The Dynamics of Trade Fragmentation: a Network approach.*

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Abstract

In this paper we analyze the possible consequences of trade fragmentation between large geopolitical blocs. To conduct the analysis, we develop a multi-sector, multi-country model with production and investment networks that capture the linkages both between different sectors and between countries. We simulate different scenarios of trade decoupling between the Western bloc (mainly EU, US and allies), the Eastern bloc (China and Russia) and a third group of neutral countries. In the different scenarios, we simulate an increase in trade costs between the countries of the opposing blocs that replicates a decline in international trade to Cold War levels. In addition, we include simulations in which such trade disruptions may or may not be anticipated by firms. A return to a Cold War-like trade scenario would imply a short-term decline of up to 5% of real national income in the Western bloc and up to 14% in the Eastern bloc. The long-term effects would be mitigated by greater substitutability between suppliers, but the impact would still be significant, with GDP falling by 2% and 6% respectively. In the long run, the increase in the cost of capital goods and the resulting decline in the capital stock would account for more than half of the negative effects.

*The views expressed in this paper are the authors' and do not necessarily reflect those of the European Central Bank, Banco de España or the Eurosystem. We thank for their help... Correspondence to: Javier Quintana (javier.quintana@bde.es)

1 Introduction

Geopolitical tensions are currently one of the main threats to the world economy outlook. For example, the consequences of the trade embargo imposed on Russia following its aggression against Ukraine have significantly impacted the European economy in the post-pandemic period. Looking ahead, a hypothetical trade decoupling between major geopolitical blocs, which could lead to a reduction in international trade and partially or entirely undo the globalization process of recent decades, may have even greater implications for growth. As a result, a significant policy debate has emerged regarding the feasibility and costs of reducing dependence on potentially adversarial countries, as well as the costs that such a process might entail. Therefore, it is necessary to gain a better understanding of the expected effects of trade fragmentation, the mechanisms through which they would manifest, and the differences across various time horizons.

We analyze the possible consequences of trade fragmentation between large geopolitical blocs. We simulate different scenarios of trade decoupling between the Western bloc (mainly Europen Union, US, and allies), the Eastern bloc (China and Russia) and a third bloc of neutral countries.

To conduct the analysis, we develop a dynamic general equilibrium multi-sector, multi-country model with production and investment networks that capture linkages both between different sectors and across countries. Sectors use intermediate inputs for their production, which they either purchase from other sectors in the economy or import from other countries. Crucially, we also allow for the propagation of sector-specific shocks through the investment network. For their investment bundles, they use capital goods that are as well either produced by other sectors of the economy or imported from foreign producers.

We use a novel investment network to capture the propagation of shocks through the supply and demand of capital goods and services. We construct the network combining two

data sources. On the one hand, information from national accounts data on the types of assets in which each sector-country invests and, on the other, data on cross-country gross fixed capital formation flows extracted from standard world input-output tables. Similarly to the input-output tables for intermediate goods, this matrix allows us to identify the importance that the sector-country j has in the investment bundle of another sector-country i, and thus to trace the effects that a specific shock to the former has on the investment and production decisions of the latter.

This a novel contribution to the study of the international propagation of shocks. Network models typically focus only on the transmission of firm shocks through the supply of intermediate inputs, given the lack of readily available data sources for a multi-country investment matrix.[1] However, in the context of trade fragmentation, models that do not include the investment network dimension would miss an important part of the effect. A first reason is that the deep economic integration that occurred over the past decades was mainly reflected in the growth of firm to firm trade, not only in intermediate goods, but also in increased dependence on other countries for the supply of capital goods. In fact, although trade flows in intermediate goods are much larger in absolute terms, the degree of dependence between blocs is similar in the case of investment goods. Thus, the negative effects of trade fragmentation would be amplified by making capital goods more expensive and thus reducing the rate of investment.

Another reason is the durable nature of capital goods, as opposed to non-durable intermediate inputs. This has implications for the dynamics and time profile of the consequences of trade fragmentation. An increase in the cost of trade in capital goods may have an immediate impact on trade flows and investment rates, but given the non-full depreciation of capital, the negative effects of a lower capital stock build up gradually over time rather than suddenly as in the case of non-durable intermediate inputs.[2]

[1] cite Vom Lehn and Winberry (2022), Foerster et al. (2022) with a matrix only for the US

[2] An example to illustrate the importance of this channel would be to compare the different economic impacts of stopping natural gas imports from Russia into the European Union with the hypothetical impact of restricting imports of solar panels from China. While both have a relevant weight in the energy supply chain in Europe, natural gas is a consumable input with limited ability to be stored, whose annual consumption

In addition, this model can also provide insights to the dynamics of the effects of trade shocks. Two main forces determine their time profile. First, the ability to substitute between different national suppliers of a given sector. According to the literature (see Head and Mayer (2014) or Boehm et al. (2023)), the ability of firms to switch suppliers from different countries in the same sector is very limited in the short run, which amplifies the negative effects of a trade disruption. Over time, however, the cost of substituting across suppliers declines, reducing the aggregate impact of the diversion of imports from the opposite bloc. Second, trade decoupling also affects the dynamics of capital accumulation. The higher cost of capital goods imported from the opposite bloc makes investment more expensive and reduces the desired level of capital by firms. This depresses the level of investment for a number of periods as firms gradually depreciate their level of capital. Thus, the increased ease of redirecting imports from the opposite bloc gradually reduces the severe negative short-term effects, while the effects of a lower capital stock accumulate over time.

2 Related literature

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We utilize a dynamic general equilibrium version of the model by Baqaee and Farhi (2019), where the dynamics arise from changes in the elasticity of substitution over different periods as well as from the forward-looking behavior of agents regarding consumption and investment, and the capital dynamics exposed to adjustment costs. Huo et al. (2024) model a global network model with capital accumulation. We enhance this model by adding an input-

must be imported in its entirety each year. Therefore, a disruption in its imports has to be accommodated almost immediately in firms' production through input substitution or with a limited ability to find new suppliers. On the other hand, a halt in imports of new solar panels from China would not immediately affect electricity generation in Europe because of the stock of panels already installed. While it might affect capital accumulation in the medium to long term, the long-lived nature of such goods allows for a greater degree of adjustment in finding new suppliers of these materials. This example illustrates the importance of taking into account the time horizon needed to replace imports of different materials when discussing strategic autonomy.

output matrix of investment goods, allowing us to estimate the cost of trade fragmentation on the price of investment goods. This IO matrix for investment is constructed in the spirit of Vom Lehn and Winberry (2022) and Foerster et al. (2022); however, while they build it only for the USA, we have a global-level matrix.

Our results critically depend on the evidence from the literature regarding the values of elasticity of substitution in international trade, considering both their different levels across sectors (Fontagné et al. (2022)) and the variations of these values in the short and medium term (Boehm et al. (2023)).

