WORKING paper

BANQUE DE FRANCE
EUROSYSTÈME

Geoeconomic Fragmentation in a Multi-Country GVC Model

Charles Serfaty & Sebastian Stumpner[1]

January 2026, WP 1030

Abstract

This paper analyzes the welfare impacts of trade decoupling in a multi-sector general equilibrium trade model with global value chains. We show that decoupling leads to a fall in world trade and world welfare, and that losses are larger if fragmentation arises via trade costs than if it arises via tariffs. Decoupling creates both winners and losers, with neutral countries typically gaining from fragmentation. This makes blocs unstable, as bloc members have an incentive to take a neutral stance. In a final exercise, we therefore ask which bloc neutral countries would choose if forced to choose one. Here the Western bloc has a natural advantage due to its size, and it can expand in several rounds

Keywords: Geoeconomic Fragmentation; Trade Blocs; Global Value Chains; Tariffs; Welfare.

JEL classification: F11, F13, F15, F60, F61, C67, C68.

---

[1] Banque de France, charles.serfaty@banque-france.fr ; Banque de France, sebastian.stumpner@banque-france.fr
This project benefited from many discussions with Antoine Berthou and Lionel Fontagné. We especially thank Lukas Boeckelmann and Andrés Lajer Baron who discussed this paper at Banque de France and Bank of Spain seminars. Yannick Kalantzis and Hervé Le Bihan commented early stages of this paper and we also thank participants from Banque de France, Bank of Spain and Kiel Institute trade seminars.

Non-Technical Summary

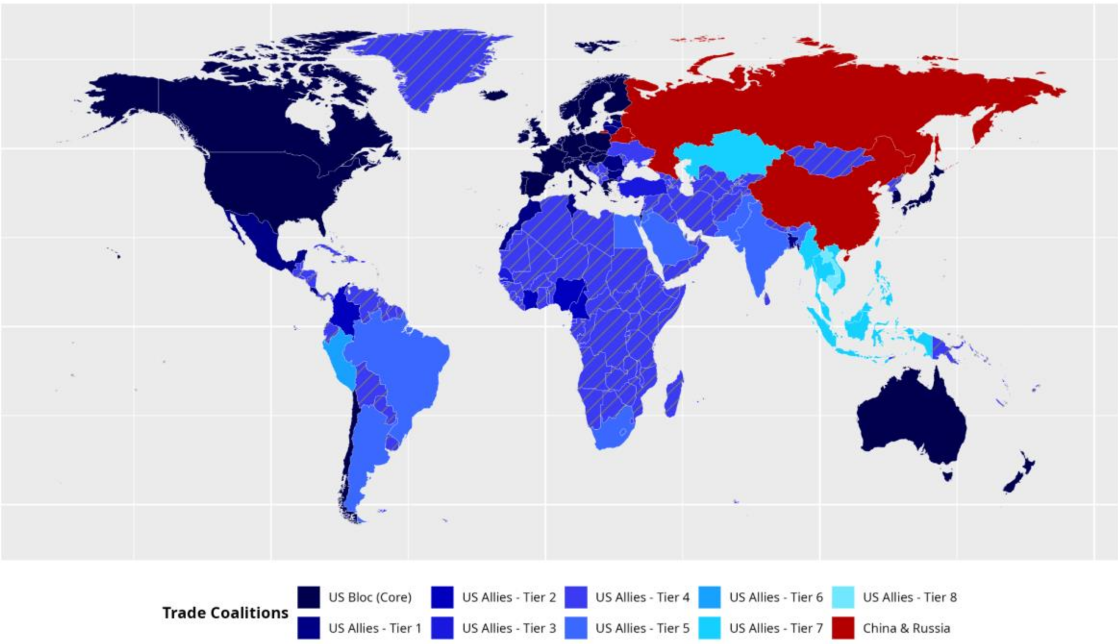
This paper quantifies how the world economy would react if trade were to fragment into rival blocs. Using a detailed multi-country, multi-sector model calibrated to OECD input–output data, the authors simulate scenarios in which a "Western" bloc and an "Eastern" bloc raise trade barriers against each other, while some economies initially remain neutral.

The model captures global value chains: countries import large volumes of intermediate inputs, so trade disruptions cascade across sectors. Under all fragmentation scenarios, world trade and world welfare decline. Losses are substantially larger when decoupling occurs through higher non-tariff trade costs than through tariffs, because tariffs generate revenue that partly compensates domestic consumers. If inter-bloc trade is made fully prohibitive, global real consumption falls by about 0.8 percent—a sizeable reversal of the gains from decades of integration.

A benchmark scenario with a 20 percent rise in inter-bloc trade costs illustrates the distributional patterns. Trade between blocs falls by almost two-thirds, while intra-bloc and neutral-bloc trade increase modestly. Western and Eastern bloc members experience welfare losses, typically between 0.1 and 0.8 percent, with larger declines for economies tightly linked to the other bloc. China and Russia face larger losses than the United States or Europe, reflecting narrower trade networks. In contrast, neutral economies such as Vietnam or Mexico often gain, as they attract production and supply-chain re-routing from both sides.

The paper also analyzes the strategic logic of tariff wars. A unilateral tariff can improve welfare for the bloc that imposes it by improving its terms of trade. Retaliation by the other bloc is nonetheless a best response and recovers part of its own losses. As a result, a bilateral tariff war is an equilibrium even though both blocs end up worse off than under free trade—a classic prisoner's dilemma.

Because neutral countries gain while bloc members lose, blocs are intrinsically fragile. The paper therefore investigates which bloc neutral countries would join if they could no longer remain neutral. The Western bloc's larger economic size makes it more attractive. Simulating successive "rounds" of accession shows that it would progressively expand, ultimately attracting all neutral economies. The accompanying map illustrates the sequence of these enlargement rounds.



Overall, the results highlight three insights: moderate fragmentation can already erase a meaningful share of global gains from trade; tariff wars are strategically rational yet mutually damaging; and bloc size strongly shapes the future architecture of global trade.

Fragmentation géoéconomique dans un modèle multilatéral de chaînes de valeur

Résumé

Cet article analyse les effets du découplage commercial sur le bien-être dans un modèle de commerce international en équilibre général multi-secteurs intégrant les chaînes de valeur mondiales. Nous montrons que le découplage entraîne une baisse du commerce mondial et de la consommation mondiale, et que les pertes sont plus importantes lorsque la fragmentation provient de coûts de transactions plutôt que de droits de douane. Le découplage génère des gagnants et des perdants, les pays neutres tirant généralement profit de la fragmentation. Cela rend les blocs instables, car leurs membres ont alors intérêt à adopter une position neutre. Dans un dernier exercice, nous examinons donc quel bloc les pays neutres choisiraient s'ils étaient contraints d'en sélectionner un. Le bloc occidental dispose ici d'un avantage naturel lié à sa taille et peut s'étendre en plusieurs étapes.

Mots-clés : fragmentation géoéconomique ; blocs commerciaux ; chaînes de valeur mondiales ; droits de douane.

1 Introduction

Starting with the 2018-2019 US-China trade war and the Russian invasion of Ukraine, there have been increasing concerns about world trade fragmenting across geopolitical blocs. What are the welfare consequences of this fragmentation, and how do they depend on the structure of geopolitical blocs and the type of friction causing the fragmentation?

This paper uses a quantitative general equilibrium trade model with global value chains to assess the impact of generalized geopolitical fragmentation across different scenarios. Our model is calibrated directly to the OECD ICIO table, covering 76 countries and a "Rest of the World" Region and 44 sectors.[1] We also derive sufficient statistics formulas for welfare and real GDP, extending the results of Arkolakis et al. [2012] to our GVC framework.

Using this framework, we analyze fragmentation effects in several steps. We begin with fixed blocs—Western, Eastern, and Neutral—and examine how world trade and welfare evolve under decoupling scenarios. We demonstrate that both world trade and welfare fall with decoupling, with losses larger when fragmentation arises via trade costs rather than tariffs. The difference between tariffs and trade costs naturally vanishes as tariffs become prohibitive and revenue converges to zero.

We then compare welfare gains and losses across countries in different blocs under a specific scenario (20% increase in trade costs). Decoupling creates both winners and losers: Western and Eastern bloc members lose from decoupling, with losses 2-4 times larger under iceberg trade cost scenarios compared to the same increase in tariffs. In contrast, neutral countries gain from decoupling, regardless of whether fragmentation occurs through trade costs or tariffs, since they do not collect tariff revenues. In the case of decoupling with higher iceberg trade costs, all countries in the opposite blocs lose from the trade war, with welfare losses going from -1.9% of baseline (Cyprus) to -0.1% (Portugal), with an average welfare loss of -0.5%. Eastern economies lose -1.1% of welfare, with all four economies losing. The welfare of "neutral" economies increases by 0.1%, with only 4 out of 44 countries experiencing modest welfare losses. At the worldwide level, welfare declines by 0.5%.[2] These losses correspond to 22.5% of the total welfare gains from trade for Eastern countries, and to 5.0% of the total welfare gains from trade for Western countries. At the worldwide level, welfare losses represent 5.4%

[1] There are 45 sectors in the ICIO data, but we merged "Domestic activities" and "Other services" categories to reduce the number of sectors with null value added. The complete list of countries in sectors can be found in Tables D.1 and D.2.

[2] Welfare change is aggregated by initial GDP when we compute collective welfare losses.

of total worldwide gains from trade.

The tariff war between Western and Eastern countries is an equilibrium in the sense that retaliation is a rational response to a unilateral tariff increase. When one bloc imposes tariffs on other countries from another bloc, members of the former bloc benefit from the trade war. Retaliation from the second bloc cancels those gains, and improves the welfare of the second bloc relative to a unidirectional tariff case, which means that tariff wars have a prisoner's dilemma structure.

Since Neutral countries gain but members of the Western and Eastern bloc incur welfare losses, our analysis suggests that trade blocs are unstable, as many bloc members would gain welfare by becoming neutral if they anticipate possible retaliation. This raises questions about bloc maintenance over time and whether tariffs against neutral countries would be needed to enforce membership.

It also raises the question of which bloc neutral countries would choose, were they forced to choose one. We show that, if "neutral" countries aligned with the Eastern bloc, fragmentation's negative impacts would intensify for Western countries while becoming less severe for existing Eastern bloc members. However, neutral countries lack the incentive to make this shift, as they benefit more from neutrality than from joining either bloc.

Finally, we consider scenarios where all countries except core Western and Eastern bloc members must choose a side, based on their economic interests. Building on the insight that blocs become more attractive as they grow larger, we evaluate whether countries would join a bloc even if all remaining countries joined the opposing side. The Western bloc's initially larger size provides a natural expansion advantage. Countries like Mexico and Morocco would join the US-led bloc in early rounds, making it more attractive to others and enabling multi-round expansion. We find that, due to its larger initial size, the US-led bloc can eventually attract all neutral countries, even though it takes eight expansion rounds to achieve this.

Under partial decoupling scenarios between blocs and as long as there are neutral economies, global welfare deterioration ranges from -0.2% (tariff shocks) to -0.5% (iceberg trade shocks), comparable to findings in Felbermayr et al. [2023], Góes and Bekkers [2022], and Bolhuis et al. [2023] when the lower severity of the scenario is taken into account. Models incorporating intermediate goods and global value chains typically yield larger gains from trade than standard models without GVCs, as demonstrated in Costinot and Rodríguez-Clare [2014] and Caliendo and Parro [2015]. To provide perspective on these magnitudes, total gains from trade in our model equal 3.2% for the US, substantially higher than the 0.7-1.4% found in simplest standard trade models among the ones in Arkolakis et al. [2012] - for example, one-sector Armington trade models. Total costs from autarky at the worldwide level are 8.6% in this model. Comparing this cost with a limited decoupling shock shows that decoupling could eliminate more than 5% of the total benefits from international trade integration. In more severe scenarios without neutral economies and larger trade barriers, trade decoupling eliminates 25% of the total gains from trade.

Our results connect to the broader literature on optimal tariffs reviewed by Caliendo and Parro [2022], showing that optimal uniform import tariffs are substantial—over 20% for the United States and China. While individual countries might benefit from unilateral tariffs, as shown by Opp [2010], retaliation cancels these gains and leaves all parties worse off than under free trade, consistent with Fajgelbaum et al. [2020]. Our approach relates to recent work on geopolitical fragmentation by Attinasi et al. [2023] and Gopinath et al. [2024].

