Methodology Note

for

APEC Policy Support Unit (PSU) Policy Brief No. 60
Win, Lose or Draw: Estimating the Impact of
Trade Disengagement on APEC Trade
May 2024

This methodology note accompanies, and is meant to complement, APEC Policy Support Unit Policy Brief No. 60. It provides a technical overview of the econometric methodology used for the analysis and provides the numerical results in tabular format. It also lays out a Monte Carlo simulation exercise that is not discussed in the Policy Brief but was used by the authors for checking the sensitivity of estimated impacts to randomising bloc composition.

Model set-up

Let's assume there are $i = 1, \dots, 21$ economies trading over t years. Each economy makes two decisions related to trade:

> **Decision point 1: How much do I trade?**
> Each economy decides the extent to which it will engage in domestic production and consumption versus international trade. This decision is dependent on domestic prices as well as prevailing international prices for goods.
>
> **Decision point 2: With whom do I trade?**
> Subject to decision point 1, each economy must decide with which partner economies it will trade and how much. This decision is bilateral in nature and considers prices offered by the trading partner being considered, prices offered by other potential trading partners and domestic prices.

Estimating decision point 1

Consider the viewpoint of economy i as an exporter. Let X_{it} = economy i's exports. Decision point 1 is estimated through the structural equation:

$$\ln(X_{it}) = \alpha + \beta_1 \ln(p_{it}) + \beta_2 \ln(p_{jt}) + \boldsymbol{\delta}\mathbf{H} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

where p_{it} is the domestic price index for economy i at each year t; p_{jt} is the foreign price index faced by economy i when trading with partner economies $j \neq i$ calculated as a simple average of the foreign prices faced by economy i during the year t; the vector $\mathbf{H}(.)$ represents economy-level controls including GDP, population, etc.; γ_i and δ_t are controls for economy- and time-idiosyncrasies, respectively; and ε_{it} is the error term. After estimating (1), we use observed data and predict $\hat{X}_{it}$ as estimates of exports under decision point 1.

Note that estimating decision point 1 for i's imports (M_{it}) follows a similar methodology, arriving at $\widehat{M}_{it}$ as estimates of imports under decision point 1. One can think of $\hat{X}_{it}$ and $\widehat{M}_{it}$ as smoothed estimates of an economy's total willingness to trade or its total trade envelope, which it will then allocate between various trading partners through decision point 2.

Estimating decision point 2

Let X_{ijt} = economy i's bilateral exports to economy $j \neq i$ at year *t*. It is important to note that from economy *j*'s perspective, this trade flow is an import; hence, both the exporting decision of *i* and the importing decision of *j* are needed in determining X_{ijt}. Therefore, for decision point 2, we estimate:

$$\ln(X_{ijt}) = \alpha + \beta_1 \ln(p_{it}) + \beta_2 \ln(p_{jt}) + \beta_3 \ln(p_{kt}) + \theta_1 \ln(\hat{X}_{it}) + \theta_2 \ln(\widehat{M}_{jt}) + \mathbf{\delta G} + \gamma_i + \delta_t + \varepsilon_{it} \quad (2)$$

where p_{it} is *i*'s domestic prices; p_{jt} is an index of prices offered by *j*; p_{kt} is an index of the prices offered by other economies $k \neq j$; the vector $\mathbf{G}(.)$ represents economy and gravity model controls; and the other variables are as defined in the previous section. After estimating (2), we use observed variables and predict $\hat{X}_{ijt}$. Notice that estimating (2) includes predicted baseline values of $\hat{X}_{it}$ and $\widehat{M}_{jt}$ from (1): this nested econometric model reflects the relationship between decision 1 and decision 2. From (2), we get $\hat{X}_{ijt}$ which is a predicted and smoothed estimate of *i*'s exports to *j* in year *t*. A similar procedure for imports gives us $\widehat{M}_{ijt}$.

Counterfactual impact analysis

We separate the 21 APEC economies into three blocs, namely, A, B and C. We assume that there are geopolitical conflicts between A and B leading them to implement restrictive trade policies against each other on a bilateral basis. Conversely, economies within each bloc do not implement restrictive policies on each other and can implement facilitative trade policies to other members of the same bloc. Bloc C, on the other hand, stays neutral and is not the target of restrictive or facilitative policies implemented by bloc A or B economies.

