Région et Développement

n° 62-2025

www.regionetdeveloppement.org

A comprehensive assessment of the impact of the EU new trade policy: A disaggregated product's approach

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Abstract – This paper assesses the effects of the European Union's preferential trade policy over 1995–2023, covering agreements with Mediterranean, Sub-Saharan African, Latin American, Western Balkan, Eastern Partnership, and recent bilateral partners (Canada, Korea, Japan, Vietnam, UK). We estimate a product-level (HS2) gravity model using PPML with high-dimensional fixed effects and incorporate non-tariff barriers (NTBs), rules of origin (bilateral vs diagonal/Pan-Euro Med cumulation), revealed comparative advantage (RCA), and preference-intensity ratios. Three results emerge. First, EU PTAs display a persistent import–export asymmetry: most agreements significantly raise EU imports, while average export effects are weak or negative. Second, institutional design matters: diagonal cumulation yields stronger and more balanced effects than bilateral regimes, whereas NTBs systematically depress trade, especially in complex, regulation-intensive goods. Third, impacts are sector-specific: gains are strongest in value-chain-intensive industries such as chemicals, plastics, machinery, and vehicles, particularly on the import side, while primary and lightly processed goods benefit less. Overall, the effectiveness of EU trade policy depends less on tariff removal than on institutional depth, regulatory convergence, and sectoral alignment. Policy should prioritize simpler, flexible RoO (broader diagonal cumulation) and NTB reduction to translate legal preferences into effective market access.

Classification JEL
F1, F5, F6

Key words
Preferential trade agreements
EU trade policy
Rules of origin
Non-tariff barriers
Gravity model

We thank the reviewers for their constructive comments.

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INTRODUCTION

The EU trade policy started in the 1960s with the conclusion of the first association agreements with non-EU partner countries (Spain, Greece, Turkey, Morocco, Tunisia). At that time, the agreements were limited to industrial products and included mainly tariff cuts. Since then, the EU has renewed, enlarged, and deepened its regional policy with 79 countries (including small Pacific and Caribbean islands).

There are currently several types of agreements. Association agreements mainly include non-EU Mediterranean partners, following the Barcelona Agreement (1995), designed to implement a free trade area (FTA) between the EU and MENA (Middle East and North African) countries. This corresponds to the Euro-Med Agreement.

In Latin America, two different waves of agreements can be identified. The earlier bilateral agreements were signed with Mexico and Chile in the early 2000s, representing the region's first generation of EU partnerships. This bloc will be called "bilateral generation 1" agreements. A second wave started with the Central America Association Agreement, signed in 2012 with Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama, and with the Andean agreement covering Colombia, Peru, and later Ecuador, which has been in force since the mid-2010s (later called "Latin American" Agreements) By contrast, MERCOSUR countries (Argentina, Brazil, Paraguay, and Uruguay) are not yet covered, since their agreement with the EU has not been ratified.

A third set of agreements includes some sub-Saharan African countries, e.g., the Ivory Coast, Cameroon, Namibia, Madagascar, and South Africa. This corresponds to the Economic Partnership Agreements (EPAs), signed in the 2010s, which replace and renew the former EU-ACP (Africa, Caribbean, Pacific) agreements in the so-called Lomé and later Cotonou frameworks.

More recently, the EU has initiated three new types of agreements. Deep and Comprehensive Trade Agreements (DCFTA) were concluded in 2016 with Ukraine, Georgia, and Moldova as a means of opening trade agreements to non-tariff aspects, such as non-tariff barriers, environment, intellectual property rights, or investment, in the framework of the EU neighbourhood Policy. In addition, Stabilization and Association Agreements (SAA) have been implemented with Western Balkans (Bosnia, Serbia, Macedonia, Albania, Montenegro, and North Macedonia) in the prospect of their future accession into the EU. Finally, a group of new bilateral Agreements has been concluded with Korea, Japan, the UK, Vietnam, and Canada to deepen and renew the EU partnership with these countries (later called "bilateral generation 2" agreements).