The remainder of this paper proceeds as follows. Section 2 presents our model and extends sufficient statistics formulas to our particular framework. Section 3 presents results from different geoeconomic fragmentation scenarios, examining how fragmentation type affects outcomes and discussing country allocation across blocs and measures of trade dependence.

2 Model

We develop a multi-country multi-industry static general equilibrium (GE) model with input-output linkages that builds on the recent literature on quantitative international trade models. Labor is the only factor of production, is inelastically supplied, and perfectly mobile across industries. Wages and prices are completely flexible, so that all markets clear and there is no unemployment. Therefore, the model is better suited for the analysis of medium-to-long run effects of economic shocks or policies at the country or industry-by-country level.

The model adopts a static framework, i.e. the trade balance is exogenous.[3] The model is

[3] In calibrations, we assume that their value relative to the US wage stays constant. This assumption implies that, in the simulations with unbalanced trade, the choice of the *numeraire* matters. In most simulations, however, we proceed in two steps. First, we shock deficits so that trade is balanced for each country in the new equilibrium. In a second step, we then introduce the policy or shock of interest and compute the change starting from the balanced trade equilibrium.

therefore not suited to answer any questions about the dynamic adjustment of the current account over time to a specific shock. Additionally, the model is *real*; it includes neither money nor nominal variables. All prices only have meaning in *relative* terms. That is, the model can tell us what the effect of a certain shock will be on the relative wage in the US vs China, or on the real wage in the US, but not on the nominal wage in the US. The model is therefore also not suited to think about nominal shocks, and in particular there are no central banks in the model.

The model is implicitly calibrated so that it matches perfectly the international input-output table provided by the OECD. In this table, each observation X_{ijst} represents sales from industry s in country i to industry t in country j. Initially, the model matches these flows in equilibrium.

Besides the standard set of shocks in trade models (iceberg transaction costs, productivity shocks, changes in deficits), we pay particular attention to trade policies. In particular we allow for both import and export tariffs, where revenues from tariffs are redistributed lump-sum to the residents of the country imposing them. We also allow for tariffs to be targeted, i.e. to apply only on products of a particular industry or against a particular partner country.

Upon specifying a shock, the model predicts changes in its endogenous variables, and we compute these changes using exact hat algebra. Most importantly, we get predictions for the change in country-level GDP and welfare, but we also obtain predictions at the industry-level, such as the change in sales of a particular industry in a given country.[4]

Once we map it to the data, the model features 78 countries (and a additional Rest of the World region) and 44 industries covering both tradable and nontradable sectors.[5] It allows for heterogeneity in consumption and production patterns across countries and sectors, and for differences in input substitutability between different sectors. The model includes all major economies, with many smaller ones aggregated into a 'rest-of-the-world' (ROW) category.

The data on which the calibration is based consists of two matrices: X^C_{ijs}, the flow of final consumption of good from sector s coming from country i to country j, and X^M_{ijst}, the flow of intermediate goods from sector s from country i used in the production of the

[4] Real GDP is defined as the market value of production. Welfare equals real gross national expenditure (GNE) - which is the same as consumption as there is neither investment nor capital in the model. GDP and welfare can differ because the former values the real value of production and the latter the real value of consumer expenditure.

[5] The complete list of sectors can be found in the appendix. They are determined by the ICIO methodological choices.

good from sector t in country j.

2.1 Households

Each economy j is populated by L_j identical households who supply labor inelastically and consume an aggregate good:

$$C_j = \left(\sum_s e_{js}^{\frac{1}{\kappa}} C_{js}^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}$$

where we allow for different consumption patterns across countries by introducing preference parameters e_{js}. Households maximize consumption subject to a budget constraint

$$X_j^C = w_j L_j + D_j + R_j,$$

which states that expenditure equals household income, which consists of labor income ($w_j L_j$), tariff revenue R_j, and an exogenous transfer from other countries (D_j), which represents the trade deficit.

This results in the following budget allocation:

$$X_{js}^C = \beta_{js}^C X_j^C \qquad \text{with} \qquad \beta_{js}^C = e_{js} \left(\frac{P_j^C}{P_{js}^C} \right)^{\kappa-1}$$

where $\beta_{js}^C = e_{js} \left(\frac{P_j^C}{P_{js}^C} \right)^{\kappa-1}$ is the endogenous share of expenditure that is spent on products of sector s, and this share depends on the price in sector s and prices of all other sectors through the CES aggregator P_j^C.

We model trade in an Armington way: Within a sector, each country produces a distinct variety of a good, and consumers consume an aggregate of these varieties:

$$C_{js} = \left(\sum_i d_{ijs}^{\frac{1}{\mu_s}} C_{ijs}^{\frac{\mu_s-1}{\mu_s}} \right)^{\frac{\mu_s}{\mu_s-1}}$$

C_{ijs} denotes the quantity of the variety produced by country i in sector s consumed in country j. We again allow for preference parameters d_{ijs} to accommodate different consumption patterns across countries.

This implies that the allocation of consumer expenditure is

$$X_{ijs}^C = \pi_{ijs}^C X_{js}^C$$

where π_{ijs}^C is the share of total consumer expenditure of country j and sector s that goes towards products from country i:

$$\pi_{ijs}^C = d_{ijs}\left(\frac{P_{js}^C}{p_{ijs}}\right)^{\mu_s-1}$$

The price indices P_j^C and P_{js}^C take the familiar CES form.

2.2 Firms

In each country, each sector exhibits perfect competition with constant returns to scale. The production function is:

$$Q_{jt} = Z_{jt}L_{jt}^{1-\sigma_{jt}}M_{jt}^{\sigma_{jt}}$$

where M_{jt} is an aggregate intermediate good that aggregates across sectors and within sectors across different varieties. We write it as a nested CES:

$$M_{jt} = \left(\sum_i a_{jst}^{\frac{1}{\epsilon_t}} M_{jst}^{\frac{\epsilon_t-1}{\epsilon_t}}\right)^{\frac{\epsilon_t}{\epsilon_t-1}}$$

$$M_{jst} = \left(\sum_i b_{ijst}^{\frac{1}{\rho_{st}}} M_{ijst}^{\frac{\rho_{st}-1}{\rho_{st}}}\right)^{\frac{\rho_{st}}{\rho_{st}-1}}$$

Firms take all prices as given and select inputs to maximize profits. Demand for labor and for the aggregate intermediate input are:

$$w_j L_{jt} = (1-\sigma_{jt})Y_{jt}$$

$$P_{jt}^M M_{jt} = \sigma_{jt} Y_{jt}$$

Demand for the aggregate intermediate good from sector s is

$$X_{jst}^M = \beta_{jst}^M X_{jt}^M \qquad \text{with} \qquad \beta_{jst}^M = a_{jst}\left(\frac{P_{jt}^M}{P_{jst}^M}\right)^{\epsilon_t-1}$$

and with $X_{jt}^{M} = \sigma_{jt} Y_{jt}$. Demand by firms in sector t of country j for the variety produced by firms of country i in sector s is then

$$X_{ijst}^{M} = \pi_{ijst}^{M} X_{jst}^{M} \qquad \text{with} \qquad \pi_{ijst}^{M} = b_{ijst} \left(\frac{P_{jst}^{M}}{p_{ijs}} \right)^{\rho_{st}-1}$$

The price index for intermediate goods from sector s used by country j and sector t takes on the typical CES form:

$$P_{jst}^{M} = \left(\sum_{i} b_{ijst} p_{ijs}^{1-\rho_{st}} \right)^{\frac{1}{1-\rho_{st}}}$$

and similarly for P_{jt}^{M}.

2.3 Transaction Costs and Tariffs

Trade is subject to iceberg transaction costs. More precisely, $t_{ijs} \geq 1$ units of a good must be shipped for one unit of good s to arrive from country i to country j. This transaction cost is not a transport cost, since the model features a separate sector providing transport cost services. The transaction cost comes from informational asymmetries and other non-tariff barriers and might increase for example if certain types of imports are banned. The total quantity produced is given by:

$$Q_{is} = \sum_{j} t_{ijs} Q_{ijs},$$

where $Q_{ijs} = C_{ijs} + \sum_t M_{ijst}$ is the quantity used in country j for consumption or intermediate use.

We allow for a rich set of trade policy choices in the form of ad valorem tariffs on imports and exports. The tariff rate for imports of good s from country i to country j is denoted τ_{ijs}^{M} and the export tariff rate τ_{ijs}^{X}. Both tariff rates may be negative, in which case countries would be subsidizing imports or exports.

Since firms are in perfect competition, prices equal marginal production cost multiplied by transaction costs, export and import tariffs:

$$p_{ijs} = t_{ijs}(1 + \tau_{ijs}^{X} + \tau_{ijs}^{M}) mc_{is}$$

where mc_{is} are marginal cost of production and are given by:

$$mc_{is} = (w_{is})^{1-\sigma_{is}} \left(P_{is}^{M}\right)^{\sigma_{is}} Z_{is}^{-1}$$

Tariff revenue is redistributed to households as a lump-sum transfers, calculated for each country j as:

$$R_j = \sum_i \sum_s \frac{\tau_{ijs}^{M}}{1+\tau_{ijs}^{M}+\tau_{ijs}^{X}} X_{ijs} + \sum_k \sum_s \frac{\tau_{jks}^{X}}{1+\tau_{jks}^{M}+\tau_{jks}^{X}} X_{jks}$$

Tariff revenue can be negative, in particular in the case of export subsidies.

2.4 Equilibrium

At equilibrium, households maximize their utility, firms maximize profits, and all markets clear. This implies that

$$Y_{is} = Y_{is} = \sum_j X_{ijs} = \sum_j \frac{1}{(1+\tau_{ijs}^{X}+\tau_{ijs}^{M})} X_{ijs}$$

with $X_{ijs} = X_{ijs}^{C} + \sum_t X_{ijst}^{M}$. We also define the total import wedge:

$$\Gamma_{ijs} = t_{ijs}(1+\tau_{ijs}^{X}+\tau_{ijs}^{M})$$

The labor market in each country clears:

$$L_i = \sum_s L_{is}$$

In order to solve for the equilibrium, we use hat algebra, a technique first suggested by Dekle et al. [2008]. The only parameters we need to calibrate are elasticities κ, μ_s, ϵ_s, and ρ_{st}. For each variable, let x denote its initial equilibrium value, x' the new equilibrium value after a shock, and $\hat{x} = \frac{x'}{x}$ the variation from one equilibrium to the next. We then solve the model in changes $\hat{x}$. All equations required to compute the equilibrium are described in Appendix A.

To solve the model, we need to set a numeraire, i.e., a good whose price does not change after the shock.[6] We choose the U.S. wage as numeraire, which implies that $\hat{w}_{US} = \frac{w'_{US}}{w_{US}} =$

[6]Note that the "numeraire" definition is only about price changes, as the price level in the initial

1. All other changes in wages and prices are then expressed in terms of US labor. As long as trade is balanced, the choice of the numeraire has no impact. However, allowing for exogenously fixed and non-null trade deficits and surpluses between countries means the choice of numeraire can significantly impact welfare outcomes under various shocks. To avoid this problem in our counterfactual exercises, we first run a simulation where we set deficits to zero and compute the new equilibrium, and then introduce the shock of interest departing from that intermediate equilibrium.

2.5 Parameters

The only parameters of the model are the elasticities.[7] Indeed, the computational method makes it irrelevant to determine the preference weight parameters, and we only need the values of trade flows that are available in the data. There are four different levels of elasticities that matter in the model.

The elasticity of substitution in consumption between aggregate sectors κ: This elasticity determines how much the consumer can substitute between final goods from different sectors (say, between cars and computers). We assume a low value of 0.9 for this elasticity, in alignment with Baqaee and Farhi [2019]. A choice of a value below one means that the consumer spending share of a sector should go up when its price increases.

The production elasticity of substitution in sector t between inputs from different aggregate sectors ϵ_t: For our benchmark estimations, we assume a uniformly low elasticity across sectors, set to 0.2. This low value means that, for example, steel cannot be replaced easily by electronics in the making of a car.