We further assume that geoeconomic fragmentation policies can be expressed as $g \in (0, 1)$ increases in bilateral prices such that if economy *i* imposes geoeconomic fragmentation policies on *j*, then it has the impact of raising *j*'s prices to $p_{jt}(1 + g)$ in a bilateral manner. Conversely, a facilitative policy could be expressed as a bilateral price discount $p_{jt}(1 - g)$. Hence, non-tariff barriers, regulatory requirements or other restrictions are considered based on their tariff-equivalent impacts.

The unit of analysis is at the bloc level *z = A, B, C*. To get the baseline, after estimating (1) and (2) for all *i*, we get the bloc *z* total baseline trade over the entire period considered:

$$X_z^B = \sum_i \sum_t X_{it}^B \ \forall \ z = A, B, C \quad (3)$$

where

$$X_{it}^B = \sum_j \hat{X}_{ijt} \ \forall \ i \neq j \quad (4)$$

To generate the counterfactuals, we assume a new price vector $\tilde{\mathbf{p}}_{ft}$ reflecting new foreign bilateral prices faced by blocs A and B; there will be no impact on bloc C as for this group $\mathbf{p}_{ft} = \tilde{\mathbf{p}}_{ft}$ by definition. Using this revised vector of prices, we predict (1) and generate $\tilde{X}_{it}$; note that for bloc C $\hat{X}_{it} = \tilde{X}_{it}$ since there is no change in its foreign price vector.

After estimating $\tilde{X}_{it} \forall\, i$, we re-predict bilateral trade flows (2) using revised prices $\tilde{\mathbf{p}}_{ft}$ as well as plug in estimates of $\tilde{X}_{it}$. Hence, for blocs A and B, the impact of geoeconomic fragmentation policies will be seen through the direct impacts of bilateral changes in prices ($\tilde{p}_{jt}$ and $\tilde{\mathbf{p}}_{kt}$) as well as the indirect impacts on trade volumes by trade partners ($\tilde{X}_{jt}$). On the other hand, for bloc C economies, the impacts of these policies will only be through the impact on trade volumes by trade partners ($\tilde{X}_{jt}$). This gives us a new set of bilateral trade estimates $\tilde{X}_{ijt}$. Re-applying (4) and (3), we get counterfactual bilateral trade flows $X_{it}^{C} = \sum_j \tilde{X}_{ijt}$ and an aggregate counterfactual estimate X_z^C for all z = A, B, C.

The counterfactual analysis is then the percentage deviations of X_z^C from X_z^B or

$$\Delta = \frac{X_z^C - X_z^B}{X_z^B} \;\forall\; z = A, B, C \tag{5}$$

given various perturbations in the bilateral price vectors $\tilde{\mathbf{p}}_{ft}$. We also calculate percentage deviations according to geographical regions defined as follows:

Region	Economies
Northeast Asia	China; Hong Kong, China; Japan; Korea; Russia; Chinese Taipei
Southeast Asia	Brunei Darussalam; Indonesia; Malaysia; the Philippines; Singapore; Thailand; Viet Nam
Oceania	Australia; New Zealand; Papua New Guinea
Americas	Canada; Chile; Mexico; Peru; the United States of America

Note that our counterfactual impact analysis is retrospective rather than predictive. Rather than trying to predict future trade flows for which we have no data, our counterfactual analysis considers what our trade over the past several decades would have looked like if we had implemented geoeconomic fragmentation policies (subject to simplifying and smoothening assumptions as necessary).

Monte Carlo simulation

The initial assignment of economies into blocs A, B and C is determined by the authors. To test whether results are sensitive to bloc assignment, we conduct Monte Carlo simulations randomising the composition of blocs. The following process is used to conduct the simulation:

1. Economies i = 1… 21 are assigned a random number $r \in (0, 10000)$ drawn from a continuous and uniform probability distribution.

2. Economies are grouped based on the assigned random number such that if $r_1 < r_2 \ldots < r_{20} < r_{21}$ then blocs are assigned as:

   $$\begin{aligned} A &= \{r_1, r_2 \ldots r_7\} \\ B &= \{r_8, r_9 \ldots r_{14}\} \\ C &= \{r_{15}, r_6 \ldots r_{21}\} \end{aligned}$$

   Bloc interactions are as previously defined regardless of the randomly assigned composition.