An extensive literature has already partially addressed the trade effects of the EU regional trade policy. A first set of articles focused on the Euro-Med partnership, specifically on Tunisia, Morocco, and Jordan. Ex-ante assessments relied on Computable General Equilibrium (CGE) models, which predicted positive trade effects (Ghoneim et al., 2012; Grumiller et al., 2018; Rau, 2014). Ex-post appraisals revealed differentiated effects depending on the flow considered. Cieślik & Hagemejer (2009) and Freund & Portugal-Perez (2012) show that Euro-Med

agreements mainly boosted imports into the EU, while export effects remained weak or insignificant; Péridy (2005) also documents an asymmetry in favor of EU-bound imports. These findings highlight a structural import–export asymmetry that our empirical framework later investigates in detail at the HS2 level. Some sectoral analyses also concluded to heterogeneous effects across sectors (Gasiorek & Mouley, 2019), depending on residual trade barriers (Bensassi et al., 2012) or geographical specificities (Cardozo et al., 2020).

Beyond MENA countries and more recently, further studies deal with EU trade agreements and point out limited effects (Eteria, 2020; Ostashko et al., 2022). For South America, Linarello (2018) highlights asymmetric impacts across partners and sectors. For EPAs, Bouët et al. (2018) and Stender et al. (2021) question their actual effectiveness once implementation and compliance costs are accounted for – an ambiguity that remains empirically relevant, particularly on the EU export side. SAAs with Western Balkans seem to have greater effects on FDI and exports (Grieveson et al., 2021; Reiter & Stehrer, 2018), despite incomplete convergence (Steinbach, 2024). This pattern is consistent with differentiated import and export responses observed in similar frameworks. Modern Agreements show contrasted effects with possible sectoral gains for EU agreements with Canada and Korea (Cherry, 2018; Forizs & Nilsson, 2017). These studies also underline performance gaps across industries such as machinery, vehicles, chemicals, and plastics, which are later examined in our section-based and RoO-complexity analyses. Finally, Laget et al. (2020) and Mattoo et al. (2022) show that the trade impact of an agreement depends on its institutional depth, with a key role for non-tariff provisions. In this study, institutional depth is proxied by the design of rules of origin and the level of non-tariff barriers (NTBs), which jointly capture the degree of integration beyond tariffs and the quality of regulatory alignment between partners.

Beyond the assessment of regional agreements *per se*, some authors focus on specific tools included in the negotiations, notably Rules of Origin (RoOs – distinguishing bilateral cumulation and diagonal cumulation under PEM) and non-tariff barriers (NTBs). Regarding RoOs, several studies suggest that when rules are too rigid, they can reduce the trade impact of an agreement, as in the case of EU-Jordan (Brunelin et al, 2019). Augier et al. (2004) highlight that a diagonal cumulation regime favors trade in MENA countries. Park et Pak (2021) show that uncertainty and restrictiveness related to RoOs are key factors determining whether exporters effectively use them. Most studies approximate RoOs with a single dummy (Bensassi et al., 2012; Cardozo, 2020), over limited country–year–product scopes. Our approach separates bilateral from diagonal cumulation (PEM), allowing us to identify distinct institutional effects and to test whether broader regional input sourcing under PEM is associated with stronger trade activation than bilateral regimes. Turning to NTBs, they have been increasingly studied in the past two decades as the reduction in tariffs at multilateral and regional levels progressively made NTBs the most crucial trade obstacle. Despite measurement challenges, existing estimates suggest sizeable ad-valorem equivalents (Berden et al., 2009; Cadot & Gourdon, 2016; Péridy, 2012; Rau, 2014), especially in SPS/TBT-intensive sectors like agriculture and textiles (Tudela-Marco et al., 2014; Cadot et al., 2016). Consistent with Dhingra et al. (2023), we treat NTBs as a central channel through which institutional depth translates into effective trade gains and use AVEs to capture persistent regulatory frictions.

