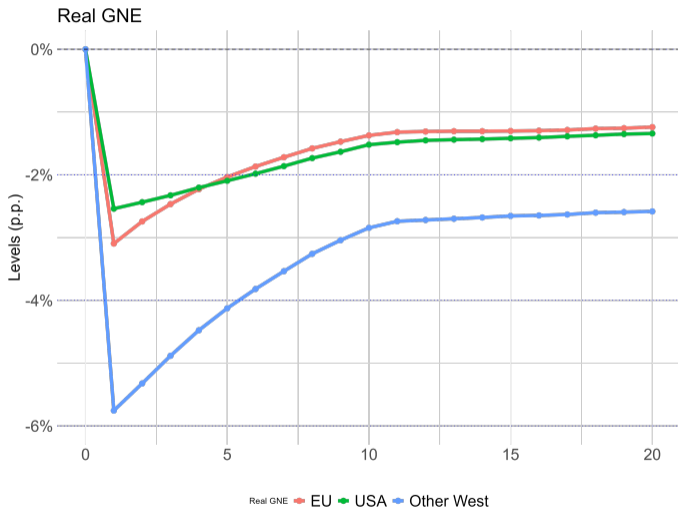
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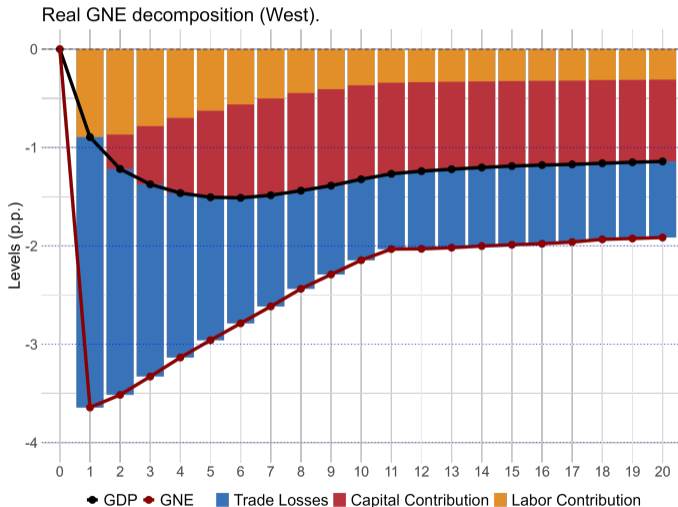
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/ The contribution of lower investment appears gradually.

/ Non-linearities determine the shape of the effect:

Initial shock and subsequent growth or U-shape.

Inflation

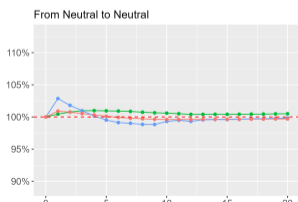
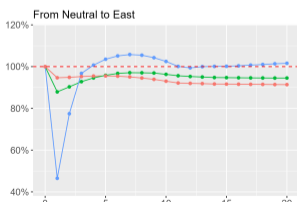
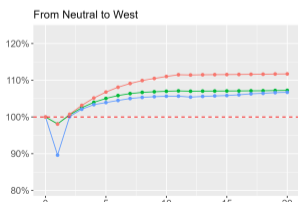
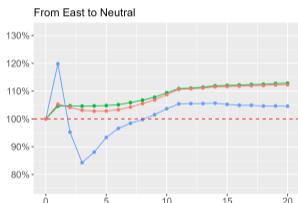
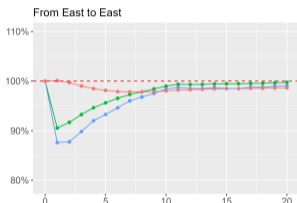
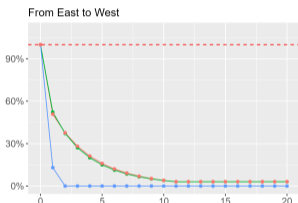
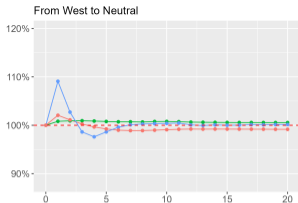
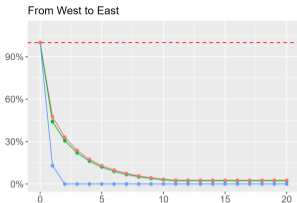
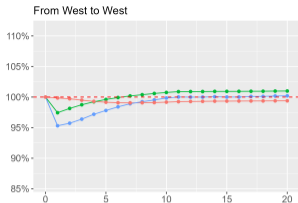