3. Analysis as outlined above is implemented using the bloc assignment defined in step 2.

4. The algorithm is looped and results are summarised over n = 1,000 runs of the simulation.

This analysis is done at the bloc level for final goods and intermediate goods trade.

Analytical results

Tabulated results of the analysis are presented below.

Table 1. Impact of cross-bloc restrictive GF policies on APEC trade by bloc (%)

	Bloc A	Bloc B	Bloc C
Final goods exports	-10.0***	-10.3***	-10.0***
Final goods imports	-10.1***	-17.3***	-18.8***
Intermediate goods exports	-16.7***	-15.3***	-2.5***
Intermediate goods imports	-17.8***	-8.9***	-4.7***
Digital/ICT exports	1.8***	2.4***	-11.1***
Digital/ICT imports	4.1***	-1.0**	-9.4***
Non-Digital/ICT exports	-8.6***	-9.4***	-8.2***
Non-Digital/ICT imports	-7.2***	-9.0***	-6.0***
Food exports	1.2*	-1.5	13.3***
Food imports	12.0***	8.4***	20.4***
Non-food exports	-16.4***	-17.1***	-15.5***
Non-food imports	-16.2***	-16.5***	-14.4***

GF=geoeconomic fragmentation; ICT=information and communications technology. Note: Results show the percentage difference between the counterfactual (i.e., with restrictive GF policies resulting in 10% price increase between A and B) and the baseline estimates. Underlying elasticity estimates were calculated using the Arellano-Bond generalised method of moments to control for reverse causality as well as Huber-White standard errors to correct for heteroscedasticity; time- and economy-level idiosyncrasies are also controlled to avoid omitted variable bias. * = significant at 90%; ** = significant at 95%; and *** = significant at 99% confidence level.
Source: Authors' calculations.

Table 2. Impact of cross-bloc restrictive GF policies on APEC trade by region (%)

	Northeast Asia	Southeast Asia	Oceania	Americas
Final goods exports	-10.3***	-14.6***	-1.4***	-10.2***
Final goods imports	-10.1***	-19.7***	-8.6***	-13.6***
Intermediate goods exports	-15.3***	-3.8***	-11.5***	-16.7***
Intermediate goods imports	-13.7***	-4.7***	-15.0***	-17.5***
Digital/ICT exports	3.7***	-11.8***	4.0***	-1.8***
Digital/ICT imports	2.3***	-10.3***	9.3***	0.6
Non-Digital/ICT exports	-8.8***	-9.3***	-4.6***	-8.9***
Non-Digital/ICT imports	-9.0***	-5.6***	-0.5*	-7.5***
Food exports	-1.7	13.6***	5.0***	-8.0***
Food imports	8.0***	17.3***	14.1***	-2.4**

Non-food exports	-16.0***	-16.7***	-9.6***	-18.4***
Non-food imports	-16.5***	-17.1***	-9.4***	-16.1***

GF=geoeconomic fragmentation; ICT=information and communications technology. Note: Results show the percentage difference between the counterfactual (i.e., with restrictive GF policies resulting in 10% price increase between A and B) and the baseline estimates. Underlying elasticity estimates were calculated using the Arellano-Bond generalised method of moments to control for reverse causality as well as Huber-White standard errors to correct for heteroscedasticity; time- and economy-level idiosyncrasies are also controlled to avoid omitted variable bias. * = significant at 90%; ** = significant at 95%; and *** = significant at 99% confidence level.
Source: Authors' calculations.

Table 3. Impact of intra-bloc facilitative GF policies on APEC trade by bloc (in %)

	Bloc A	Bloc B	Bloc C
Final goods exports	58.9***	81.1***	49.0***
Final goods imports	81.5***	59.9***	67.4***
Intermediate goods exports	9.1***	9.7***	5.6***
Intermediate goods imports	7.9***	15.8***	4.4***
Digital/ICT exports	32.1***	23.1***	31.8***
Digital/ICT imports	23.2***	32.0***	20.6***
Non-Digital/ICT exports	16.4***	16.0***	13.2***
Non-Digital/ICT imports	12.7***	16.0***	9.6***
Food exports	4.3***	10.4***	-6.5***
Food imports	-7.6***	0.5	-18.0***
Non-food exports	27.3***	28.1***	22.8***
Non-food imports	27.4***	26.8***	22.0***

GF=geoeconomic fragmentation; ICT=information and communications technology. Note: Results show the percentage difference between the counterfactual (i.e., with facilitative GF policies resulting in 10% price decrease within members of A and B) and the baseline estimates. Underlying elasticity estimates were calculated using the Arellano-Bond generalised method of moments to control for reverse causality as well as Huber-White standard errors to correct for heteroscedasticity; time- and economy-level idiosyncrasies are also controlled to avoid omitted variable bias. * = significant at 90%; ** = significant at 95%; and *** = significant at 99% confidence level.
Source: Authors' calculations.