Several papers already analyze the impact of potential trade fragmentation, with a particular focus on its impact on various European countries (Attinasi et al. (2023) or Baqaee et al. (2023)). Compared to these studies, our work enriches the analysis by providing more detailed mechanisms regarding the dynamics of the impact, especially the role of capital accumulation in this process.

3 Model

We analyze the consequences of trade fragmentation using a dynamic general-equilibrium open-economy network model. The model includes production networks through which firms supply both intermediate inputs and investment goods to other sectors of their economy as well as to other countries. Within each country $c \in \mathcal{C}$, a representative competitive firm produces the country's variety of sector $s \in \mathcal{S}$. The output of each firm $i \in \mathcal{N} \equiv \mathcal{C} \times \mathcal{S}$ is traded to be used as an intermediate input or installed as a capital good by any other firm j, or as final consumption by households in some country c. The representative household of each country endogenously supplies labor and owns the firms of their respective country. Households use national income from both labor and capital income to consume a bundle of goods and services from each sector-country pair.

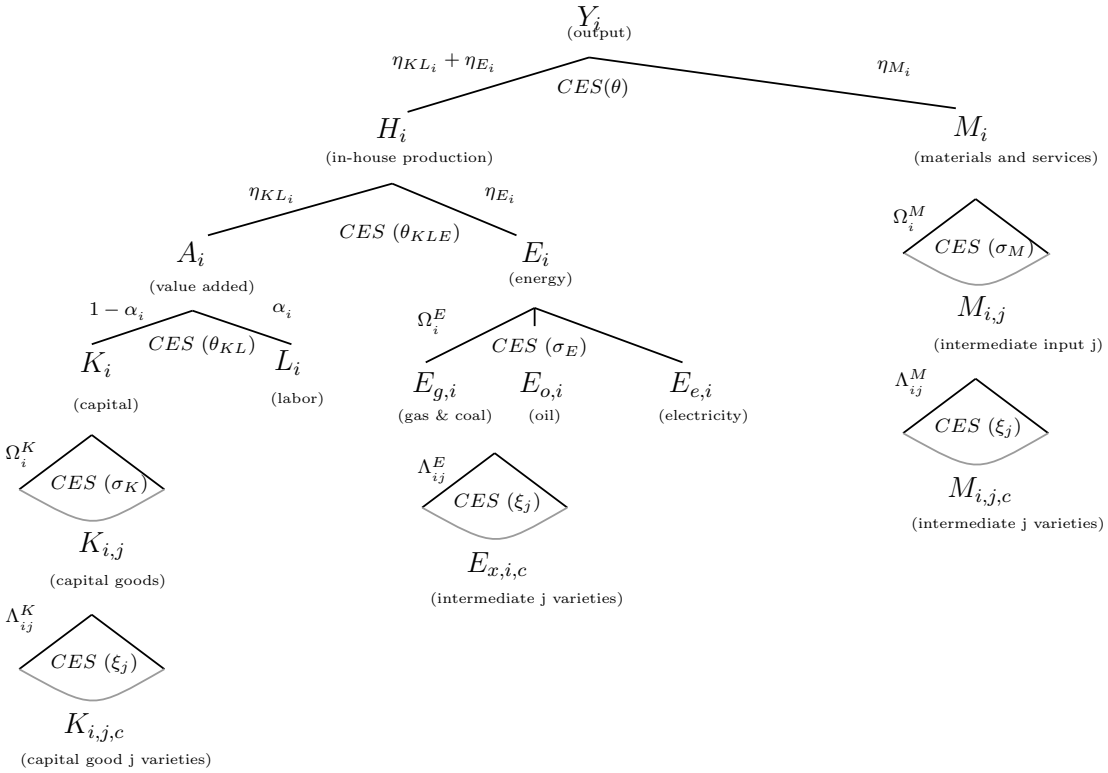


Figure 1: Production Function.

Figure 1 graphically illustrates the production function of the firms.

3.1 Firms

Within each of the $\mathcal{C}$ countries there are $\mathcal{S}$ firms, each of them producing the local variety of their respective sectors, $Y_{s,c}$.[3] To produce their output, firms transform labor (L), capital (K), energy (E) and other intermediate inputs (M), combined with a level of productivity (Z). Each of the representative firms is competitive and sells its output equal to its production cost.

Firms produce following a nested CES function with constant returns to scale. The production function has the form $((KL)E)M)$. Firms create value added by combining capital and labor. Then, to operate the value-added component (A), firms need energy (E),

[3]See Table A1 for a the classification of 44 industries.

which is complementary to the capital-labor bundle. Finally, firms combine the capital-labor-energy bundle, or in-house component (H), with intermediate inputs (M) purchased from the other sectors.[4]

$$Y_i = Z_i \cdot \left[(\eta_{KL,i} + \eta_{E,i}) \cdot H_i^{\frac{\theta-1}{\theta}} + \eta_{M,i} \cdot M_i^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \tag{1}$$

where $\eta_{KL,i}$, $\eta_{E,i}$ and $\eta_{M,i}$ are the share parameters of value added, energy expenditure and intermediate input, respectively. These parameters satisfy $\eta_{KL,i} + \eta_{E,i} + \eta_{M,i} = 1$[5] and θ is the elasticity with which firms can substitute the home-produced capital-labor-energy component with intermediate inputs sourced from other firms.

The in-house component is the result of combining capital and labor with energy. Value added and energy can be substituted with theta elasticity θ_{KLE}.

$$H_i = \left[\left(\frac{\eta_{KL,i}}{\eta_{KL,i} + \eta_{E,i}} \right) A_i^{\frac{\theta_{KLE}-1}{\theta_{KLE}}} + \left(\frac{\eta_{E,i}}{\eta_{KL,i} + \eta_{E,i}} \right) E_i^{\frac{\theta_{KLE}-1}{\theta_{KLE}}} \right]^{\frac{\theta_{KLE}}{\theta_{KLE}-1}} \tag{2}$$

Firms use both labor and capital, combined with an elasticity θ_{KL}, to produce value added and where α_i represents the labor share parameter.

$$A_i = \left[\alpha_i \cdot L_i^{\frac{\theta_{KL}-1}{\theta_{KL}}} + (1 - \alpha_i) K_i^{\frac{\theta_{KL}-1}{\theta_{KL}}} \right]^{\frac{\theta_{KL}}{\theta_{KL}-1}} \tag{3}$$

Intermediate Inputs For the intermediate input and energy bundles, firms use goods and services provided by the rest of the sector-country pairs. In both cases these inputs are combined with a nested two-level CES. The energy bundle is a combination of energy sources, while the intermediate materials component is a bundle consisting of the rest of the non-energy sectors of the economy.[6] First, firms purchase the different domestic varieties of

[4] Throughout the paper, for the sake of clarity, we omit the time subscript in those formulas where it is not relevant.