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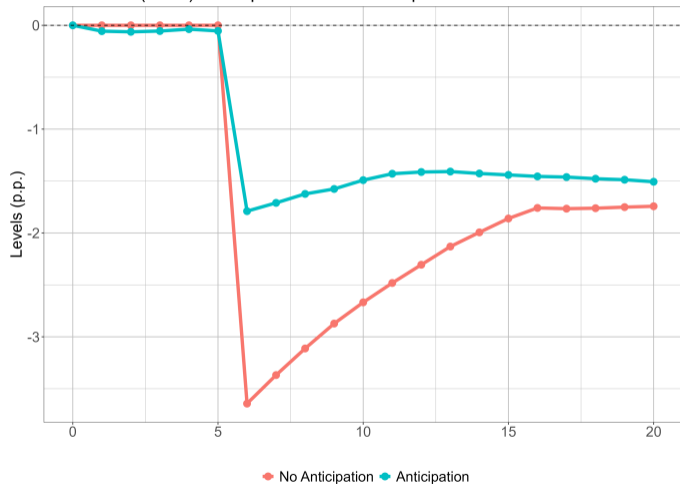
Inflation



—●— Consumption —●— Intermediate inputs —●— Investment goods

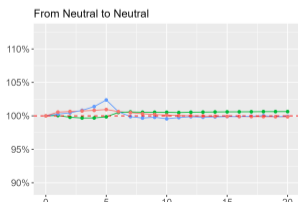
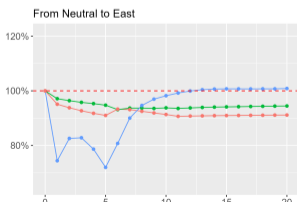
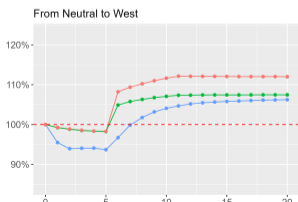
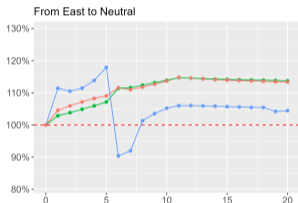
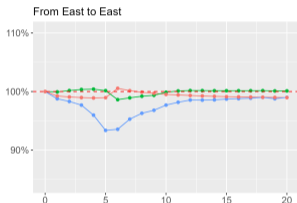
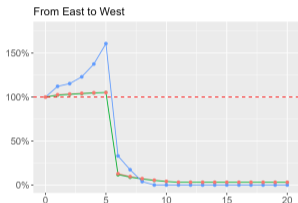
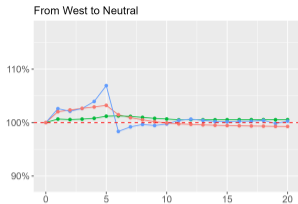
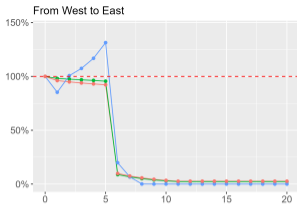
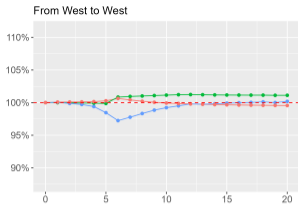