Table 4. Impact of intra-bloc facilitative GF policies on APEC trade by region (in %)

	Northeast Asia	Southeast Asia	Oceania	Americas
Final goods exports	81.2***	55.9***	20.5***	43.9***
Final goods imports	81.2***	65.8***	46.9***	74.3***
Intermediate goods exports	9.6***	18.5***	2.8***	9.2***
Intermediate goods imports	9.4***	17.5***	1.6***	8.4***
Digital/ICT exports	27.9***	23.5***	25.2***	26.6***
Digital/ICT imports	30.1***	10.2***	5.3***	22.8***
Non-Digital/ICT exports	16.3***	15.5***	8.7***	16.0***
Non-Digital/ICT imports	16.0***	9.4***	1.8***	13.1***
Food exports	12.0***	-6.7***	-3.0***	17.5***
Food imports	1.6	-14.0***	-16.0***	9.3***

Non-food exports	26.0***	26.3***	15.2***	33.1***
Non-food imports	26.8***	29.0***	15.3***	27.4***

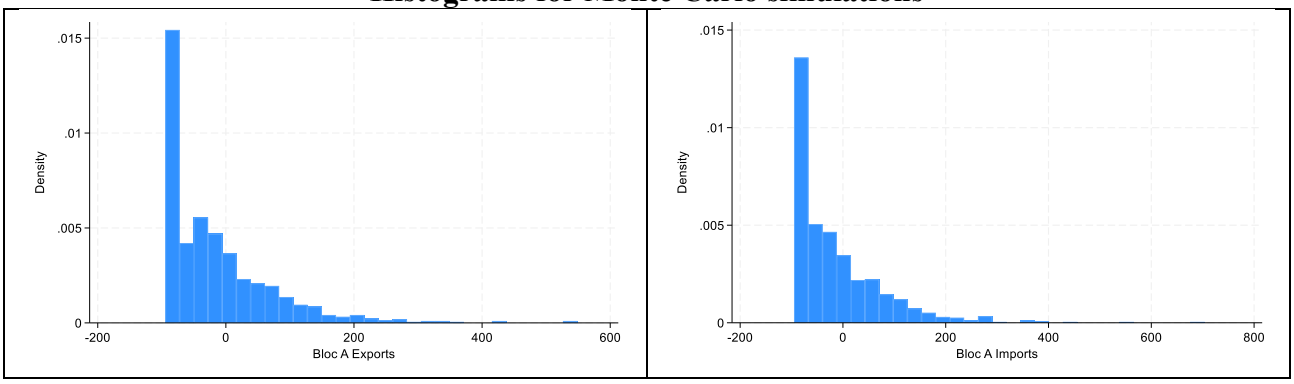
GF=geoeconomic fragmentation; ICT=information and communications technology. Note: Results show the percentage difference between the counterfactual (i.e., with restrictive geoeconomic fragmentation policies resulting in 10% price increase between A and B) and the baseline estimates. Underlying elasticity estimates were calculated using the Arellano-Bond generalised method of moments to control for reverse causality as well as Huber-White standard errors to correct for heteroscedasticity; time- and economy-level idiosyncrasies are also controlled to avoid omitted variable bias. * = significant at 90%; ** = significant at 95%; and *** = significant at 99% confidence level.
Source: Authors' calculations.