[5] This values are respectively calibrated as the initial share of expenditure in each component over total expenditure of the firm

[6] We assume that these sources are the output of the Energy Mining (D05T06), Refined Petroleum Products (D19) and Electric Power (D35) sectors.

each sector, X_{icjh}, to produce their bundle of the good or service produced by each sector, X_{icj}. Thus, the (j,h) element of matrix Λ^{ic} captures the importance of national variety h of the good j for the firm producing sector i from country c and ξ_j represents the Armington trade elasticity of the sector j [7]

$$X_{ic,j} = \left(\sum_{h=1}^{C} (\Lambda_{j,h}^{i,c})^{\frac{1}{\xi_j}} X_{ic,jh}^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}} \text{ for } X = \{M, E\} \tag{4}$$

In the second nesting level, firms combine the different goods and services, X_{ij}, with an elasticity σ_X to produce their energy or intermediate inputs bundle, X_i. The (i,j) element of matrix Ω^X represents the importance of good or service from sector j within the bundle of firm i from country c.

$$X_{ic} = \left(\sum_{j=1}^{S^X} (\Omega_{ic,j}^{X})^{\frac{1}{\sigma_X}} X_{ic,j}^{\frac{\sigma_X - 1}{\sigma_X}} \right)^{\frac{\sigma_X}{\sigma_X - 1}} \text{ for } X = \{M, E\} \tag{5}$$

Given the non-durable nature of energy and intermediate inputs, the amount of inputs used by a firm in a period for a given input is equal to the realized demand in the same period.

Capital Stock. Similar to the bundle of intermediate inputs, firm in sector i from country c uses a stock of capital K_{ic} that results of the combination of its stock of the assets supplied by the rest of sector-country representative firms, $K_{ic,jh}$.[8] [9] Again, this combination is made under a two-step nested CES function. First, firms use a bundle of the capital good produced by each sector j based on the combination of different national varieties of that good, $K_{ic,jh}$. The element (j,h) of the matrix $\Lambda^{ic,K}$ is the share parameter of country variety h in the bundle of capital good j of the firm producing sector i in country c. The different varieties of the capital good produced by the different firms in sector j are substituted with

[7] Section XX discusses how this elasticity increases over longer time horizons.

[8] For simplicity, this notation allows all sectors to be suppliers of investment goods. However, once calibrated in the data, the investment matrix is much sparser than the intermediate input matrix, which reflects that the supply of investment goods is concentrated in a few sectors, whereas most sectors are to some extent suppliers of intermediate inputs.

[9] Given the durable nature of capital goods, the relevant magnitude is the stock of different assets in a period, which in turn is determined by the investment path.

an Armington trade elasticity ξ_j.

$$K_{ic,j} = \left(\sum_{h=1}^{C} (\Lambda_{j,h}^{ic,K})^{\frac{1}{\xi_j}} K_{ic,jh}^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}} \tag{6}$$

In the second level, firm combines the different types of assets, $K_{ic,j}$, into its aggregate capital bundle K_{ic}. These assets can be substituted for each other with an elasticity σ_K and the share parameter of the capital good j for the firm i is given by the element (i, j) of the matrix Ω^K.

$$K_{ic} = \left(\sum_{j=1}^{S} (\Omega_{i,j}^{K})^{\frac{1}{\sigma_K}} \cdot K_{ic,j}^{\frac{\sigma_K - 1}{\sigma_K}} \right)^{\frac{\sigma_K}{\sigma_K - 1}} \tag{7}$$

Investment. Capital goods are durable and their stock in a given period ($K_{icjc',t+1}$) depends both on the non-depreciated stock of the previous period ($K_{icjc',t}$) and on the investment of the previous period ($I_{ijc,t}$).

$$K_{icjh,t+1} = (1 - \delta_j) \cdot K_{icjh,t} + I_{icjh,t} \tag{8}$$

Therefore, the equilibrium condition for the investment decision equates the price of the capital good of sector j from country c' for firm i in country c with the discounted returns that such firm will get from it

$$P_{icjc',t} = \sum_{z=1}^{\infty} \left(\frac{(1 - \delta_j)^{z-1}}{\Pi_{s=1}^{z}(1 + i_{c,t+s})} R_{icjc',t+s} \right) \tag{9}$$

where the flow of nominal returns that the asset produced by sector j in country c will produce ($R_{icjc',t+s}$) for the sector-country firm i, discounted at the nominal interest rate ($i_{c,t+s}$) for each period and the depreciation rate (δ_j), must equal the price of the asset ($P_{icjc',t}$). Therefore,Equation (9) shows the additional contribution of networks to the capital accumulation process, as the shocks to the capital supplier sectors will also affect the required returns of assets they supply.

Labor. Labor is imperfectly mobile across sectors and firms face a specific labor supply curve

$$L_i = \omega_i^L \left(\frac{W_i}{W_c}\right)^{\upsilon} \cdot L_c \tag{10}$$

where L_i is the amount of employment of a sector in country c, W_i is the wage offered by the firm, and W_c and L_c are the average wage and total employment in country c. The initial share of employment of each sector is given by ω_i^L . Elasticity υ determines the mobility of labor across sectors and, implicitly, determines the dispersion of wages. Very large values of υ impose almost perfectly mobility and wage equalization across sectors.

Given the average nominal wage, companies in a country face a labor supply curve that reflects the imperfect mobility of labor between different sectors.

$$L_{i,c} = \omega_{i,c}^L \left(\frac{W_i}{W_c}\right)^{\upsilon} \cdot L_c \tag{11}$$

where $L_{i,c}$ is the amount of employment of a sector i in country c, $W_{i,c}$ is the wage offered by the firm, and W_c and L_c are the average wage and total employment in country c. The initial share of employment of each sector is given by $\omega_{i,c}^L$. Elasticity υ determines the mobility of labor across sectors and, implicitly, determines the dispersion of wages. Very large values of υ impose almost perfectly mobility and wage equalization across sectors.

3.2 Households

In every country there is a representative household which owns all the firms in the country and supplies labor. Households' preferences are represented by the function

$$U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log C_t - \frac{L_t^{1+\frac{1}{\mu}}}{1+\frac{1}{\mu}}\right) \tag{12}$$

where μ is the Frisch elasticity of labor supply and β the discount factor.

Consumption Households use their income to consume a bundle of the output produced by all the sector-country pairs in the economy. Similarly to firms' production function, the consumption bundles has a nested CES structure. Households consumption aggregator is a combination of the consumption of the different goods and services in the economy

$$C_i = \left(\sum_{j=1}^{S} \Omega_{i,j}^{C} C_{c,j}^{\frac{\sigma_C - 1}{\sigma_C}} \right)^{\frac{\sigma_C}{\sigma_C - 1}} \tag{13}$$

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

Also, within the consumption of a given sector j, households combine the different domestic varieties produced in each country, combined with an elasticity of ξ_j

$$C_{ij} = \left(\sum_{h=1}^{C} \lambda_{ijh}^{C} C_{ijh}^{\frac{\xi_j - 1}{\xi_j}} \right)^{\frac{\xi_j}{\xi_j - 1}} \tag{14}$$

where λ_{ijh}^{C} represents the share of expenditure by the household in country i on the variety of good j produced in country h.