Real GNE. (West). Anticipation vs. No Anticipation Scenario

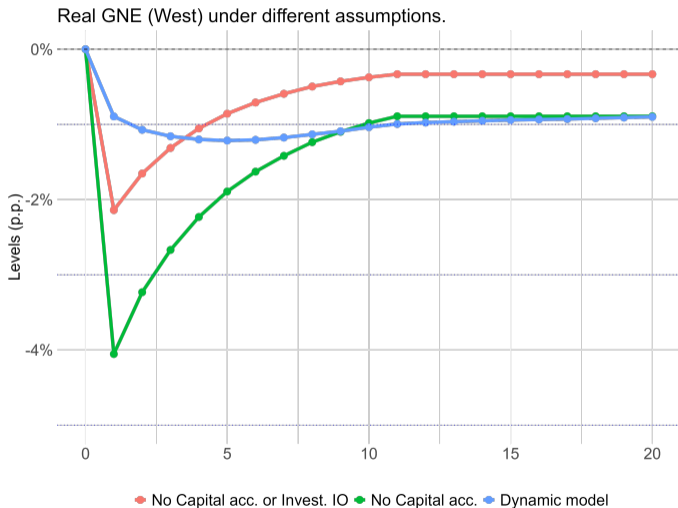


## Sudden vs. Anticipated Trade Disruption

- i* With anticipation, GDP level losses are substantially smaller in the short term
  - Equal in the long term.
- i* Higher elasticity of substitution and lower costs of new suppliers.
- i* Stockpiling of investment goods from opposite blocs.
- i* Small pre-shock losses: *statically* inefficient investments.



— Consumption — Intermediate inputs — Investment goods



## What is the contribution of capital accumulation and investment matrix?

Two comparisons:

- 1/ No capital dynamics (full within period depreciation) and no price of investment bundle.
- 2/ No capital dynamics (full within period depreciation) but price of investment bundle.
  - i* Gradual depreciation reduces the short-term impact.
  - i* The price of the investment bundle increases the long-term effects.

## Main results:

- i* Moderate **long-run** effects in Western economics:
  - ii* Between 0.8pp and 1.7pp level effect on GNE over 10-year horizon depending on the degree of trade fragmentation (60% or 95% trade reduction between blocs).
  
- i* Potentially large **short-run** effects with sudden trade trade stop:
  - ii* Up to 4pp GDP loss over first 3 years in the Cold War (severe) scenario.
  - ii* In the short run disruption of intermediate inputs GVC has stronger effect. In the long run the lower stock of capital becomes more relevant.
  
- i* **Anticipation** allows a smoother (*from above*) transition.
  - ii* Pre-shock: increases trade of investment goods *across* blocs.
  
- i* More severe effects for **Eastern** bloc: between 3pp and 6pp lower GDP level.
- i* Small gains for **neutral** countries: between 0.1pp and 0.5pp higher GNE.
  - ii* Gains from trade rerouting but mitigated by lower world GDP.

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## Households

Households' preferences are represented by the function

$$U = \mathbb{E}_0 \sum_{t=0}^T \beta^t \left( \log C_t + \frac{L_t^{1+\mu}}{1+\mu} \right) \quad (1)$$

where  $\mu$  is the Frisch elasticity of labor supply and  $\beta$  the discount factor.

$$C_i = \left( \sum_{j=1}^S c_{ij} C_{cj}^{\frac{\sigma_C-1}{\sigma_C}} \right)^{\frac{\sigma_C}{\sigma_C-1}} \quad (2)$$

where the  $(i, j)$  element of matrix  $C$  represents the importance of goods from sector  $j$  on the basket consumption of country's  $i$  household.



## Trade Across Blocs

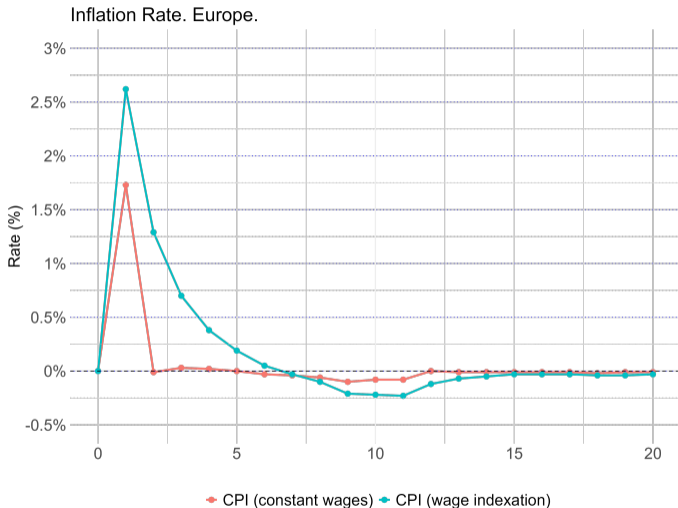
	Total			Final Consumption		
	West	East	Neutral	West	East	Neutral
From West	–	4.3	9.2	–		
From East	1.6	–	2.7		–	
From Neutral	3.1	2.5	–			–
	Intermediate Inputs			Investment Goods		
	West	East	Neutral	West	East	Neutral
From West	–			–		
From East		–			–	
From Neutral			–			–

Imported shares from origin blocs over total consumption by type of goods and services.