The elasticity of substitution between different varieties of the same final good t μ_t: This elasticity determines how much the consumer can substitute between aggregate different varieties of the same sectoral good originating from different countries. For goods, we use the database from Fontagné et al. [2022] to determine the elasticities. By utilizing tariff data at the HS6 level and leveraging the cross-sectional variation of tariffs on identical goods, their method enables the aggregation of HS6 codes to the ICIO level. By using the broad economic classification categories, imports of final goods can be distinguished from imports of intermediate goods, which enables the computation of elasticities specific to final goods.

stationary equilibrium does not matter for our solution.

[7] We thank Lionel Fontagné for his help in this section of the paper.

The elasticity of substitution between different varieties of the same intermediate good s ρ_{st}: This elasticity determines how much the producer can substitute between aggregate different varieties of the same sectoral intermediate good originating from different countries. While the model allows in principle for these elasticities to be sector-pair specific, the elasticities from Fontagné et al. [2022] are only specific to the supplying sector, i.e. we restrict the elasticities so that $\rho_{st} = \rho_s$. However, the elasticities differ from the consumer elasticities, since they are based on the BEC category of intermediate goods.[8] We provide the full detail on our elasticities ρ_s and μ_s in Table D.2.

Elasticity between similar services from different countries: because determining elasticities for trade in services is more challenging than for goods, we assume they are equal to 5. This value is close to the benchmark elasticity of substitution for varieties of the same good in trade literature - and close to the mean of the distribution for elasticities on goods computed by Fontagné et al. [2022]. We also used it for goods for which the method in Fontagné et al. [2022] did not give results.

2.6 Welfare Effects of Trade in GVC Models

In this section, we derive a sufficient statistic result in the spirit of ACR 2012 to study the domestic welfare effects of any foreign shock. That is, we look at a version of the model without deficits ($D_i = 0$) and with zero initial tariffs. Under these conditions, welfare is given by the real wage. Foreign shocks can be any combination of foreign productivity shocks, transaction costs, and tariffs imposed by foreign countries. Tariffs imposed by the domestic economy are not allowed since these would create domestic revenues, and welfare would no longer equal the real wage.

Take a country j, and assume its wage is the *numeraire*, so that $\hat{w}_j = 1$. We have:

$$\hat{P}_j^C = \left(\sum_s \beta_{js}^C \left(\hat{P}_{js}^C \right)^{1-\kappa} \right)^{\frac{1}{1-\kappa}}.$$

We then look at the domestic consumer share of expenditure in sector s:

$$\hat{\pi}_{jjs}^C = \left(\frac{\hat{P}_{js}^C}{\hat{p}_{jjs}} \right)^{\mu_s - 1}.$$

[8] The elasticities computed by the method are the trade elasticities and are therefore not exactly equal to structural elasticities of the model: if the trade elasticity is ϵ_t, then the structural elasticity is $\rho_t = \epsilon_t$.

Since we are only looking at foreign shocks, the change in the domestic producer price is

$$\hat{p}_{jjs} = \left(\hat{P}^M_{js}\right)^{\sigma_{js}}.$$

From this we get:

$$\hat{P}^C_{js} = \left(\hat{P}^M_{js}\right)^{\sigma_{js}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}}.$$

We next derive an expression for the change in the intermediate goods price index of sector s, $\hat{P}^M_{js}$. Using the price index formula gives the following formula:

$$\hat{P}^M_{js} = \left(\sum_v \beta^M_{jvs} \left(\hat{P}^M_{jvs}\right)^{1-\epsilon_s}\right)^{\frac{1}{1-\epsilon_s}}.$$

The domestic intermediate share of sector s purchasing from sector v is:

$$\hat{\pi}^M_{jjvs} = \left(\frac{\hat{P}^M_{jvs}}{\hat{p}_{jjv}}\right)^{\rho_{vs}-1} = \left(\frac{\hat{P}^M_{jvs}}{\left(\hat{P}^M_{jv}\right)^{\sigma_{jv}}}\right)^{\rho_{vs}-1} \quad \rightarrow \quad \hat{P}^M_{jvs} = \left(\hat{P}^M_{jv}\right)^{\sigma_{jv}} \left(\hat{\pi}^M_{jjvs}\right)^{\frac{1}{\rho_{vs}-1}}.$$

If we plug this into the price index expression we get:

$$\hat{P}^M_{js} = \left(\sum_v \beta^M_{jvs} \left(\left(\hat{P}^M_{jv}\right)^{\sigma_{jv}} \left(\hat{\pi}^M_{jjvs}.\right)^{\frac{1}{\rho_{vs}-1}}\right)^{1-\epsilon_s}\right)^{\frac{1}{1-\epsilon_s}} \tag{1}$$

To proceed to a closed-form solution of this equation we need to make the simplifying assumption that the elasticity of substition between different sectoral aggregates of intermediate goods is one ($\epsilon_s = 1$). In that case we obtain:

$$\hat{P}^M_{jt} = \prod_v \left(\hat{\pi}^M_{jjvt}\right)^{\frac{\beta^M_{jvt}}{\rho_{vt}-1}} \left(\hat{P}^M_{jv}\right)^{\sigma_{jv}\beta^M_{jvt}}.$$

Let B_j be the $S \times S$ matrix with entries β_{jvt} so that $B_j = v \downarrow [\beta^M_{jvt}]_{\rightarrow t}$, and $\Gamma_j = diag(\sigma_{jv})$, and let δ_{jst} be the (s,t) element of the matrix $(I - B'_j \Gamma_j)^{-1}$. Then we have

$$\hat{P}^M_{js} = \prod_t \prod_v \left(\hat{\pi}^M_{jjvt}\right)^{\delta_{jst}\frac{\beta^M_{jvt}}{\rho_{vt}-1}}.$$

We then arrive at an expression for the welfare change from any foreign shock that extends the ACR formula to our framework:

$$
\begin{aligned}
\hat{W}_j = \frac{1}{\hat{P}_j^C} &= \left(\sum_s \beta_{js}^C \left(\hat{P}_{js}^C\right)^{1-\kappa}\right)^{\frac{1}{\kappa-1}} \\
&= \left(\sum_s \beta_{js}^C \left(\left(\hat{P}_{js}^M\right)^{\sigma_{js}} \left(\hat{\pi}_{jjs}^C\right)^{\frac{1}{\mu_s-1}}\right)^{1-\kappa}\right)^{\frac{1}{\kappa-1}} \\
&= \left(\sum_s \beta_{js}^C \left(\left(\prod_t \prod_v \left(\hat{\pi}_{jjvt}^M\right)^{\delta_{jst}\frac{\beta_{jvt}^M}{\rho_{vt}-1}}\right)^{\sigma_{js}} \left(\hat{\pi}_{jjs}^C\right)^{\frac{1}{\mu_s-1}}\right)^{1-\kappa}\right)^{\frac{1}{\kappa-1}}. \qquad (2)
\end{aligned}
$$

This is the exact domestic welfare change of any foreign shock if $\epsilon_s = 1$. In the more general case of $\epsilon_s \neq 1$, this expression still represents a first-order approximation of the welfare change.[9]

This formula extends the traditional ACR formula to our GVC model. Given the higher complexity of the model, it involves more variables, some of which are more difficult to measure than import shares, and we need to utilize sectoral data. Trade flows alone are insufficient; due to the global value chain's complexity and the potential for substitution across different intermediate goods, it is essential to consider each sector's usage in intermediate production, necessitating imputation methods like the ICIO or microeconomic data.

This formula can be compared to some of the results available in Galle et al. [2023], which included trade models involving heterogeneous groups of workers and regions. Galle et al. [2023] contains a formula for a model with intermediate goods but with a simpler intermediate production structure, using Cobb-Douglas aggregation.[10] The main focus of the paper was however redistribution within a country and not the role of intermediate production.

To better assess the significance of certain shocks on welfare, we compare the resulting welfare changes from trade cost shocks with the potential welfare losses that would arise if countries were to revert to trade autarky. That is, we look at the ratio

$$\frac{\log(\hat{W}_j)}{\log(\hat{W}_j^{Aut})}$$

. The denominator is the welfare change if a country were to revert back to autarky

[9] We can derive the same expression taking a first-order Taylor approximation of equation 1

[10] See Section 7 of Galle et al. [2023].

from the initial equilibrium, i.e. where $\hat{\pi}_{jjst} = \frac{1}{\pi_{jjst}}$ and $\hat{\pi}^C_{jjs} = \frac{1}{\pi^C_{jjs}}$ $\forall s, t$. This ratio has the advantage that for any trade cost shock that has negative welfare effects, the ratio is always between 0 and 1, and can be interpreted as the share of the gains from trade that is erased by the trade cost shock under consideration.

Additionally, if we place the further restrictions of Cobb-Douglas consumer utility across sectors, then this ratio is scale invariant with respect to the trade elasticity. Under that additional assumption the welfare formula reduces to:

$$\hat{W}_j = \prod_s \left(\left(P^M_{js}\right)^{\sigma_{js}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}} \right)^{-\beta^C_{js}} = \prod_s \left(\left(\prod_t \prod_v \left(\hat{\pi}^M_{jjvt}\right)^{\delta_{jst} \frac{\beta^M_{jvt}}{\rho_{vt}-1}} \right)^{\sigma_{js}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}} \right)^{-\beta^C_{js}},$$

and the log welfare change is:

$$\log(\hat{W}_j) = -\sum_s \sum_v \gamma_{js} \frac{\beta^M_{jvs}}{\rho_{vs} - 1} \log(\hat{\pi}_{jjvs}) - \sum_s \beta^C_{js} \frac{1}{\mu_s - 1} \log(\hat{\pi}^C_{jjs}),$$

where $\gamma_{js} \equiv \sum_t \beta^C_{jt} \sigma_{jt} \delta_{jts}$. Under this welfare formula, the ratio of welfare changes is invariant to the trade elasticity, i.e. it is unchanged for an arbitrary ϕ such that $\tilde{\rho}_{vs} - 1 = \phi(\rho_{vs} - 1)$ and $\tilde{\mu}_s - 1 = \phi(\mu_s - 1)$.

3 Numerical Exercises

In this section, we consider a few applications of the model to assess the potential impact of a trade decoupling scenario. The central scenario studied is one that has been discussed for example in Felbermayr et al. [2023], Góes and Bekkers [2022], and Bolhuis et al. [2023]. A bloc of US allies (the OECD minus Mexico and Turkey in our case) experience an increase in their trade costs with China and Russia, and also with their direct allies (Belarus, Hong Kong).[11] We assume other countries stay neutral.[12] We neutralized the

[11] More precisely, countries from "OECD" bloc whose data are included in the ICIO data are: Australia, Austria, Belgium, Canada, Chile, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Republic of, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and the United States. Countries from the Chinese bloc include Belarus, China, Hong Kong and Russia. We let Mexico and Turkey stay "neutral", considering they were part of the Chinese bloc in other similar exercises. We assume the "Rest of the World" country is neutral as well. In the scenario exposed later where every country takes part in the commercial war, we assumed "neutral" countries joined the Chinese side.

[12] Exports from one bloc to another could in principle transit through these neutral countries in a model, conditional on transaction costs being low enough. In the model, it can occur only to the extent

deficits in the data in order to avoid making our results depend on the choice of the *numeraire*. We study scenarios where transaction costs or tariffs are rising between the Eastern and Western bloc, but stay unchanged between either bloc and Neutral countries, and also within blocs.

We start with the analysis of world trade and world welfare for a fixed bloc composition, and consider three different scenarios for decoupling: Transaction costs, import tariffs, and export tariffs. Global trade and welfare fall with decoupling, with initial trade costs being particularly costly in terms of welfare. A complete decoupling leads to global losses in welfare (measured by real consumption) of roughly 0.8%. Welfare losses are larger when decoupling occurs through rising transaction costs compared to tariffs, as long as trade costs are not prohibitive, which happens at roughly a 200% increase in transaction costs and a 400% increase in either import or export tariffs.

We then move on to a specific scenario of a 20% increase in trade costs, driven by either higher transaction costs or tariffs, and study welfare at the country-level. Decoupling creates both winners and losers. Members of the Western and Eastern bloc lose from decoupling, and those losses are two to four times larger in scenarios of transaction costs compared to tariffs. In contrast, neutral countries gain from decoupling, and for these countries the source of decoupling (trade costs vs tariffs) does not matter since they do not collect tariff revenues.