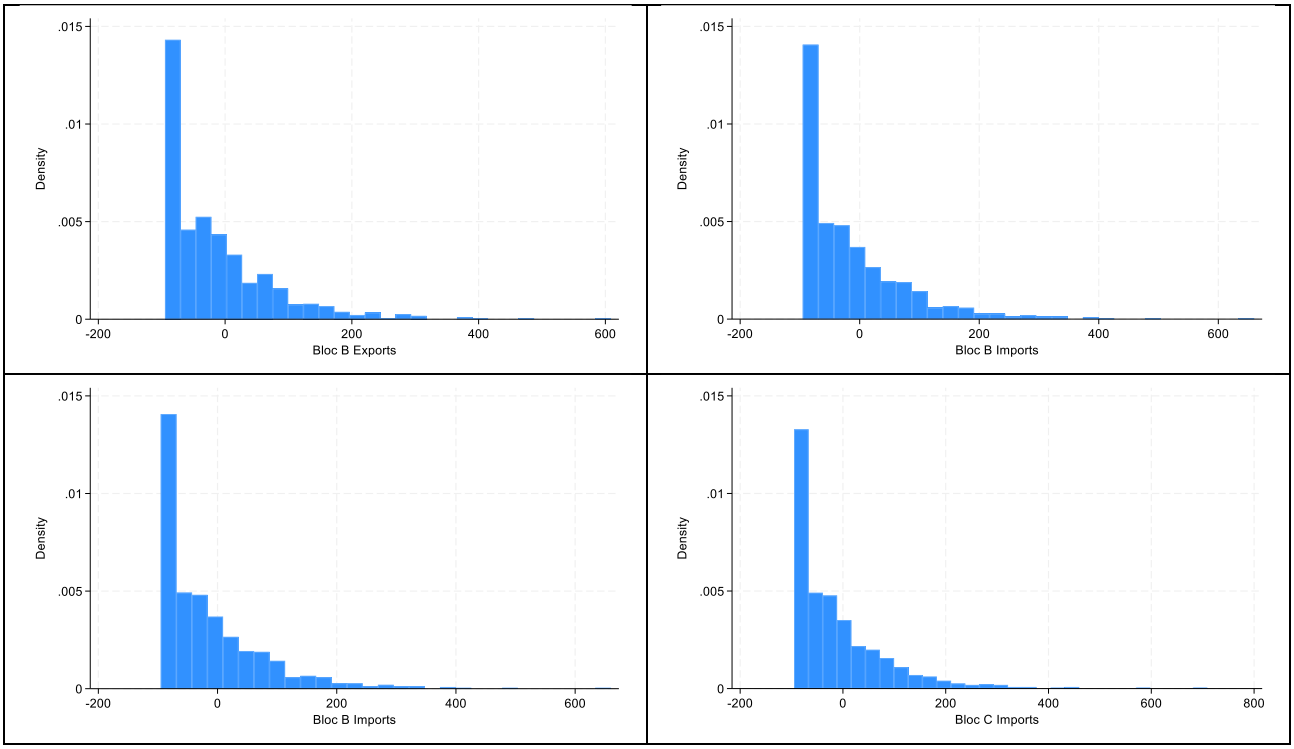
Table 5. Impact of GF restrictive policies on trade with randomised blocs (%)
Monte Carlo simulation with 1,000 draws

	Bloc A	Bloc B	Bloc C
Final goods exports			
Mean	-17.3	-17.2	-16.1
Median	-40.4	-40.5	-39.2
Standard deviation	87.8	87.4	88.9
Final goods imports			
Mean	-16.5	-16.7	-13.9
Median	-41.7	-41.8	-40.6
Standard deviation	91.4	90.7	95.1
Intermediate goods exports			
Mean	7.7	7.0	10.3
Median	-2.0	-2.7	0.2
Standard deviation	38.8	36.8	39.5
Intermediate goods imports			
Mean	7.4	6.6	10.7
Median	-2.4	-2.8	1.2
Standard deviation	38.6	36.6	38.0

GF=geoeconomic fragmentation. Note: Monte Carlo summary statistics are for n = 1,000 iterations.
Source: Authors' calculations.