Intertemporal decision. Households in each country receive income in each period from both wages and income from the country's firms. Households in each country have access to two savings vehicles.

The household budget constraint states that households in each country derive their income from wages and income from the country's firms. Households in each country have access to two savings vehicles. First, they can trade a local bond at a nominal interest rate, $(i_{c,t})$, and traded in the local currency. Additionally, there is a bond traded internationally with zero supply, traded in US dollars. This latter bond implies that nominal exchange rates are fixed by the differences in nominal rates of the different economies. It also allows for the existence of temporary trade deficits.

3.3 Nominal variables

Prices. We assume that prices adjust flexibly within each period. Additionally, we assume that the producer of a specific good receives the same price, denominated in its local currency, regardless of the buyer's country. In our model, trade fragmentation is modelled as an increase in the trade costs between country pairs, making the price of each good or service specific to the buyer-seller relationship. Therefore, the price paid by the representative firm in sector i in country c for the good produced by the firm in sector j in country c', denoted as $P_{icjc'}$, is given by:

$$P_{icjc'} = (1 + \tau_{c,c'}) \cdot \mathcal{E}_{c',c} \cdot P_{jc'} \tag{15}$$

where $\tau_{c',c}$ represents the iceberg trade cost between countries c' and c, $\mathcal{E}_{c',c}$ is the exchange rate between these two countries, and $P_{jc'}$ is the selling price set by the representative firm in sector j from country c'.

Nominal wages. We assume that nominal wages in each country are indexed to past inflation.[10]

$$W_{c,t+1} = W_{c,t} \cdot (1 + \phi_w \cdot \pi_{c,t}) \tag{16}$$

where $\pi_{c,t}$ is the inflation rate in country c.

CORRECIÓN El salario nominal, expresado en la moneda local, se negocia entre las empresas y el hogar representativo de cada país. Asumi que el proceso de setting del salario nominal tiene un nivel de indexación a la inflación pasada.

$$W_{c,t} = W_{c,t-1} \cdot \Pi^{w}_{c,t} \tag{17}$$

[10]Implicitly, given that W_c is the weighted average of sector-level wages, reflecting their relative distribution, this condition raises all wages to the same extent as the average wage.

dónde $\Pi_{c,t}$ es un indexation scheme que responde a la inflación del periodo y a la inflación del periodo con un nivel de indexaxión ϕ_W

$$\Pi^{w}_{c,t} = \pi^{\phi_W}_{c,t-1} \cdot \pi^{1-\phi_W}_{c,t} \tag{18}$$

donde $\pi_{c,t}$ es la inflación del periodo t en el país c.

This condition plays an important role in the persistence of inflation following a fragmentation shock. Since the initial disruption of supply chains increases the relative price of intermediate inputs, energy, and capital goods compared to labor, the initial cost shock would have lasting effects as nominal wages begin to regain purchasing power in subsequent periods.

Exchange rates Exchange rates are determined by the no-arbitrage condition between the interest rates paid on local bonds in each country and the interest rate paid on the internationally traded bond. Thus, the evolution of the exchange rate between any pair of countries c and c' is determined by the interest rates set by their respective monetary authorities:

$$\frac{\mathcal{E}^{c,c'}_{t+1}}{\mathcal{E}^{c,c'}_{t}} = \frac{1 + i_{c,t}}{1 + i_{c',t}} \tag{19}$$

The final level of exchange rates is given by the trade balance condition.

Monetary policy. The central banks of each country follow a standard Taylor rule that responds to the inflation rate and the deviation of GDP.

4 Data and Calibration

Production parameters: We calibrate the model using the Inter Country Input Output (ICIO) tables provided by the OECD with data for the year 2019. These tables contain

information on trade flows between 44 sectors in 66 countries, in addition to information on total gross output and value added. Crucially for our analysis, these trade flows distinguish between intermediate consumption, final consumption by households and government, and goods for gross fixed capital formation.

These data allow us to calibrate the parameters of the production function of different sectors by estimating the weight of each good in an industry's intermediate input bundle, as well as the particular national variety of that good that is imported into each country's industry.

Investment matrix: the most important calibration exercise in this paper is the investment matrix. As described earlier, the objective is to calibrate the significance of capital goods supplied by each sector-country pair within the investment bundle of any other producer. This type of information is not readily available off the shelf.

To achieve this, two sources of information are combined. First, National Accounts provide data on investment stocks and flows by type of capital asset—classified according to ESA 2010—across sectors, based on the NACE classification. This source enables us to construct the weight of each asset within the investment bundle of each sector for 13 different types of capital assets, including both tangible and intangible assets. At the same time, it allows us to assess the contribution of each sector to the country's total investment in each asset type.

The second data source is the global input-output tables, which provide information on flows of goods dedicated to gross fixed capital formation. These flows identify the sector-country of origin but only specify the destination country, without detailing the specific sector within it. Consequently, this source allows us to identify the weight of each sector-country in the capital accumulation process of any other country.

Lastly, the information from the first source—which provides details on asset types and

the sector-country of destination, but not the origin—is linked with the second source, which contains data on the sector-country of origin and the destination country, but not the sector-country of destination. To do this, a crosswalk is constructed between the types of assets provided by National Accounts and the sector from the input-output tables that produces them, based on the NACE classification and the types of goods and services each category produces. In this way, we can express the sector-country to country flows from the input-output tables as asset-country to country flows. Finally, using information from National Accounts, we allocate these flows to each sector-country according to their share in the total investment of that asset within their respective country.

While both matrices have the same structure and their interpretation is comparable, there are significant empirical differences between the input-output matrix of intermediate inputs and that of investment. Firstly, the investment matrix is much more sparse than the intermediate inputs matrix, reflecting that investment goods are produced by a limited number of sectors. Among these investment hubs, the construction sector stands out prominently, followed by other sectors such as Machinery and Transport Equipment. It is important to note that service sectors, such as Professional and Research Services, also have significant weight due to their role in supplying intangible capital goods.

This pattern is also evident in the distribution among countries. In addition to sectoral concentration, the clustering among countries is relatively higher for investment goods—excluding Construction, which is predominantly local- than for intermediate inputs. Thus, although the absolute volumes of international trade flows of intermediate inputs are higher, a trade disruption could lead to a relatively greater increase in the cost of investment goods.

Trade elasticities: trade elasticity (ξ_{it}) is a key variable for understanding both the magnitude and the dynamics of the aggregate effects of trade fragmentation. The ability of firms to redirect the supply of their previously imported products from the opposite bloc can be expected to be limited in the short run, but to increase over longer time horizons. We base our analysis on values in Fontagné et al. (2022), using his short- and medium-term estimates.

We assume that the elasticities grow linearly between their short-run and long-run values over 10 years, reaching their long-run values at t=10. Table A1 shows the sector-specific short ($\xi_{i,1}$) and long term ($\xi_{i,10}$) values of trade elasticities.