In addition, the existing literature repeatedly points to a directional asymmetry: EU Preferential Trade Arrangements (PTAs) tend to foster imports more systematically than exports, reflecting structural and institutional asymmetries between the EU and its partners. However, most existing studies focus on specific agreements or sectors, without jointly accounting for these underlying structural differences.

Recent evaluations consistently report asymmetric export/import effects and heterogeneous outcomes across EU PTAs. For Euro-Med, studies find stronger import than export responses for the EU (e.g., Cieślik & Hagemejer, 2009; Freund & Portugal-Perez, 2012), while EPAs often show limited overall impacts (Bouët et al., 2018; Stender et al., 2021). By contrast, SAAs for the Western Balkans are associated with export/FDI gains despite incomplete convergence (Grieveson et al., 2021; Reiter & Stehrer, 2018; Steinbach, 2024). These patterns anticipate our findings: import-export asymmetries are sizable and institutional design – especially RoO regimes and non-tariff frictions – critically conditions the activation of preferences.

Against this background, this article provides several contributions to the assessment of the renewed EU regional trade policy. First, it simultaneously covers all partners countries that have signed a trade agreement with the EU (except for small Pacific and Caribbean islands)[1]. The sample includes 76 partner countries – whether linked by an agreement or not – and the 28 EU member states (depending on their year of accession) from 1995 to 2023. This wide coverage makes it possible to evaluate the consistency of EU trade policy and to differentiate its effects across the main blocs: Euro-Med, DCFTA, EPA, SAA, Latin American agreements (Andean and Central America), early bilateral agreements (first generation with Mexico and Chile), and modern bilateral agreements (second generation with Canada, Korea, Japan, Vietnam and the UK-Post Brexit).

Second, the analysis relies on a highly disaggregated dataset at the Harmonized System 2-digit level, allowing for a detailed examination of sectoral heterogeneity and differentiated effects across products and blocs. Two complementary aggregations are also performed: HS chapters are grouped first into three product categories according to the complexity of their rules of origin (RoO) and second into broader sections. This dual perspective highlights both institutional asymmetries and structural patterns that might remain hidden at the HS-chapter level. Overall, the combination of bilateral flows, products, and time yields more than three million observations.

Third, the model simultaneously accounts for EU trade agreements, rules of origin (through bilateral and diagonal cumulation under the Pan Euro-Med), non-tariff barriers (NTBs), and revealed comparative advantages (RCA). These structural variables make it possible to disentangle their separate effects and to test interaction terms such as bloc×NTB, thereby assessing whether institutional provisions mitigate or exacerbate regulatory frictions. Moreover, including RCA helps capture productive specialization and structural asymmetries, offering a more comprehensive understanding of why similar agreements may yield divergent outcomes across sectors or partners.

[1] Norway, Switzerland, and Iceland are excluded from the analysis, since these small countries have concluded very specific trade policies with the EU that remain outside the main preferential frameworks considered here.

Fourth, the model incorporates preferential trade ratio that measure how flows under trade agreements compare with those directed to non-FTA partners. This makes it possible to evaluate the relative intensity and effective use of preferences, shedding light on how EU and partner countries reallocate trade between preferential and non-preferential channels.

Methodologically, the analysis relies on a 4-index gravity model estimated with Poisson Pseudo Maximum Likelihood (PPML) estimator and multidimensional fixed effects, following the most recent literature (Larch & Yotov, 2023; Egger et al., 2022). The PPML is now recognized as a benchmark for estimating gravity equations, as it naturally handles zero trade flows – which are numerous in disaggregated datasets – while providing heteroskedasticity-robust estimates. In addition, combining PPML with multiple fixed effects is essential to control for unobserved heterogeneity that could otherwise bias the results.