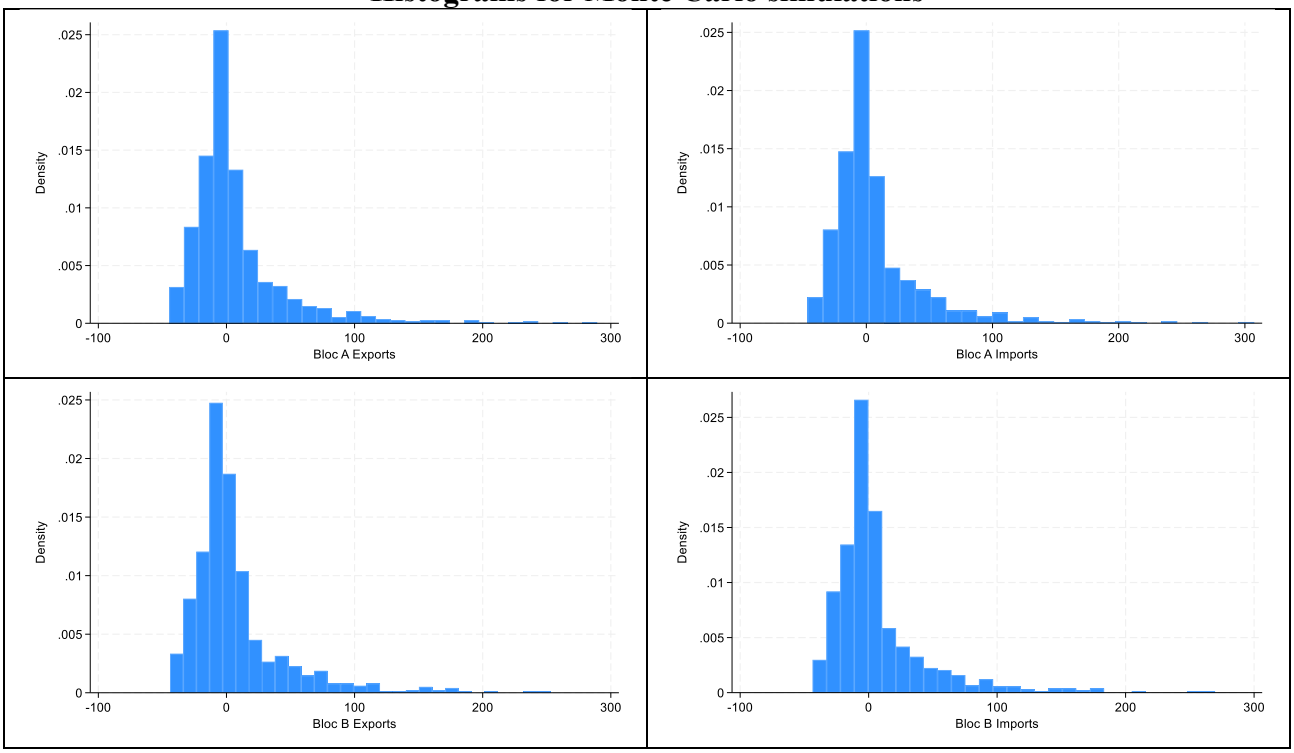
Figure 1. Impact of GF restrictive policies on final goods trade by bloc
Histograms for Monte Carlo simulations

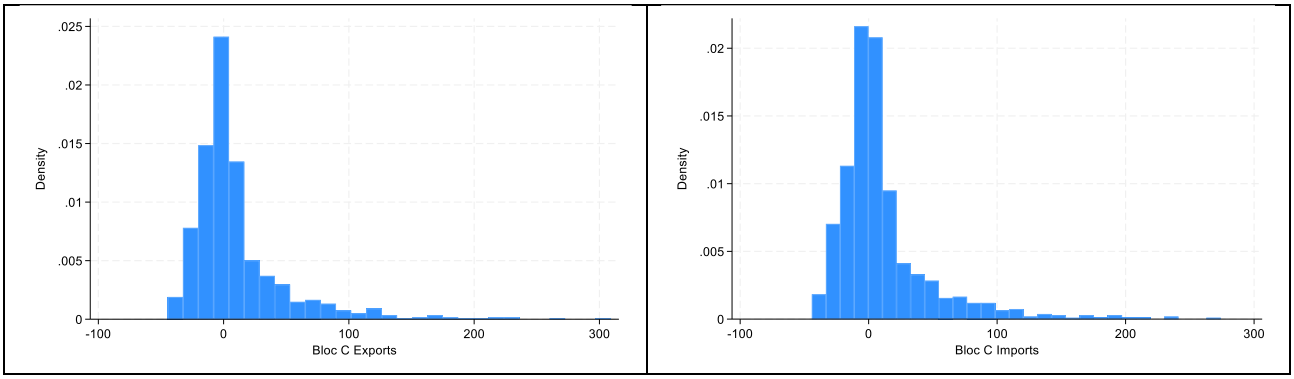




GF=geoeconomic fragmentation.
Source: Authors' calculations.

Figure 2. Impact of GF restrictive policies on intermediate goods trade by bloc
Histograms for Monte Carlo simulations





GF=geoeconomic fragmentation.
Source: Authors' calculations.