Production elasticities. Following the literature in Atalay (2017) and Baqaee and Farhi (2019), we set the labor-capital elasticity (θ_{KL}) equal to 0.9; the elasticity between intermediate inputs and in-house production (θ) equal to 0.5; the elasticity between different intermediate inputs (σ_M), energy sources (σ_E) and capital goods (σ_K) equal to 0.2, and the elasticity of household consumption across sectors (σ_C) equal to 0.9. Following Böhringer and Rivers (2021), we set the elasticity between energy and value added (θ_{KLE}) equal to 0.4.

Consumption elasticities. We assume that households substitute between goods and services produced by each sector with an elasticity σ_c of 0.9, a value taken from the literature (Atalay (2017)).

5 Scenarios

To illustrate the dynamics of the model, we simulate a hypothetical scenario in which the cost of trade between geopolitical blocs increases by 100%. We assume that this shock is permanent and occurs suddenly and unexpectedly. This increase in costs affects trade between countries in the Western bloc (European Union, United States, and allies) and countries in the Eastern bloc (China and Russia); however, we allow for the existence of a third bloc of neutral countries that are not affected by these additional barriers.

These trade costs take the form of an iceberg cost that importers from the trading blocs must incur when importing goods or services from the opposite bloc. However, these are not tariffs, and governments do not collect any amount.

The results are aggregated into six country blocs: the European Union, the United States,

the rest of the Western bloc countries, China, Russia, and the neutral bloc countries.

The increase in trade costs that we simulate results in an immediate reduction of more than one-third of trade flows between blocs, and by the second year, this reduction reaches half. By the fifth year, the reduction amounts to three-quarters, and in the long term, trade between the Western and Eastern blocs virtually disappears. The reason for this increase in costs is due to higher trade elasticities over longer time horizons. Thus, in the initial periods, despite a significant increase in costs, firms are unable to substitute imported goods with new suppliers, forcing them to internalize the cost increases and amplifying their impact on production. Figure 3 shows the exact changes in trade flows.

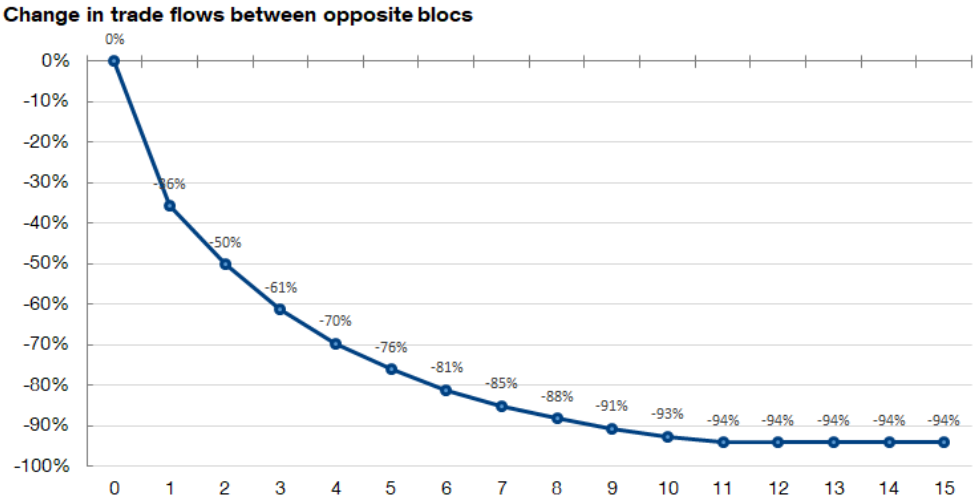


Figure 2: Changes in trade flows between Western and Eastern bloc countries.

6 Results

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Comments

- Among Western countries, the European Union experiences a relatively greater impact

than the United States, although part of this impact can be considered already discounted due to the trade between Europe and Russia, which has effectively been reduced to insignificant amounts. [11] However, within the Western bloc, the most affected are those countries, particularly several Pacific countries, that would be especially impacted by a trade rupture with China.

- The countries in the Eastern bloc are the most affected. The main reason is the relative size of this bloc compared to the Western bloc. Thus, the percentage of global GDP from which Eastern countries are disconnected is significantly larger, resulting in greater losses.

- Table **??** shows a more disaggregated variation of trade between blocs. It is important to note that, due to their durable nature, the response in trade flows of investment goods is more responsive than that of intermediate inputs. It is also important to highlight the role of neutral countries, as they increase their trade flows to both blocs. Additionally, since the West was particularly a supplier of investment goods to the Eastern bloc, the neutral bloc tends to fill that gap. On the other hand, since the Eastern bloc had a significant role in the imports of intermediate inputs by the Western bloc, these are the goods in which trade increases the most between the latter and the neutral countries.

- Neutral countries benefit from trade diversion and access to relatively cheaper capital goods. As long as augmented trade costs between opposing blocs reduce demand for capital-supplying sectors, general equilibrium effects imply cheaper access from neutral countries that do not suffer such costs. However, these effects are limited in that, although neutral countries benefit from the rerouting of part of global trade and thus increase their share of global GDP, the effect is mitigated by the decline in global GDP caused by the Western and Eastern blocs.

[11] We are currently working on adapting the IO tables to simulate a starting scenario in which the trade decoupling between Russia and the EU has already occurred.

6.1 Mechanisms

6.1.1 The role of the investment network on GDP

- The contribution to changes in GDP varies by component. **??** breaks down the variation in the GDP of the European Union into changes in the labor quantity, variations in the capital stock, and the loss of efficiency due to trade disruption.[12] The trade disruption component has a greater effect in the initial periods, during which firms' substitution capacity is lower. However, as this capacity increases, its negative contribution to GDP diminishes.

- Conversely, the contribution of the lower capital stock increases over time as the effects of reduced investment induced by the higher cost of investment goods accumulate. Thus, in the long term, omitting this channel would underestimate the effect of trade fragmentation by almost half of its total impact.

- Figure 4 highlights the importance of considering this mechanism in the specific case of trade fragmentation. Thus, the price of the investment bundle for firms in the European Union increases substantially more than the cost of other inputs in the economy due to the greater interconnection in the supply of these types of goods. Therefore, ignoring the effect of the cost of investment goods will tend to underestimate the cost of the trade decoupling shock.

[12]This component is explained by the need for firms to adjust their suppliers and given the limited elasticity of substitution, the accounting consumption of intermediate inputs necessary to produce the same amount of the effective input bundle increases. Therefore, this effect can be assimilated to a productivity loss induced by lower efficiency in the combination of inputs.

6.1.2 The role of the investment network on inflation.

- The investment network and investment dynamics also play an important role in the inflation path. Figure 5 shows the contribution of different components to inflation in the European Union. The red bars indicate the cost-push shock resulting from the increased cost of imported inputs. As previously mentioned, since substitution elasticities grow over time, the initial shock is significantly positive for the inflation rate, but in subsequent periods, the contribution becomes negative once trade tensions are addressed by producers with greater substitution capacity.