Introducing the methodological refinements represents an additional contribution of this study, since much of the previous literature has relied on simpler log-linear specifications or limited fixed-effect structures.

The remainder of the article is organized as follows. Section 1 presents the model, variables, and data, along with the choice of the estimator. Section 2 discusses the baseline estimation results and the extended specification, including interaction terms between NTBs and FTA blocs. Section 3 examines heterogeneity across products by regrouping HS chapters according to the complexity of rules of origin and HS sections. Finally, Section 4 concludes and outlines the main policy implications.

1. MODEL SPECIFICATION

The model builds on recent developments in structural gravity. Theoretically, it follows Anderson and van Wincoop (2003) and explicitly accounts for multilateral resistance. The analysis is conducted at the HS2 level to capture product heterogeneity in EU trade and potential differentiated policy effects.

The specification combines institutional and trade-policy variables – rules of origin (RoO) and non-tariff barriers (NTBs) – with structural variables such as revealed comparative advantages (RCA) and preference ratios, which measure the relative intensity of preferential versus non-preferential trade. In line with the depth literature, we treat agreement "depth" in an operative sense: RoO design and NTB ad-valorem frictions proxy the vertical (restrictiveness/implementation) and horizontal (scope) facets most relevant for preference activation at HS2; formal provision-count indices are left to future research.

The specific impact of EU trade policy is captured through considering the seven homogeneous blocs: Euro-Med, DCFTA, Western Balkans (SAA), Sub-Saharan Africa (EPA), Latin American agreements, first-generation bilateral agreements (Mexico and Chile), and second-generation bilateral agreements (Canada, Korea, Japan, Vietnam, and the UK).

From an econometric standpoint, the model is estimated using the Poisson Pseudo-Maximum Likelihood (PPML) estimator (Santos Silva & Tenreyro, 2006), which naturally handles zero trade flows and corrects for heteroskedasticity. In the

baseline specification, PPML is combined with multidimensional fixed effects – exporter–importer pair (ϕ_{ij}), product (δ_p), and time (γ_t) – as recommended by Head & Mayer (2014) and Yotov et al. (2016). Overall, the model includes four dimensions (exporter, importer, products, and year), more than three million observations, and a complete set of explanatory variables with multiple fixed effects.

The estimating equation can be written as:

$$Trade_{ijpt} = \exp\left(\sum_b \beta_b FTA_{b,ijt} + \beta_{NTB} NTB_{ijt} + \sum_c \beta_c ROO_{c,ijt-1} + \beta_i \ln RCA_{itp} + \beta_j \ln RCA_{jtp} + \beta_x \ln ratioX_{ijtp} + \beta_m \ln ratioM_{ijtp}\right) \cdot \exp(\phi_{ij} + \gamma_t + \delta_p) \cdot \varepsilon_{ijpt}$$

where $Trade_{ijpt}$represents the bilateral trade (exports or imports) between EU member i and partner j, for product p and year t.

$FTA_{b,ijt}$are bloc dummies; $NTB_{ijt}$is the bilateral ad-valorem equivalent of non-tariff frictions; $ROO_{c,ijt-1}$captures the applicable cumulation regime with one-year lag; $\ln RCA_{itp} and \ln RCA_{jtp}$represent revealed comparative advantages and $\ln ratioX_{ijtp}$, $\ln ratioM_{ijtp}$are preference ratios. Fixed effects ($\phi_{ij}, \gamma_t, \delta_p$) control for bilateral, temporal, and product heterogeneity to capture time-varying multilateral resistance.

The panel covers the period 1995–2023, consistent with NTB availability from the ESCAP–World Bank Trade Cost Database. It includes 76 partners – both FTA and non-FTA – and the 28 EU member states according to their accession year, representing over 90% of total EU external trade. These partners include the major blocs with preferential trade agreements with the EU and the main non-preferential partners[2].