Even though members of the Western and Eastern bloc lose from decoupling, a tariff war is an equilibrium outcome. We show that the tariff war has a prisoners' dilemma structure. Applying a unilateral import tariff is welfare improving for either bloc, and is also the best response to a tariff imposed by the opposing bloc.

The structure of welfare gains and losses from decoupling across countries implies that blocs are inherently unstable. Neutral countries gain from decoupling while both Eastern and Western bloc countries lose, giving rise to incentives to members of either bloc to become neutral. In the final set of exercises we therefore assume that neutral countries had to join either the Western or Eastern bloc, and we ask which bloc they would choose, based on economic motives.

that it is already captured in the initial ICIO data. For example, if there is a sector in Vietnam that produces cars with low value added using cars from China, it can be used to reroute imports with a lot of Chinese value added into the United States and reciprocally. In other words, in a decoupling scenario, the model should exacerbate already existing rerouting, but it will not make it possible to create new "routes" that do not yet exist.

3.1 The effect of decoupling on trade and global welfare

We start by assessing the effect of trade costs on trade and global welfare. Figure 3.1 shows the reduction of interbloc trade as a function of trade costs. We consider transaction costs, export tariffs and import tariffs as trade costs, but find that the type of trade cost does not matter for the decline in interbloc trade. Trade costs become prohibitive at around 200%, but this effect is highly nonlinear, with a trade decline of 75% that is already reached at less than a 50% trade cost.

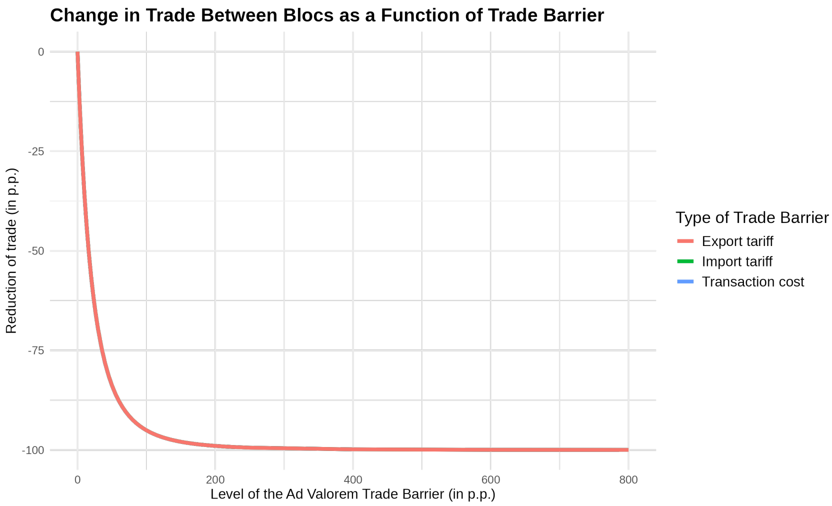


Figure 3.1: Change in interbloc trade as a function of the change in the interbloc trade costs, modeled as either transaction cost, export tariff, or import tariff. The line is an interpolation across 40 scenarios for each trade cost change.

We compute the elasticity of interbloc trade to trade costs in a regression on model-implied values using variation across different scenarios:

$$\log(\hat{T}_s^{blocs}) = C_0 + \alpha \log(\hat{\tau}_s) + \epsilon_s$$

We find a coefficient of $\hat{\alpha} = -4.0$ with an R^2 of 99.7% when estimating this equation via OLS over 40 scenarios. That is, a 1% increase in trade costs reduces interbloc trade by 4%. This reduced form aggregate elasticity of course depends on the pre-shock structure of global trade and production, and the calibrated elasticities.

Figure 3.2 shows the decline in world welfare, measured by world real consumption, as a function of the trade barrier. Initial increases in trade costs are particularly costly for world welfare, and welfare losses are larger for transaction costs compared to tariffs since the latter generate revenue. Once trade costs become prohibitive for interbloc trade, however, this difference vanishes. A complete decoupling of the Eastern and Western bloc would lead to an aggregate global decline in real consumption of 0.8%.

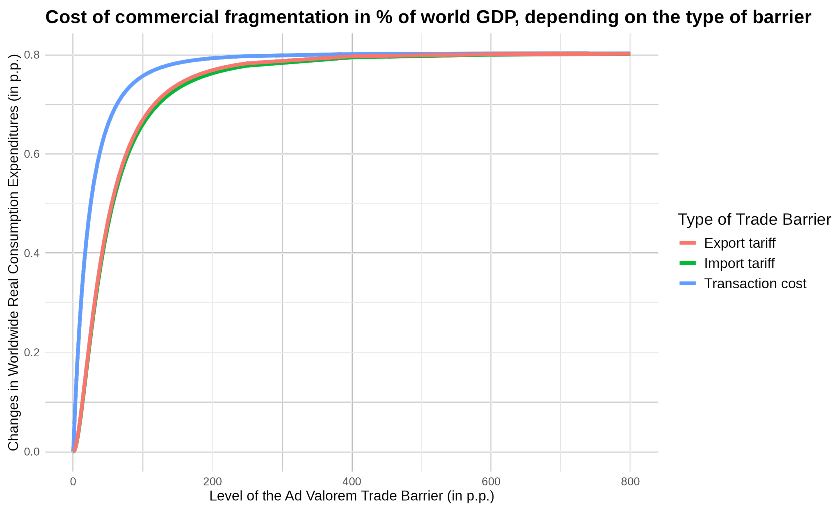


Figure 3.2: Cost of Rising Trade Barriers in a Geopolitical Fragmentation Scenario. Positive values on the vertical axis indicate a welfare loss.

3.2 Winners and Losers from Decoupling

We now focus on a specific scenario, a 20% increase in trade costs, and consider the distribution of welfare gains and losses across countries. We leave the analysis of welfare changes in the case of higher increases in trade costs to the appendix.[13]

First, we look at the impact on total trade between blocs as a function of tariffs between blocs, in Figure 3.3.[14] Trade between blocs declines steeply, by 64%, when 20% tariffs are implemented. This contributes to a 9.6% decline in world trade. This large impact is partially offset by an increase in trade within blocs (+2.2%, contributing to a 0.9% rise in world trade), and also by an increase in trade between each bloc and "neutral" economies (+2.2%, contributing to a 0.8% increase in world trade), with a negligible impact on trade within neutral economies. The total effect on world trade is negative: -7.9%. Our results also show that the effect of import tariffs on world trade is very similar to the impact of equivalent export tariffs or iceberg transaction costs.

Table 1 presents welfare changes for the main countries of the Western and Eastern blocs, and for several neutral economies, where the interbloc trade barrier takes the form of a

[13]Figures F.1 and F.2 show welfare changes by country as a function of the decline in interbloc trade induced by interbloc import tariffs. The results stay qualitatively the same.

[14]Trade is measured in real terms, using prices as they were before the initial rise in tariffs

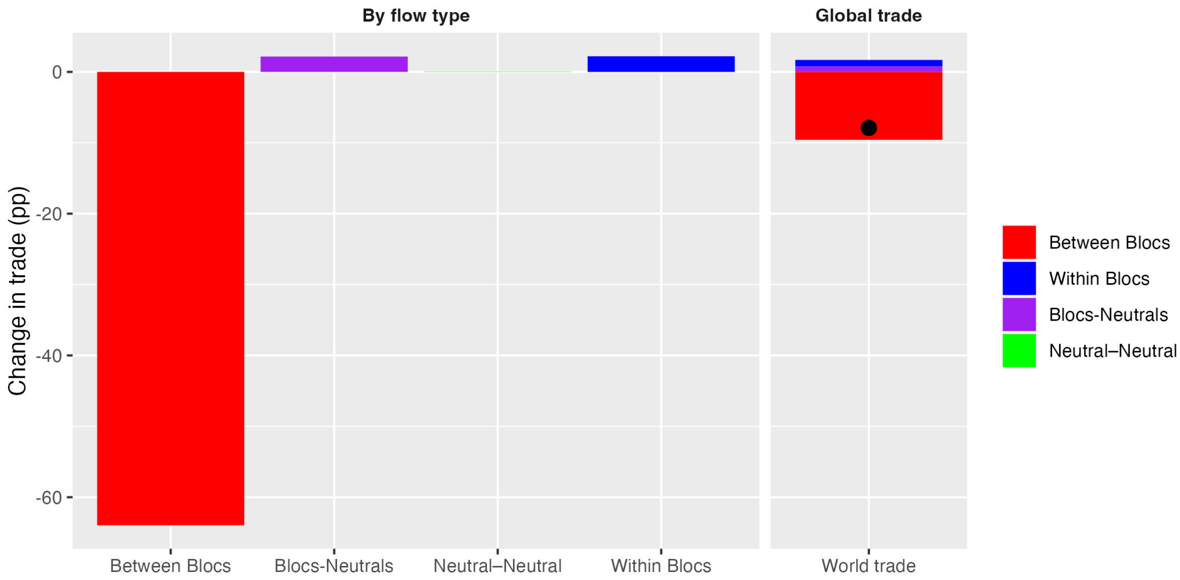


Figure 3.3: Impact of a 20%. rise in imports tariffs on trade between and within blocs (left), contributions to the evolution in global trade (right).

20% rise in either an import tariff, an export tariff, or a transaction cost. Figure 3.4 shows the distribution of welfare changes for the specific case of a 20% import tariff.

In each of the scenarios Eastern and Western bloc countries lose from decoupling, and more so when decoupling happens through transaction costs compared to tariffs. Among Western economies, welfare changes tend to be worse for countries that have close trade ties with the opposing bloc, such as South Korea and Australia.

Certain neutral economies benefit from the fragmentation, as they keep trading with the two blocs and benefit from the diversification attempts. Vietnam and Mexico are key economies in this regard, as they are able to export to the US some goods previously produced in China. These neutral economies are not affected much by the choice of restrictions, as their welfare change is essentially the same in all three scenarios.

China and Russia are more affected than the United States or European economies, which reflects the fact that they have less allies in this trade decoupling scenario. In general, welfare losses for countries in the Eastern and Western bloc are very different depending on the model specification. In particular, welfare losses tend to be 2-4 times larger under iceberg trade costs than under either export or import tariffs.

Table E.1 in the Appendix shows welfare gains for a "worst case" scenario from the perspective of the West in which all neutral countries are part of the Eastern bloc, and trade

Country	Import tariff	Export Tariff	Transaction
FRA	-0.20	-0.23	-0.42
DEU	-0.22	-0.26	-0.53
JPN	-0.24	-0.26	-0.56
KOR	-0.76	-0.46	-1.34
NLD	-0.10	-0.27	-0.48
GBR	-0.16	-0.19	-0.37
USA	-0.09	-0.15	-0.25
CHN	-0.41	-0.34	-0.98
RUS	-0.76	-0.69	-1.72
VNM	0.57	0.56	0.56
MEX	0.12	0.12	0.12
IND	0.05	0.05	0.05
SAU	0.05	0.06	0.06
BRA	0.03	0.03	0.03
Nominal Trade Between Blocs	-56.9	-56.9	-57.0

Table 1: Impact of a trade decoupling scenario in the presence of neutral countries, with a 20% increase in trade costs.

costs between the West and East grew by 20%. Welfare losses for Western countries are more sizable in this scenario, between one to three times higher than in Table 1, depending on the country and exact scenario. Welfare losses are also worse for Eastern countries, presumably because trade frictions now cover a larger share of world trade. Finally, all neutral countries suffer declines in welfare, reaching up to 5%, in these scenarios, highlighting that there are no economic motives for neutral countries to move to the Eastern bloc.

Finally, we compute the welfare losses from decoupling (through transaction cost) relative to welfare losses from returning to autarky, in the scenario where there are no neutral economies - we assume that all previously neutral economies join the Eastern bloc. This ratio can be interpreted as the share of the gains from trade that are eliminated by decoupling, and it depends less on the total size of gains from trade in the model.

To compute total gains from trade, we run a simulation where trade costs with *all* other trade partners increase to a prohibitive level.[15] Total costs from autarky are very different from one country to the other. The United States appears as one of the economies experiencing the least amount of gains from trade in our model, with gains up to 3.2% of its aggregate consumption. Gains from trade in our model are larger than gains from trade as computed for a standard Armington or Eaton-Kortum model by Arkolakis et al.

[15] To compute the welfare change for a return to autarky we assume that total iceberg transaction costs increase by 800%.