- However, the decline in the capital stock due to the increased cost of investment goods also has a positive but persistent effect over time. Thus, once the negative effect on the capital stock accumulates, the productive capacity of the economy is reduced, and costs increase.

- Therefore, the persistence of inflation in the results does not solely stem from wage indexation but also from considering the role of the investment matrix, which provides an additional mechanism for entrenching inflation.

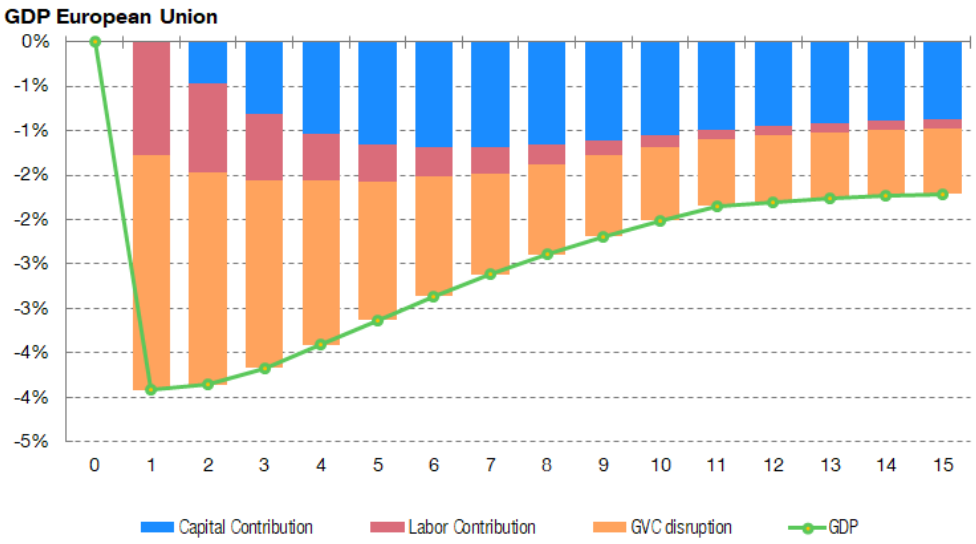


Figure 3: Decomposition of European Union GDP level by component.

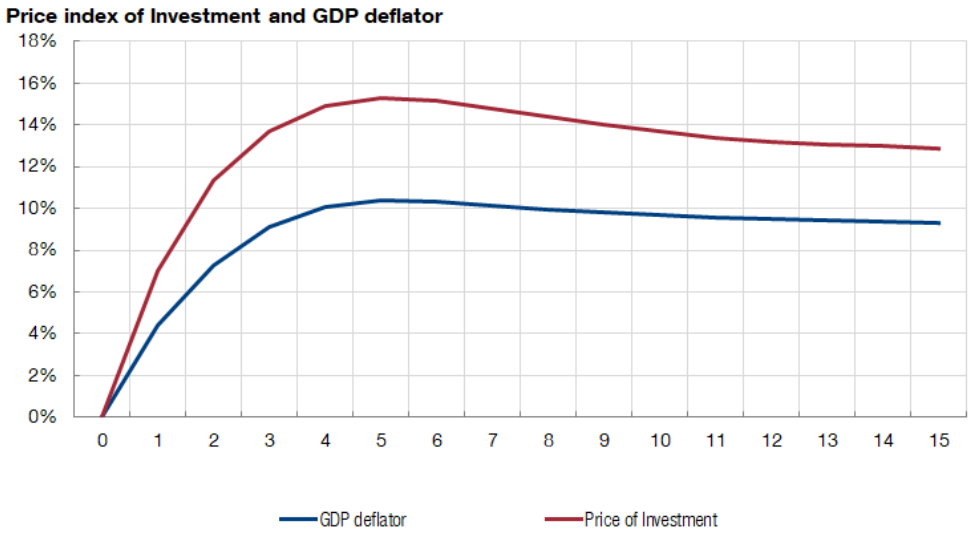


Figure 4: Cumulative change in GDP deflator and average cost of Investment bundle in the European Union.

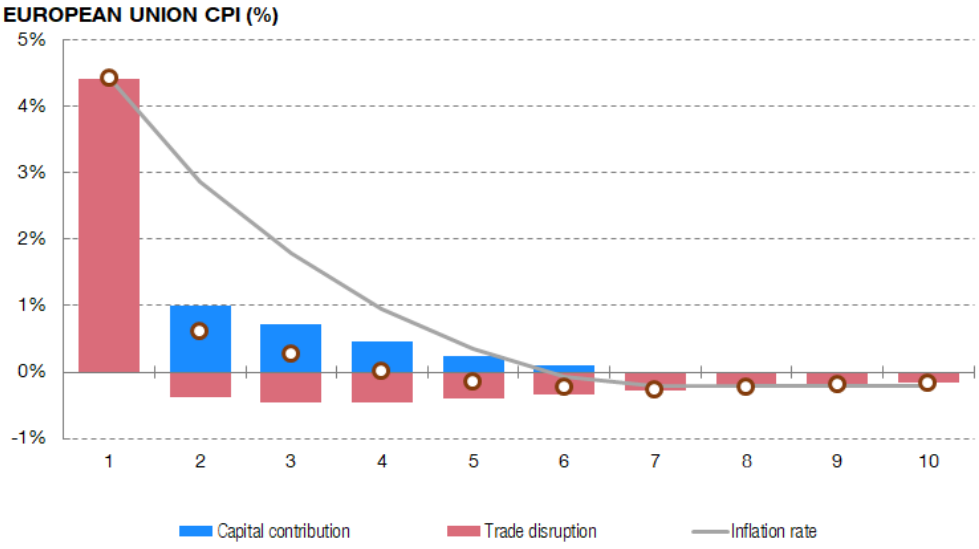


Figure 5: Contributions of cost-push shock from trade disruptions and capital stock to CPI in the European Union. The difference between cost-push shock and inflation rate is the role of wage indexation.