## Trade Across Blocs

	Total			Final Consumption		
	West	East	Neutral	West	East	Neutral
From West	–	4.3	9.2	–	3.7	6.7
From East	1.6	–	2.7	1.3	–	1.6
From Neutral	3.1	2.5	–	2.1	2.0	–
	Intermediate Inputs			Investment Goods		
	West	East	Neutral	West	East	Neutral
From West	–	4.8	10.6	–	3.6	11.5
From East	1.8	–	3.2	2.2	–	4.1
From Neutral	4.1	3.1	–	2.4	0.8	–

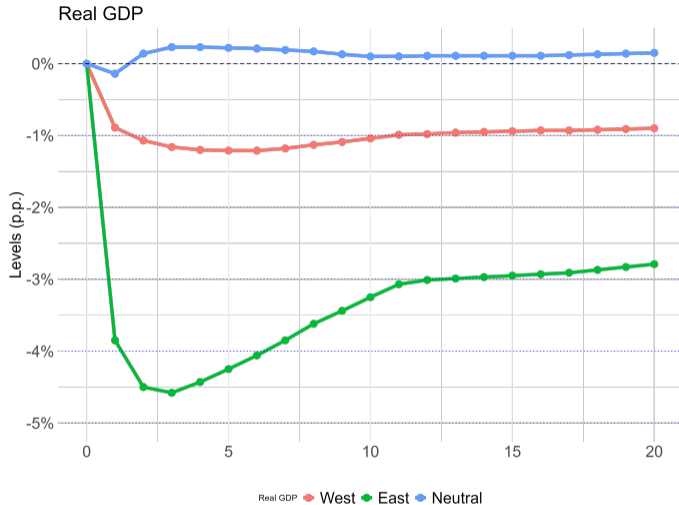
Imported shares from origin blocs over total consumption by type of goods and services.



## Cold War scenario: Sudden Trade Disruption

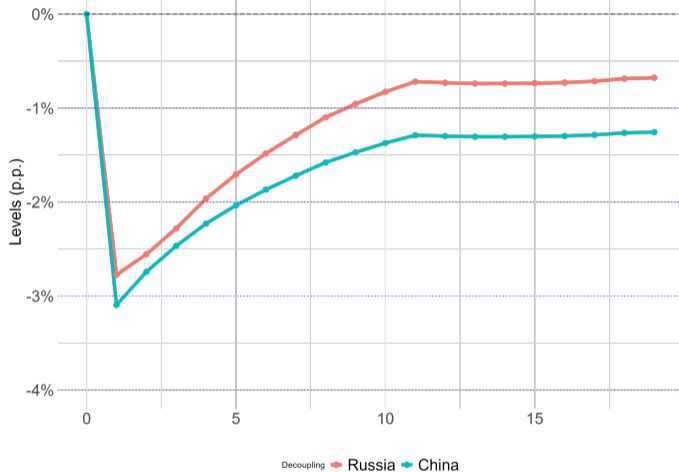
- / Trade fragmentation significantly increases the cost of other factors relative to labor.
- / Wage indexation can lead to significant second-round effects.

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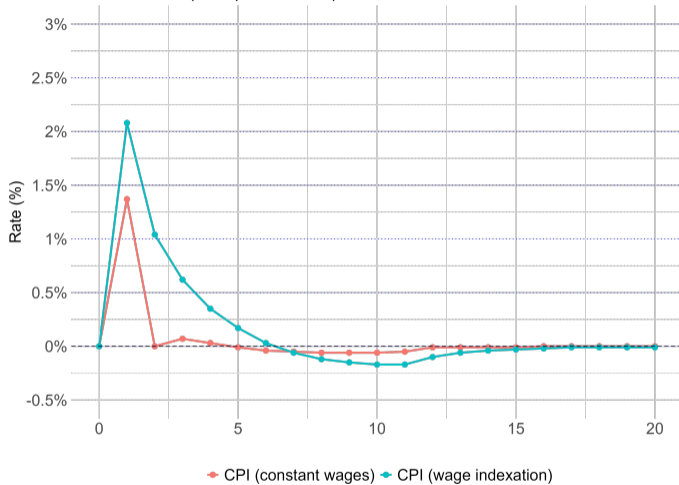
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## Real GNE (European Union)



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### Inflation Rate (European Union)



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