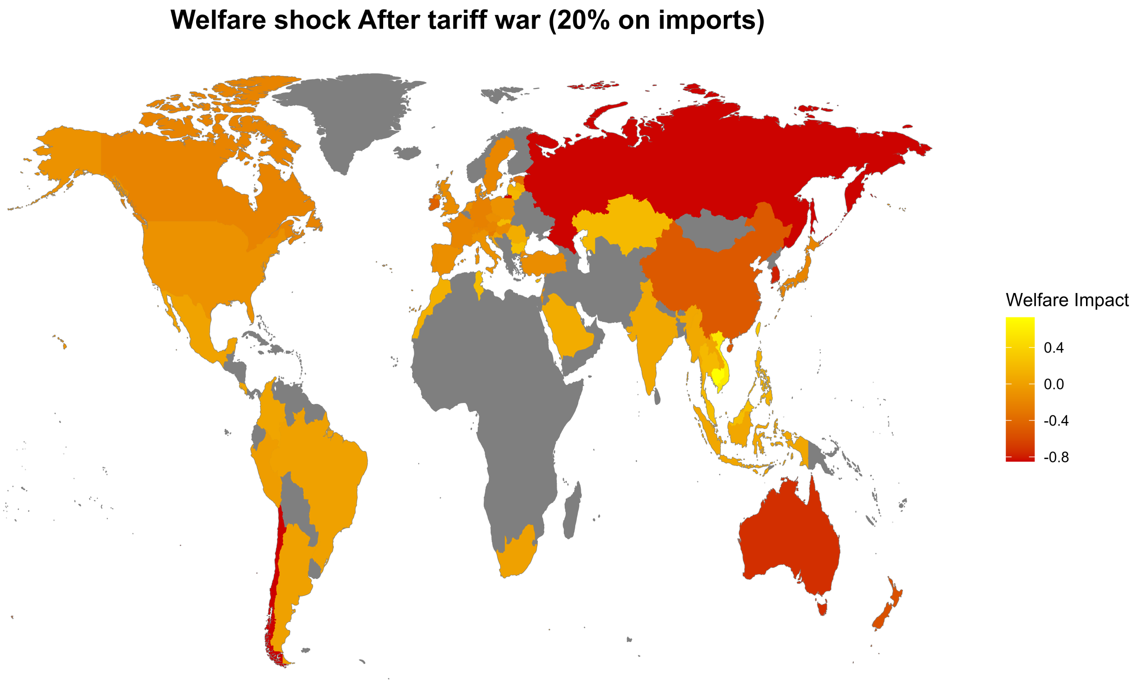


Figure 3.4: Impact of a rise in import tariffs on welfare.

[2012], whose range was between 0.7% and 1.4%.[16] China experiences larger gains from trade than the United States our model - 3.9%, and Russia even larger ones - 7.3%. More open economies experience substiantially larger gains from trade, which is a common feature of trade models with constant elasticities of trade.

Appendix Figure E.1 summarizes the results on the welfare ratio. The unweighted average welfare loss over countries is 16.0%. Countries that experience apparently small losses in terms of welfare sometimes experience large losses when compared to total gains from trade: losses are equivalent to 24.8% of total gains from trade for the United States, to 26.6% for China.

[16]In the Caliendo-Parro model with 29 sectors though, using the WIOD and other elasticities of substitution, gains from trade are larger than in our model: 8.0%. For a comparison of different results using various models, see Table 4.1 in Costinot and Rodríguez-Clare [2014]. In Baqaee and Farhi [2019], gains from trade are one of the motivations to make the model richer: "for the US, the gains from trade increase from 4.5% to 9% once we account for intermediates with a loglinear network, but they increase further to 13% once we account for realistic complementarities in production."

3.3 Prisoner's Dilemma Structure of Tariff Wars Between Blocs

We now show that, even though both blocs lose from rising trade costs, a tariff war with interbloc tariffs is an equilibrium outcome, conditional on assuming that countries join in opposing blocs. We analyze the welfare effects of unilateral tariffs, when one side applies import tariffs to the opposing bloc without any retaliation. We assume that all countries take a side and join a bloc, and consider the case where all previously neutral economies are part of the Eastern bloc.

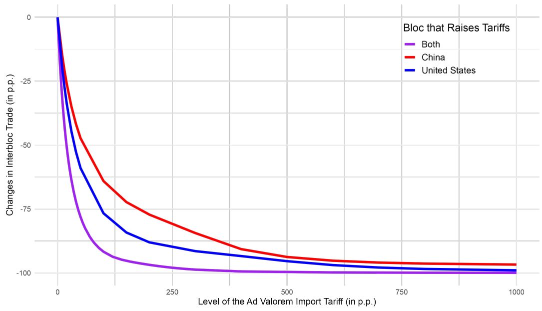
This exercise shows two results. First, trade wars where every economy sides with another economy are more damaging for neutral economies: for Vietnam, a tariff war implies a -2.5% welfare decline if Vietnam and other economies are part of the Eastern bloc, to be compared with a 0.6% welfare gain when they stay neutral. We tested other simulations showing that neutral economies do not benefit either from joining the Western bloc.

Second, it illustrates the prisoner's dilemma structure of tariff wars between opposite blocs, conditional on accepting this structure of opposing blocs. In this class of models, unilateral moderate levels of import tariffs are welfare-enhancing when they are imposed by a single country. We show below that this is also true at the level of the bloc: imposing unilateral tariffs at the bloc level is welfare-enhancing for all members of the bloc. As retaliatory tariffs are the best response to tariffs imposed by the other bloc, this implies that tariffs generate a prisoner's dilemma, in line with the optimal tariff argument, explained for example in Johnson [1953].

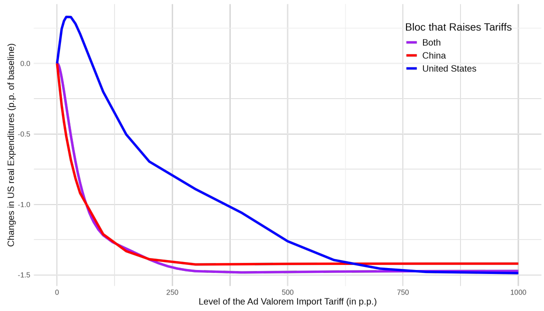
To start this exercise, we look at the impact on trade between blocs, as a function of the tariff rate and of the bloc that imposes tariffs in Figure 3.5a. We see that trade declines more in the case of a bilateral trade war than if either the United States bloc or the Chinese bloc imposes tariffs. Trade sanctions imposed by China alone have less global trade impact, for every level of tariff. Reciprocal tariffs are more damaging for trade overall.

Unilateral *tariffs* can generate gains for the countries that apply them.[17] For simplicity, in Figure 3.5b we focus on the two core bloc countries, US and China, but the structure of welfare gains and losses from uniltateral and bilateral tariffs extends to other bloc members. For tariffs below 100%, the United States benefits from imposing tariffs on its own, without facing retaliation, as it is shown in Figure 3.5b. The US also loses more from a unilateral Chinese bloc import tariff, as it is shown in this same graph.

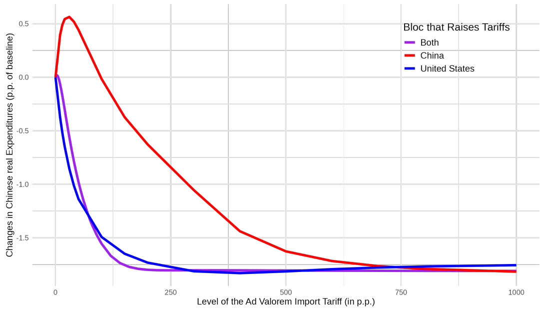
[17] This result does not hold for iceberg transaction costs, as they involve losses for the countries that implement the rise.



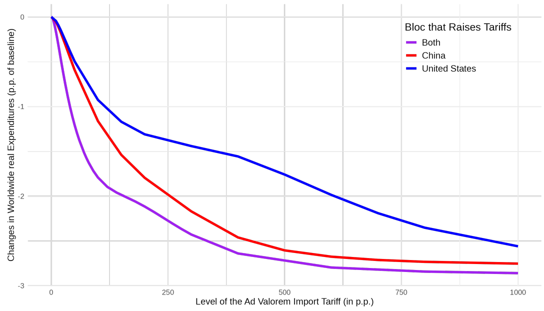
(a) Reduction of Trade between Blocs



(b) US Real Consumption Change



(c) China Real Consumption Change



(d) World Real Consumption Change

Figure 3.5: Trade and Welfare Outcomes in scenarios of a unilateral Western-bloc tariff (blue lines), a unilateral Eastern-bloc tariff (red lines), and both tariffs (purple lines)

For moderate levels of tariffs, retaliating symmetrically against Chinese tariffs improves welfare for the US - the purple line is above the red one. For large enough levels of tariffs, however, welfare losses associated with a US bloc unilateral tariff become very close to those associated with a reciprocal or adverse tariff. Indeed, for prohibitive levels of tariffs, as tariff income from the tariffs becomes negligible, terms of trade gains become small and the difference between unilateral and bilateral tariffs becomes negligible - indeed, trade must be balanced between blocs, as there are no neutral economies.[18] The price distortion is such that, at prohibitive tariff levels, it might be more interesting for an economy not to retaliate. In Figure 3.5c, we show the same relationships hold from the perspective of China, when it faces tariffs from the United States or implements its own tariffs.

This is also true for other countries in the blocs, as we show in Table 2 for the case of a 20% (bilateral or unilateral) tariff. At this moderate level of tariffs, all our economies of

[18]We assume that trade is balanced for all economies: for any i, $\sum_j T_{ij} - T_{ji} = 0$. As a consequence, merging countries within a bloc implies that trade with the complementary bloc is balanced.

interest benefit from applying a unilateral bloc tariff, and the best response to a tariff by the opposing bloc is in turn to apply a tariff. Therefore, the prisoner's dilemma is not only true at the individual level of countries but also at the collective level for blocs.

Country	CHN shoots	USA shoots	Both shoot
FRA	-0.76	0.40	-0.39
DEU	-0.84	0.49	-0.47
JPN	-0.93	0.56	-0.38
KOR	-1.98	1.11	-0.79
NLD	-0.99	0.86	-0.36
GBR	-0.63	0.25	-0.49
USA	-0.52	0.33	-0.30
CHN	0.54	-0.65	-0.30
RUS	0.84	-1.16	-0.58
VNM	1.81	-3.60	-2.46
MEX	1.02	-2.54	-1.82
IND	0.23	-0.81	-0.64
SAU	1.19	-1.28	-0.41
BRA	0.64	-0.65	-0.19

Table 2: Impact of a trade decoupling scenario with a 20% tariff, distinguishing unilateral and symmetric trade wars.

We also show the impact of asymmetric and symmetric trade wars between blocs at the worldwide level in Figure 3.5d. At the worldwide level, asymmetric trade war is always better than reciprocal trade war in our simulations - as asymmetric trade wars means less distortions in total. One can also note that the impact is lower if the United States and Western bloc is the only bloc imposing a unilateral import tariff.

3.4 Bloc Formation when Neutral Countries can Choose

Our results from section 3.2 show that in a setting with neutral countries and two opposite blocs, countries from the two opposing blocs lose from decoupling, while bystanding neutral countries tend to gain or experience small shocks from trade war. This raises the question of bloc stability in such an exercise. How can blocs be maintained over time if countries can also choose to become neutral? One possibility is that both blocs can exercise threats or non-commercial policies towards the neutral countries that would force the neutral countries to choose a side.

In this section, we consider a trade war scenario where each country is forced to choose a bloc. Is there a natural coalition that emerges? We assume that there are countries which are assumed to form a core bloc with either the US or China, and we let the remaining countries choose a bloc.[19]

We start from our main scenario: a 20% increase in trade costs (modeled here as iceberg transaction costs) between the East and the West. We then consider the choice of any given neutral country if it has to join one of these two blocs. The key issue is that the choice of a given neutral country will depend on the choice of the remaining neutral countries. We use the insight that a bloc becomes more appealing as it grows. Therefore, if a given neutral country, say Mexico, still wants to join the bloc of the United States even under the assumption that all other undetermined countries join the bloc of China, it means its commercial interests are aligned with those of the United States. If the reverse holds for the Chinese bloc, then Mexican commercial interests are considered aligned with those of China. Finally, if neither is true, then Mexican interests are not clearly aligned with either bloc.