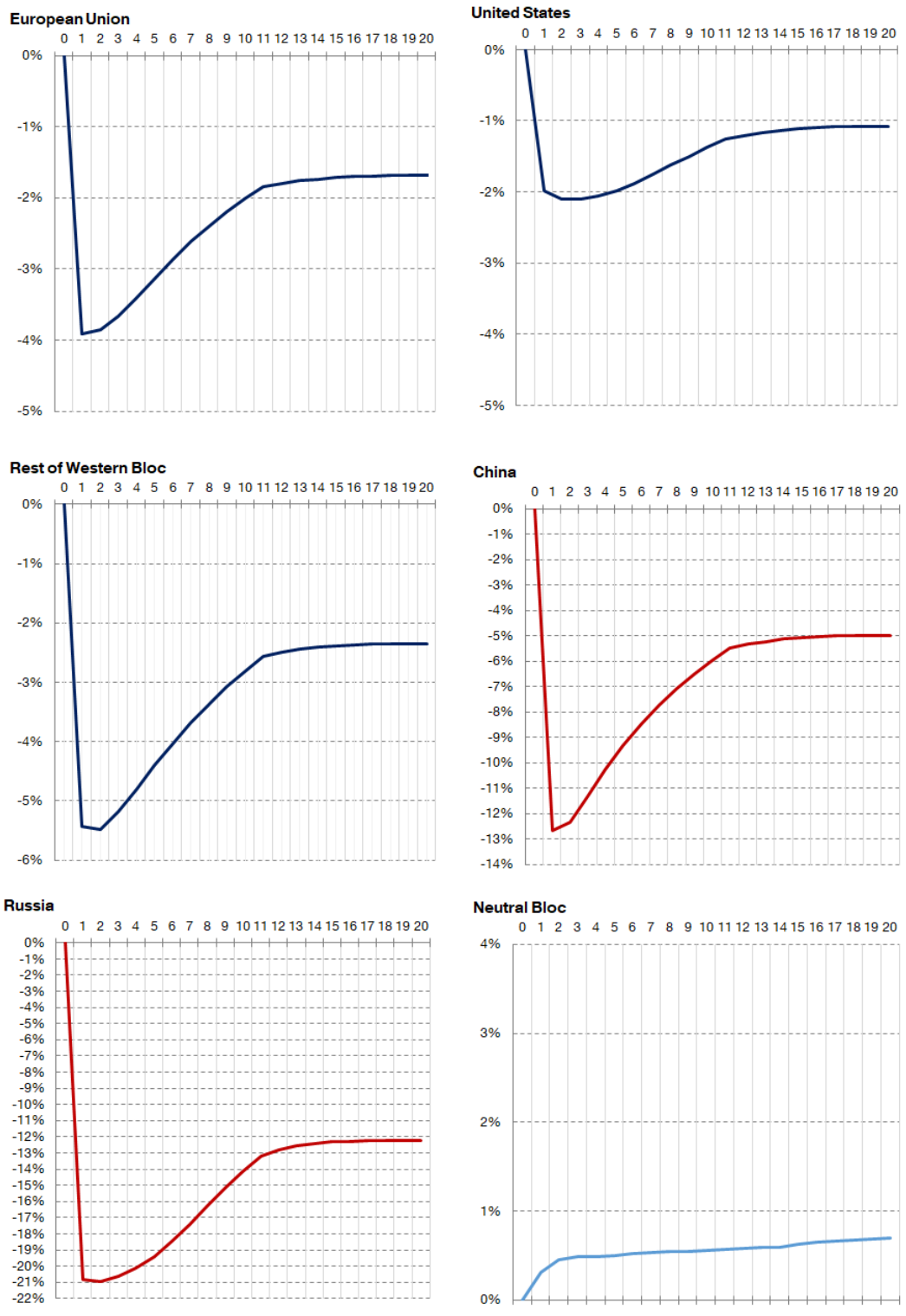


Figure 6: Changes in GDP levels with respect to a scenario without trade fragmentation.

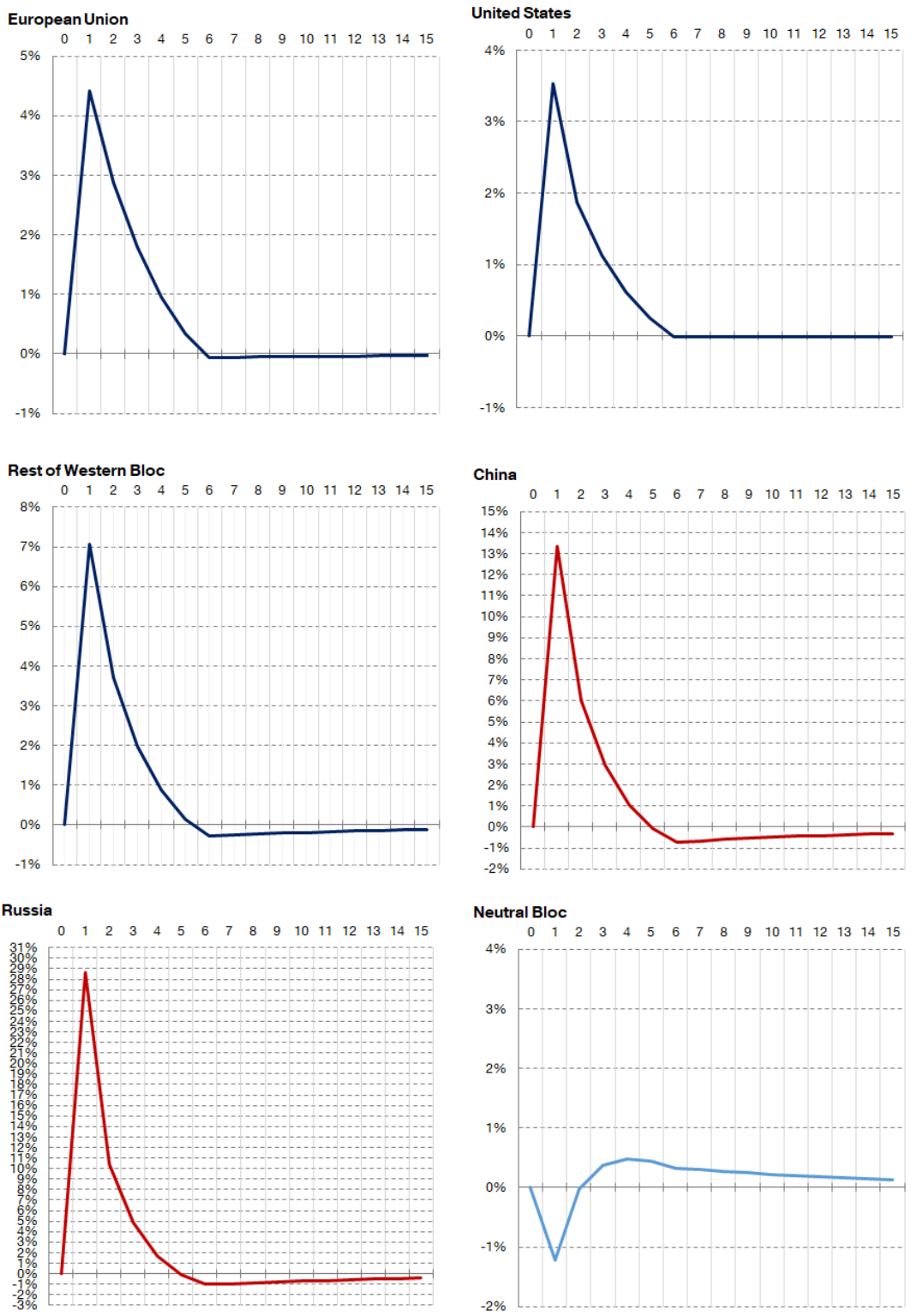


Figure 7: Changes in inflation rates with respect to a scenario without trade fragmentation.