For each neutral country (Mexico in this example) we therefore run the four following simulations of decoupling:

- One where all the neutral countries, Mexico included, join the commercial bloc of China (East).
- One where all the neutral countries, except Mexico, join the commercial bloc of the United States (West) and Mexico joins East.
- One where all the neutral countries, Mexico included, join West.
- One where all the neutral countries, except Mexico, join East and Mexico joins West.

Then, we compare welfare gains if Mexico alone joins West (when all other countries join East) to welfare gains when Mexico also joins East with all other countries. If it is better off when it joins West, it should join the US bloc. We do the same test for every country, and also test for whether they would join East. Then, we assume those countries join the bloc in which they are better off even in this worst case scenario. Then, with the newly defined blocs, we run the test again for all other undetermined economies.[20]

[19]Chinese core bloc is made of Belarus, China, Hong Kong and Russia. US core bloc is made of a subset of the OECD: the United States, OECD members in the European Union and Cyprus, Australia, Canada, Chile, Iceland, New Zealand, Norway, Japan, South Korea, Switzerland, United Kingdom.

[20]Note that we treat the Rest of the World regions as a unified economy, which might have consequences for our bloc determination algorithm. It might be that with a finer division, many economies from the aggregated Rest of the World would not have joined the US bloc, which might have an impact for next iterations. In the map of Figure 3.6, Rest of the World countries are hatched.

In our assumptions, the US bloc is considerably larger than the Chinese bloc.[21] As a consequence, it is more attractive, and after 8 iterations, it ends up attracting all other economies in the data, including the aggregated Rest of the World economy (at wave 4). Among the countries that join in the first iteration are Mexico, Morocco, and Tunisia. Based on these countries joining in round one, several other countries (including Colombia and Ivory Coast) are incentivized to join in round two. Countries geographically closest to China join the US bloc in later rounds, which reflects the fact that they need a bigger US coalition to be interested in joining the US bloc. Results are shown in Figure 3.6. Each shade of blue represents a different iteration, which might be interpreted as the proximity with the core US bloc relative to the core Chinese bloc.

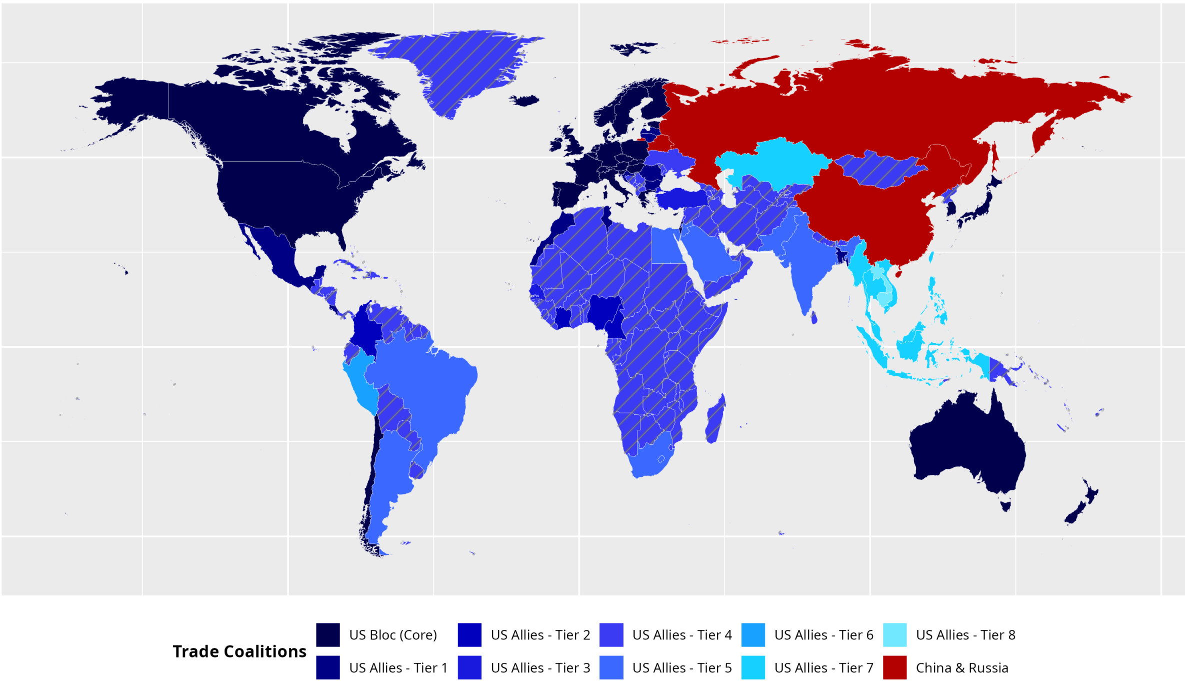


Figure 3.6: Countries by "Tiers": blocs and the iteration at which each country joins the US bloc. *Note: Hatched regions correspond to countries belonging to the aggregate "Rest of the World" region.*

[21]The core Western bloc represents 57% of world GDP in our data and its exports represent 58% of world trade. GDP of the Eastern bloc represents 21% of world GDP and its exports represent only 14% of total world trade.

4 Conclusion

In this paper, we study the impact of geoeconomic fragmentation in GVC trade models, focusing on scenarios of rising trade costs between an Eastern and a Western bloc, with some countries remaining neutral. While rising interbloc trade costs imply rapidly declining interbloc trade, the effect on world trade is partially mitigated by a contemporaneous increase in intra-bloc trade and trade with neutral countries. The world as a whole loses from bloc decoupling, and these losses are naturally larger if decoupling occurs through iceberg transaction costs compared to tariffs, since the latter generate revenue.

Even though the world as a whole and also all member states of the Western and Eastern bloc lose from decoupling, we show that a tariff war between blocs with intermediate tariffs is an equilibrium outcome, as bloc tariffs have a prisoners' dilemma structure. While being part of the bloc that initiates the tariff war is welfare-improving, it also entails facing retaliations that create losses worse than the initial gains from unilateral (at the bloc-level) tariffs.

While all member states of the Western and Eastern bloc lose from decoupling, neutral countries tend to gain as they start to trade more with both blocs. We show that most "neutral" countries are better off if they stay neutral and do not take sides. In the event when neutral economies are forced to choose a bloc, we show that the bigger bloc has the advantage over the other: being part of a larger coalition matters. As the core Western bloc represented almost 50% of world GDP in our model, it had a clear advantage over the smaller Eastern bloc to increase membership.

These scenarios did not explore the possibility of tariffs that depend on the sectors. Investigating optimal unilateral tariff policies at the sectoral level, potentially taking into account policy-motivated preferences for certain sectors such as agriculture or specialized industries, might be important to advance further on the costs and likely scenarios of geoeconomic fragmentation. Such a study would tell us more about the incentives associated with joining or avoiding trade wars for most economies.

References

Costas Arkolakis, Arnaud Costinot, and Andrés Rodríguez-Clare. New trade models, same old gains? *American Economic Review*, 102(1):94–130, 2012.

Maria Grazia Attinasi, Lukas Boeckelmann, and Baptiste Meunier. Friend-shoring global value chains: a model-based assessment. *ECB Economic Bulletin*, (2), 2023.

David Baqaee and Emmanuel Farhi. Networks, barriers, and trade. Technical report, National Bureau of Economic Research, 2019.

Marijn A Bolhuis, Jiaqian Chen, and Benjamin Kett. The costs of geoeconomic fragmentation. *Timely. Topical. Free.*, page 35, 2023.

Lorenzo Caliendo and Fernando Parro. Estimates of the trade and welfare effects of nafta. *The Review of Economic Studies*, 82(1):1–44, 2015.

Lorenzo Caliendo and Fernando Parro. Trade policy. *Handbook of International Economics*, 5:219–295, 2022.

Arnaud Costinot and Andrés Rodríguez-Clare. Trade theory with numbers: Quantifying the consequences of globalization. In *Handbook of international economics*, volume 4, pages 197–261. Elsevier, 2014.

Robert Dekle, Jonathan Eaton, and Samuel Kortum. Global rebalancing with gravity: Measuring the burden of adjustment. *IMF Staff Papers*, 55(3):511–540, 2008.

Pablo D Fajgelbaum, Pinelopi K Goldberg, Patrick J Kennedy, and Amit K Khandelwal. The return to protectionism. *The Quarterly Journal of Economics*, 135(1):1–55, 2020.

Gabriel Felbermayr, Hendrik Mahlkow, and Alexander Sandkamp. Cutting through the value chain: The long-run effects of decoupling the east from the west. *Empirica*, 50 (1):75–108, 2023.

Lionel Fontagné, Houssein Guimbard, and Gianluca Orefice. Tariff-based product-level trade elasticities. *Journal of International Economics*, 137:103593, 2022.

Simon Galle, Andrés Rodríguez-Clare, and Moises Yi. Slicing the pie: Quantifying the aggregate and distributional effects of trade. *The Review of Economic Studies*, 90(1): 331–375, 2023.

Carlos Góes and Eddy Bekkers. The impact of geopolitical conflicts on trade, growth, and innovation. *arXiv preprint arXiv:2203.12173*, 2022.

Gita Gopinath, Pierre-Olivier Gourinchas, Andrea Presbitero, and Petia B Topalova. Changing global linkages: A new cold war? 2024.

Harry G Johnson. Optimum tariffs and retaliation. *The Review of Economic Studies*, 21 (2):142–153, 1953.

Marcus M Opp. Tariff wars in the ricardian model with a continuum of goods. *Journal of International Economics*, 80(2):212–225, 2010.

A Appendix: Equilibrium Equations

The system of equations of the exact solution in variation is given by:[22]

$$\hat{w}_i = \sum_s \frac{VA_{is}}{VA_i}\hat{Y}_{is} \qquad N \text{ eqns} \tag{A.1}$$

$$\hat{Y}_{is} = \sum_j \left(\frac{X^C_{ijs}}{Y_{is}}\hat{\pi}^C_{ijs}\hat{\beta}^C_{js}\left(\frac{VA_j}{X^C_j}\hat{w}_j + \frac{D_j}{X^C_j}\hat{D}_j + \frac{R'_j}{X^C_j}\right) + \sum_t \frac{X^M_{ijst}}{Y_{is}}\hat{\pi}^M_{ijst}\hat{\beta}^M_{jst}\hat{Y}_{jt}\right) \qquad NS \text{ eqns} \tag{A.2}$$

$$\hat{\beta}^M_{jst} = \left(\frac{\hat{P}^M_{jt}}{\hat{P}^M_{jst}}\right)^{\epsilon_t - 1} \qquad NS^2 \text{ eqns} \tag{A.3}$$

$$\hat{\pi}^M_{ijst} = \left(\frac{\hat{P}^M_{jst}}{\hat{p}_{ijs}}\right)^{\rho_{st} - 1} \qquad N^2S^2 \text{ eqns} \tag{A.4}$$

$$\hat{P}^M_{jt} = \left(\sum_s \beta^M_{jst}(\hat{P}^M_{jst})^{1-\epsilon_t}\right)^{\frac{1}{1-\epsilon_t}} \qquad NS \text{ eqns} \tag{A.5}$$

$$\hat{P}^M_{jst} = \left(\sum_i \pi^M_{ijst}\hat{p}_{ijs}^{1-\rho_{st}}\right)^{\frac{1}{1-\rho_{st}}} \qquad NS^2 \text{ eqns} \tag{A.6}$$

$$\hat{p}_{ijs} = \hat{\Gamma}_{ijs}\left(\hat{w}_i\right)^{1-\sigma_{is}}\left(\hat{P}^M_{is}\right)^{\sigma_{is}}\hat{Z}^{-1}_{is} \qquad N^2S \text{ eqns} \tag{A.7}$$

[22] We do not use hat variation for tariff revenue to allow an initial state with null tariffs.