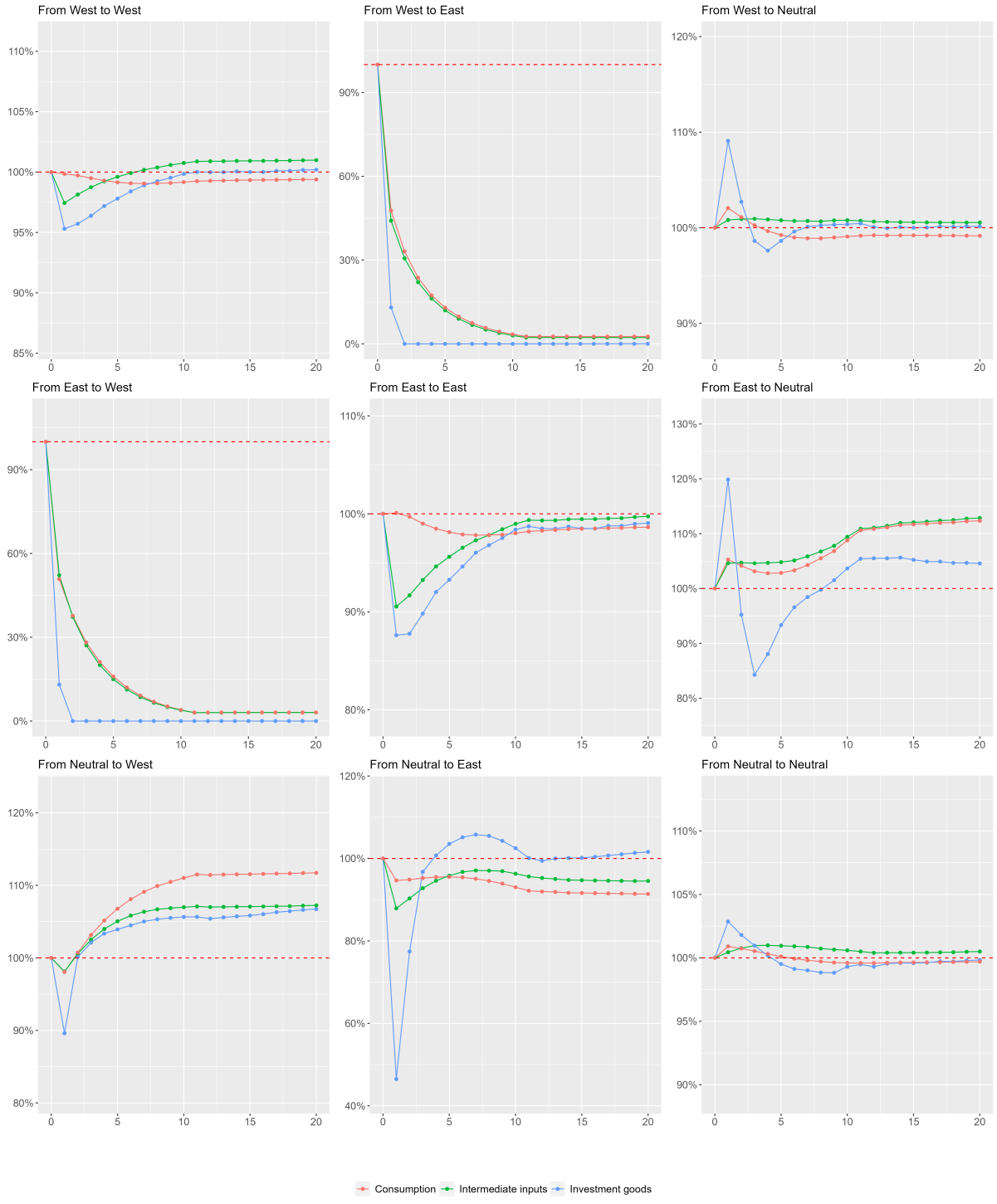


Figure 8: Trade changes by type of goods

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A Figures and Tables

Table A1: Long-run trade elasticities

	Sector	Long-run
D01T02	Agriculture, hunting, forestry	2.91
D03	Fishing and aquaculture	2.91
D05T06	Mining and quarrying, energy producing products	3.41
D07T08	Mining and quarrying, non-energy producing products	3.41
D09	Mining support service activities	3.41
D10T12	Food products, beverages, and tobacco	4.17
D13T15	Textiles, textile products, leather, and footwear	4.71
D16	Wood and products of wood and cork	8.80
D17T18	Paper products and printing	8.21
D19	Coke and refined petroleum products	3.67
D20	Chemical and chemical products	10.56
D21	Pharmaceuticals, medicinal chemical, and botanical products	10.56
D22	Rubber and plastics products	6.75
D23	Other non-metallic mineral products	4.79
D24	Basic metals	7.39
D25	Fabricated metal products	4.22
D26	Computer, electronic and optical equipment	5.14
D27	Electrical equipment	4.11
D28	Machinery and equipment, nec	5.01
D29	Motor vehicles, trailers, and semi-trailers	8.92
D30	Other transport equipment	8.99
D31T33	Manufacturing nec; repair and installation of machinery and equipment	4.06
D35	Electricity, gas, steam, and air conditioning supply	3.27
D36T39	Water supply; sewerage, waste management and remediation activities	3.27
D41T43	Construction	3.27
D45T47	Wholesale and retail trade; repair of motor vehicles	3.27
D49	Land transport and transport via pipelines	3.27
D50	Water transport	3.27
D51	Air transport	3.27
D52	Warehousing and support activities for transportation	3.27
D53	Postal and courier activities	3.27
D55T56	Accommodation and food service activities	3.27
D58T60	Publishing, audio-visual and broadcasting activities	3.27
D61	Telecommunications	3.27
D62T63	IT and other information services	3.27
D64T66	Financial and insurance activities	3.27
D68	Real estate activities	3.27
D69T75	Professional, scientific, and technical activities	3.27
D77T82	Administrative and support services	3.27
D84	Public administration and defence; compulsory social security	3.27
D85	Education	3.27
D86T88	Human health and social work activities	3.27
D90T93	Arts, entertainment, and recreation	8.35
D94T96	Other service activities	8.35

Based on Fontagné et al. (2022)

Table A2: Countries allocation by geopolitical blocs

West	**East**	**Neutral**
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		

Table A3: Other parameters

Variable		Value	Source
ς	Capital adjustment cost	.4	Vom Lehm & Winberry (2022)
μ	Frisch elasticity	1	
β	Discount rate	.95	
υ	Labor adjustment cost	1	Horvath (2000)
Ω^X, λ^X, α η	Expenditure shares, and production parameters		ICIO OECD
Ω^K, δ	Investment matrix and dep. rate		KLEMS, ICIO OECD
	Wage indexation index	0.5	
	Taylor rule response to		
ϕ_{pi}	inflation	1.5	
$\phi_{\hat{y}}$	output	0.5	