$$\hat{\pi}^C_{ijs} = \left(\frac{\hat{P}^C_{js}}{\hat{p}_{ijs}}\right)^{\mu_s-1} \qquad N^2S \text{ eqns} \tag{A.8}$$

$$\hat{\beta}^C_{js} = \left(\frac{\hat{P}^C_{j}}{\hat{P}^C_{js}}\right)^{\kappa-1} \qquad NS \text{ eqns} \tag{A.9}$$

$$\hat{P}^C_{js} = \left(\sum_i \pi^C_{ijs}\hat{p}^{1-\mu_s}_{ijs}\right)^{\frac{1}{1-\mu_s}} \qquad NS \text{ eqns} \tag{A.10}$$

$$\hat{P}^C_{j} = \left(\sum_s \beta^C_{js}\hat{P^C}^{1-\kappa}_{js}\right)^{\frac{1}{1-\kappa}} \qquad N \text{ eqns} \tag{A.11}$$

Tariff revenues in the new equilibrium are determined by tariffs and trade flows:

$$R'_j = \sum_i \sum_s \frac{\tau^{M\prime}_{ijs}}{1+\tau^{M\prime}_{ijs}+\tau^{X\prime}_{ijs}} X'_{ijs} + \frac{\tau^{X\prime}_{jis}}{1+\tau^{M\prime}_{jis}+\tau^{X\prime}_{jis}} X'_{jis}$$

where $X_{ijs} = X^C_{ijs} + \sum_t X^M_{ijst}$. The previous equation can then be written as:

$$\begin{aligned} R'_j = & \sum_i \sum_s \frac{\tau^{M\prime}_{ijs}}{1+\tau^{M\prime}_{ijs}+\tau^{X\prime}_{ijs}} \Big(\pi^{C\prime}_{ijs}\beta^{C\prime}_{js}(VA_j\hat{w}_j + \hat{D}_jD_j + R'_j) + \sum_t \hat{\pi}^M_{ijst}\hat{\beta}^M_{jst}\hat{Y}_{jt}X^M_{ijst}\Big) \\ & + \sum_i \sum_s \frac{\tau^{X\prime}_{jis}}{1+\tau^{M\prime}_{jis}+\tau^{X\prime}_{jis}} \Big(\pi^{C\prime}_{jis}\beta^{C\prime}_{is}(VA_i\hat{w}_i + \hat{D}_iD_i + R'_i) + \sum_t \hat{\pi}^M_{jist}\hat{\beta}^M_{ist}\hat{Y}_{it}X^M_{jist}\Big). \end{aligned} \tag{A.12}$$

Conditional on the choice of a numeraire and a set of shocks $\{\hat{Z}_{is}, \hat{D}_j, \hat{t}_{ijs}\}$ and policies $\{\hat{\tau}^X_{ijs}, \hat{\tau}^M_{ijs}\}$, equations A.1-A.12 uniquely determine the equilibrium and all endogenous variables.[23]

The endogenous variables of the model include:

- Changes in country-level variables: wage $\hat{w}_j$, expenditure on final goods $\hat{X}^C_j$, tariff revenue $\hat{R}_j$, CPI index $\hat{P}^C_j$.
- Changes in country-by-industry variables: employment $\hat{L}_{js}$, gross output $\hat{Y}_{js}$, expenditure on intermediate inputs $\hat{X}^M_{js}$, price index of intermediate inputs $\hat{P}^M_{js}$, sectoral consumer expenditure $\hat{X}^C_{js}$, expenditure share $\hat{\beta}^C_{js}$, sectoral CPI index $\hat{P}^C_{js}$.
- country-by-sector-pair variables: expenditure on intermediate goods $\hat{X}^M_{jst}$ (e.g. ex-

[23]Equations A.1-A.12 represent a system of $3N+4NS+2N^2S+N^2S^2+2NS^2$ equations and unknowns.

penditure of the car industry in Germany on electrical equipment products), share of intermediate expenditure on products from sector s $\hat{\beta}^M_{jst}$, price index of intermediates of sector s $\hat{P}^M_{jst}$.

- country-pair-by-sector level: price of traded variety $\hat{p}_{ijs}$, trade flows for final use $\hat{X}^C_{ijs}$, expenditure share of final goods $\hat{\pi}^C_{ijs}$, total trade flows $\hat{X}_{ijs}$.
- country-pair-by-sector-pair variables: sales of goods for intermediate use X^M_{ijst}, expenditure share $\hat{\pi}^M_{ijst}$.

B Appendix: Computational Details

We solve the system with the following algorithm, following an exogenous change in the vector $\hat{\theta} = (\hat{\tau}, \hat{Z}, \hat{D})$

1. Begin with an initial guess for the vector of wage changes $\hat{w}^{(0)}$
2. Given the vector of wage changes, solve for prices
3. Make an initial guess for changes in prices $\hat{p}^{(0,0)}_{ijs}$
4. Compute the change in the price index of intermediate inputs $\hat{P}^{M,(0,0)}_{jst}$ from equation A.6
5. Given $\hat{w}^{(0)}$ and $\hat{P}^{M,(0,0)}_{jst}$, update the change in prices, $\hat{p}^{(0,1)}_{ijs}$, using equation A.7
6. Compare $\hat{p}^{(0,1)}_{ijs}$ and $\hat{p}^{(0,0)}_{ijs}$. If close enough together, stop. If not, use $\hat{p}^{(0,1)}_{ijs}$ to compute $\hat{P}^{M,(0,1)}_{jst}$, and $\hat{p}^{(0,2)}_{ijs}$, and iterate until convergence
7. Given prices $\hat{p}_{ijs}$ and $\hat{P}^M_{jst}$, compute $\hat{P}^C_{js}$ and expenditure share changes $\hat{\pi}^M_{ijst}$ and $\hat{\pi}^C_{ijs}$
8. Use equation A.2 to solve for the vector of gross output changes, using an iterative procedure. Make an initial guess for $\hat{Y}_{is}$, update it using equation A.2, and iterate until convergence. Then, use linear equation A.12 to solve for tariffs, taking $(\hat{Y}_{is})$ as given, and iterate until tariff revenue is consistent with the rise in production.
9. Use the labor market equilibrium (equation A.2) to compute the implied change in wages. If labor demand exceeds (falls short of) labor supply in country i, increase (decrease) the wage change for that country.

C Appendix: Additional Theoretical Results

This section derives an alternative expression for the welfare change of any foreign shock which only depends on a sector's own use of intermediates.

We can also express $\hat{P}^M_{js}$ as a function of the change in a sector's own use of inputs and the change in the domestic share of expenditure in that same sector:

$$\hat{P}^M_{js} = \left(\hat{\beta}^M_{jss}\right)^{\frac{1}{\epsilon_s - 1}} \hat{P}^M_{jss} = \left(\hat{\beta}^M_{jss}\right)^{\frac{1}{\epsilon_s - 1}} \left(\hat{\pi}^M_{jjss}\right)^{\frac{1}{\rho_{ss} - 1}} \left(\hat{P}^M_{js}\right)^{\sigma_{js}}$$

This gives:

$$\hat{P}^M_{js} = \left(\left(\hat{\beta}^M_{jss}\right)^{\frac{1}{\epsilon_s - 1}} \left(\hat{\pi}^M_{jjss}\right)^{\frac{1}{\rho_{ss} - 1}}\right)^{\frac{1}{1-\sigma_{js}}}$$

We can now derive the expression for the change in the CPI:

$$\begin{aligned}
\hat{P}^C_j &= \left(\sum_s \beta^C_{js} \left(\hat{P}^C_{js}\right)^{1-\kappa}\right)^{\frac{1}{1-\kappa}} \\
&= \left(\sum_s \beta^C_{js} \left(\left(\hat{P}^M_{js}\right)^{\sigma_{js}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}}\right)^{1-\kappa}\right)^{\frac{1}{1-\kappa}} \\
&= \left(\sum_s \beta^C_{js} \left(\left(\left(\hat{\beta}^M_{jss}\right)^{\frac{1}{\epsilon_s - 1}} \left(\hat{\pi}^M_{jjss}\right)^{\frac{1}{\rho_{ss} - 1}}\right)^{\frac{\sigma_{js}}{1-\sigma_{js}}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}}\right)^{1-\kappa}\right)^{\frac{1}{1-\kappa}}
\end{aligned}$$

and the welfare change is

$$\hat{W}_j = \left(\sum_s \beta^C_{js} \left(\left(\left(\hat{\beta}^M_{jss}\right)^{\frac{1}{\epsilon_s - 1}} \left(\hat{\pi}^M_{jjss}\right)^{\frac{1}{\rho_{ss} - 1}}\right)^{\frac{\sigma_{js}}{1-\sigma_{js}}} \left(\hat{\pi}^C_{jjs}\right)^{\frac{1}{\mu_s - 1}}\right)^{1-\kappa}\right)^{\frac{1}{\kappa-1}} \tag{C.1}$$

D Appendix: List of Countries and Sectors with Sectoral Elasticities

OECD countries		**Non-OECD economies**	
AUS	Australia	ARG	Argentina
AUT	Austria	BRA	Brazil
BEL	Belgium	BRN	Brunei Darussalam
CAN	Canada	BGR	Bulgaria
CHE	Switzerland	KHM	Cambodia
CHL	Chile	CHN	China (People's Republic of)
COL	Colombia	HRV	Croatia
CRI	Costa Rica	CYP	Cyprus
CZE	Czech Republic	IND	India
DNK	Denmark	IDN	Indonesia
EST	Estonia	HKG	Hong Kong, China
FIN	Finland	KAZ	Kazakhstan
FRA	France	LAO	Lao People's Democratic Republic
DEU	Germany	MYS	Malaysia
GRC	Greece	MLT	Malta
HUN	Hungary	MAR	Morocco
ISL	Iceland	MMR	Myanmar
IRL	Ireland	PER	Peru
ISR	Israel	PHL	Philippines
ITA	Italy	ROU	Romania
JPN	Japan	RUS	Russian Federation
KOR	Korea	SAU	Saudi Arabia
LVA	Latvia	SGP	Singapore
LTU	Lithuania	ZAF	South Africa
LUX	Luxembourg	TWN	Chinese Taipei
MEX	Mexico	THA	Thailand
NLD	Netherlands	TUN	Tunisia
NZL	New Zealand	VNM	Viet Nam
NOR	Norway	ROW	Rest of the World
POL	Poland	BGD	Bangladesh
PRT	Portugal	BLR	Belarus
SVK	Slovak Republic	CIV	Côte d'Ivoire
SVN	Slovenia	CMR	Cameroon
ESP	Spain	EGY	Egypt
SWE	Sweden	JOR	Jordan
TUR	Turkey	NGA	Nigeria
GBR	United Kingdom	PAK	Pakistan
USA	United States	SEN	Senegal
		UKR	Ukraine

Table D.1: Countries in OECD ICIO data. Remaining countries are captured by a rest-of-the-world aggregate.

Sector	ρ	μ
Agriculture, hunting, forestry	3.25	4.88
Fishing and aquaculture	6.10	7.43
Mining and quarrying, energy producing products	4.16	4.16
Mining and quarrying, non-energy producing products	9.31	9.31
Mining support service activities	5.00	5.00
Food products, beverages and tobacco	4.48	5.28
Textiles, textile products, leather and footwear	7.54	5.53
Wood and products of wood and cork	10.00	4.81
Paper products and printing	8.39	9.49
Coke and refined petroleum products	5.28	6.37
Chemical and chemical products	8.88	10.15
Pharmaceuticals, medicinal chemical and botanical products	7.55	20.36
Rubber and plastics products	8.43	4.84
Other non-metallic mineral products	7.61	3.02
Basic metals	8.10	20.36
Fabricated metal products	5.37	5.20
Computer, electronic and optical equipment	9.08	5.29
Electrical equipment	5.16	6.61
Machinery and equipment, nec	4.32	6.09
Motor vehicles, trailers and semi-trailers	7.17	11.23
Other transport equipment	12.65	9.12
Manufacturing nec; repair and installation of machinery and equipment	5.58	5.65
Electricity, gas, steam and air conditioning supply	5.00	5.00
Water supply; sewerage, waste management and remediation activities	8.21	8.21
Construction	5.00	5.00
Wholesale and retail trade; repair of motor vehicles	5.00	5.00
Land transport and transport via pipelines	5.00	5.00
Water transport	5.00	5.00
Air transport	5.00	5.00
Warehousing and support activities for transportation	5.00	5.00
Postal and courier activities	5.00	5.00
Accommodation and food service activities	5.00	5.00
Publishing, audiovisual and broadcasting activities	7.69	6.95
Telecommunications	5.00	5.00
IT and other information services	5.00	5.00
Financial and insurance activities	5.00	5.00
Real estate activities	5.00	5.00
Professional, scientific and technical activities	5.00	5.00
Administrative and support services	5.00	5.00
Public administration and defence; compulsory social security	5.00	5.00
Education	5.00	5.00
Human health and social work activities	5.00	5.00
Arts, entertainment and recreation	5.00	5.00
Other service activities	5.00	5.00

Table D.2: Sectors in OECD ICIO data.

E Appendix: Welfare changes from decoupling if neutral countries joined the Eastern bloc

Country	Import tariff	Export Tariff	Transaction
FRA	-0.39	-0.54	-1.23
DEU	-0.47	-0.58	-1.34
JPN	-0.38	-0.75	-1.50
KOR	-0.79	-1.27	-3.17
NLD	-0.36	-0.68	-1.57
GBR	-0.49	-0.28	-0.98
USA	-0.30	-0.34	-0.81
CHN	-0.30	-0.33	-1.00
RUS	-0.58	-0.37	-1.72
VNM	-2.46	-1.32	-5.57
MEX	-1.82	-1.49	-3.89
IND	-0.64	-0.33	-1.26
SAU	-0.41	-0.44	-1.86
BRA	-0.19	-0.53	-0.98

Table E.1: Impact of a trade decoupling scenario when ”neutral” economies join the Eastern bloc, with a 20% increase in trade costs.

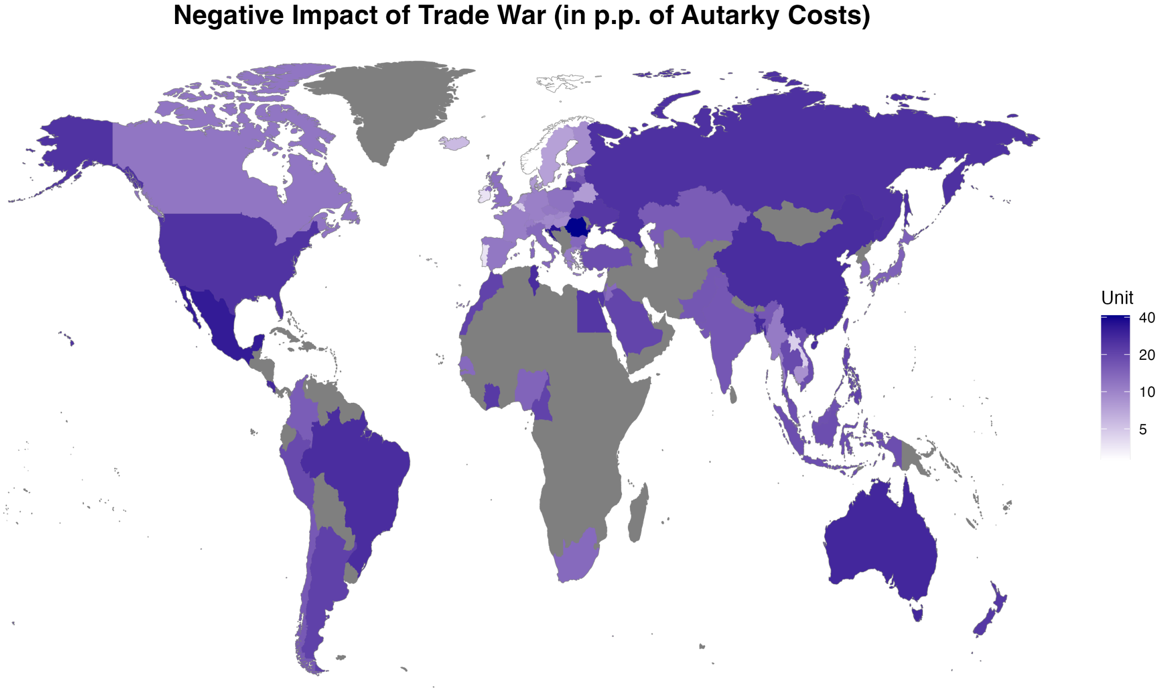


Figure E.1: Welfare Impact of a 20% increase in iceberg transaction costs between blocs, expressed as a fraction of autarky costs. This map describes the scenario when neutral economies join the Eastern Bloc.

F Appendix: Welfare Cost of Limited Geoeconomic Fragmentation as a Function of Reduction in Trade Between Blocs

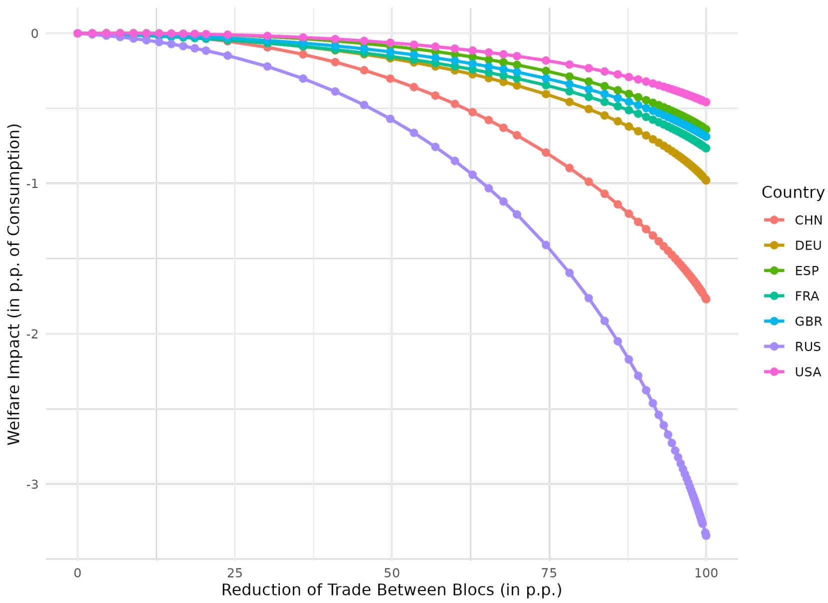


Figure F.1: Welfare Impact of Geopolitical Fragmentation Scenario as a Function of the Decline in Interbloc Trade

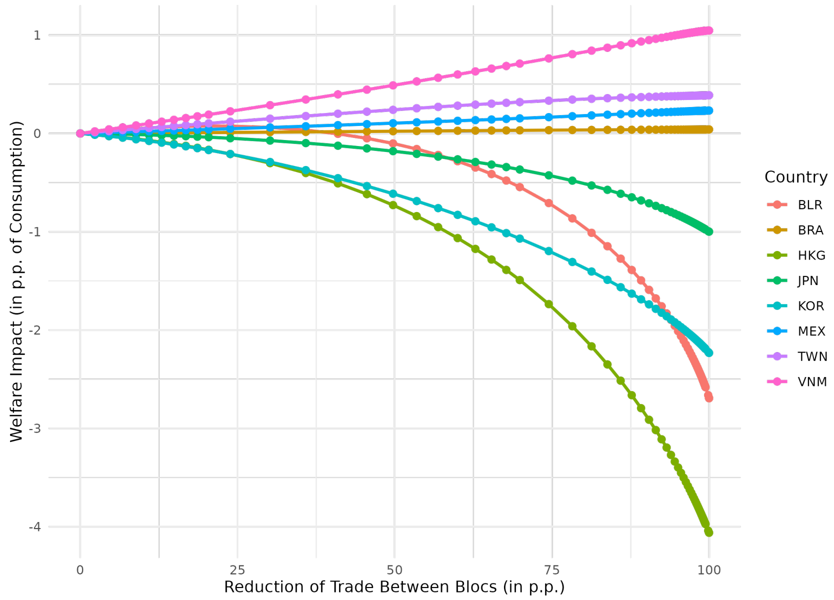


Figure F.2: Welfare Impact of Geopolitical Fragmentation Scenario as a Function of the Level of the Decline in Interbloc Trade

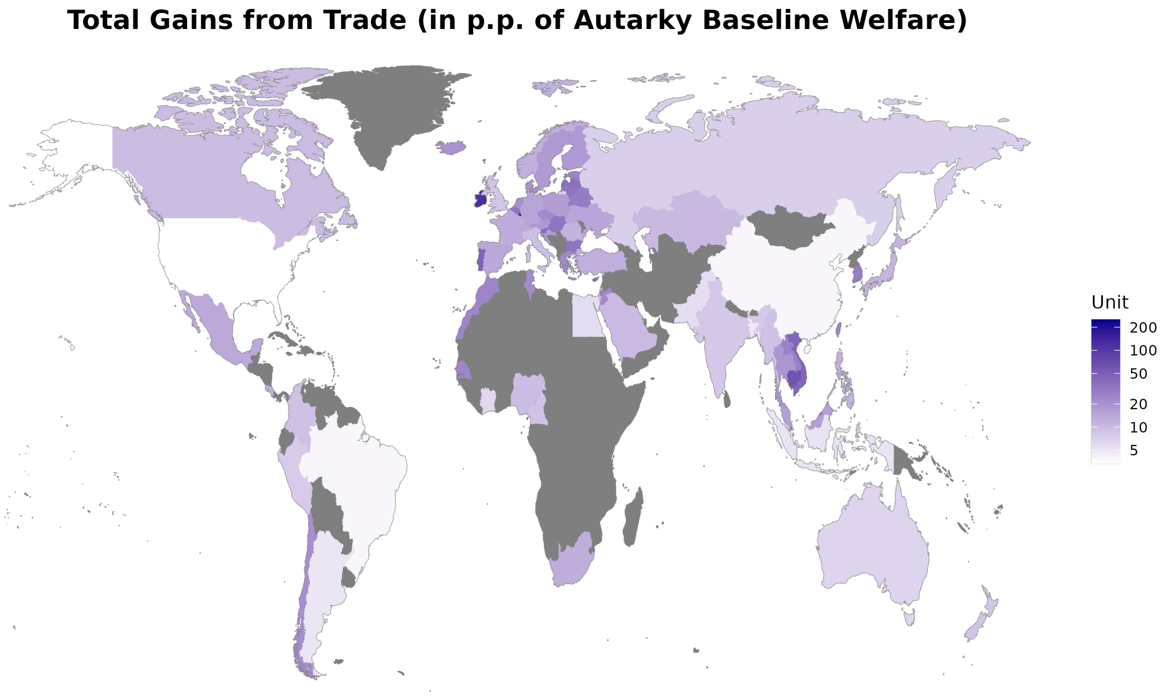


Figure G.1: Total Gains From Trade Relative to Autarky.

G Total Gains from Trade

Country	Gains from Trade (in p.p.)	Country	Gains from Trade (in p.p.)
Argentina	5.06	Laos	26.31
Australia	6.67	Latvia	36.54
Austria	18.09	Lithuania	34.02
Bangladesh	4.87	Luxembourg	223.82
Belarus	29.80	Malaysia	15.99
Belgium	34.95	Malta	55.70
Brazil	3.87	Mexico	13.70
Brunei	36.01	Morocco	25.39
Bulgaria	33.83	Myanmar	9.05
Cambodia	60.92	Netherlands	20.49
Cameroon	9.05	New Zealand	8.60
Canada	10.01	Nigeria	9.82
Chile	21.43	Norway	11.96
China	3.91	Pakistan	5.80
China:Hong Kong	55.37	Peru	7.81
Clipperton Island	12.91	Philippines	12.02
Colombia	9.22	Poland	17.02
Costa Rica	12.88	Portugal	47.92
Croatia	16.94	Romania	11.90
Cyprus	41.33	Russia	7.30
Czech Republic	23.37	Saudi Arabia	10.19
Denmark	19.59	Senegal	25.47
Egypt	5.87	Singapore	252.00
Estonia	26.09	Slovakia	32.87
Finland	17.61	Slovenia	38.80
France	12.91	South Africa	12.75
Germany	14.71	South Korea	29.16
Greece	23.76	Spain	13.96
Hungary	33.53	Sweden	17.62
Iceland	19.99	Switzerland	13.41
India	8.35	Taiwan	25.19
Indonesia	5.23	Thailand	18.82
Ireland	120.33	Tunisia	23.11
Israel	10.27	Turkey	12.24
Italy	9.55	UK	8.56
Ivory Coast	6.34	Ukraine	14.50
Japan	11.29	USA	3.36
Jordan	23.46	Vietnam	43.54
Kazakhstan	10.47	Rest of the World	10.62