Trade data come from the BACI database (CEPII; Gaulier & Zignago, 2010), measured in current thousand US dollars at the HS2 level, aggregated from the 6-digit classification[3]. This level of disaggregation offers a balance between sectoral detail and statistical stability, while limiting the prevalence of zero flows. The panel is squared to include all exporter–importer–product–year cells (i, j, p, t). Zero trade flows are retained and handled directly by PPML. EU enlargement is treated dynamically: a country becomes an EU member in its accession year, and intra-EU flows are then excluded from the estimation sample, preventing the conflation of enlargement with FTA effects.

The variables are defined as follows. FTA blocs are represented by seven dummies $(FTA_{b,ijt})$ identifying whether an agreement is in force for the pair i, j in year t**.** Rules of Origin (RoO) are proxied by the applicable cumulation regime. Bilateral cumulation allows inputs from the EU and one partner to qualify as

[2] Angola, UAE, Argentina, Australia, Burkina Faso, Bangladesh, Bahrain, Brazil, China, Congo, Gabon, Guinea, Hong Kong, Indonesia, India, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mali, Malaisia, Nigeria, Nez-Zealand, Pakistan, Philippines, Qatar, Russia, Saudi Arabia, Senegal, Togo, Thailand, USA, Venezuela.

[3] The products included cover the main HS chapters: 1 to 40; 50 to 63; 72 to 89.

originating, while diagonal cumulation (PEM) extends this to multiple countries within the Pan-Euro-Med network. The enforcement year is obtained from the European Commission's Access2 Markets portal, and the RoO variable enters with a one-year lag to capture adjustment delays. Non-tariff barriers (NTBs) are measured as bilateral ad-valorem equivalents of trade costs from the ESCAP–World Bank database, following Novy (2013). Because the ESCAP data are provided in ISIC classification, an all-goods (agriculture + industry) bilateral indicator is used, expressed in levels (not logs) to preserve its direct cost interpretation.

Revealed Comparative Advantages (RCA) are computed from BACI data using the Balassa index at the HS2 level for each country and year:

$$RCA_{ktp} = \frac{X_{ktp}/X_{kt}}{X_{wtp}/X_{wt}}, k \in i, j.$$

To retain zero-export observations, the transformation $\ln(1 + RCA_{ktp})$ is applied. The minimum of $\ln RCA$ is therefore zero, corresponding to $RCA = 0$. Higher values indicate stronger revealed specialization in product p.

Preference ratios measure the relative intensity of trade under preferential agreements compared with trade with non-preferential partners. They are constructed at the relevant market-side aggregation (exporter–product–year for exports; importer–product–year for imports) and assigned to each (i, j, p, t)observation. Specifically:

$$ratioX_{i,p,t} = \frac{\sum_{j:FTA_{ijt}=1} X_{ijpt}}{\sum_{j:FTA_{ijt}=0} X_{ijpt}}, \qquad \ln ratioX_{i,p,t} = \ln (ratioX_{i,p,t}).$$

$$ratioM_{j,p,t} = \frac{\sum_{i:FTA_{ijt}=1} M_{ijpt}}{\sum_{i:FTA_{ijt}=0} M_{ijpt}}, \quad \ln ratioM_{j,p,t} = \ln (ratioM_{j,p,t}).$$

When the denominator equals zero (i.e., no non-FTA trade exists for that product and year), the ratio is set to missing to avoid division by zero. Economically, higher values of $\ln ratioX$ or $\ln ratioM$ indicate a stronger concentration of trade under preferential agreements relative to non-preferential flows; positive values imply that preferential trade dominates.

All models are estimated using PPML with the fixed-effect structure described above. Export and import equations are estimated separately. Standard errors are clustered at the bilateral pair level to account for within-pair serial correlation; two-way clustering by pair and product (Cameron & Miller, 2015) yields consistent significance levels. Coefficients can be interpreted as semi-elasticities, i.e., $100 \times [\exp(\beta) - 1]\%$.

Before estimating the model, it is essential to examine the main stylized facts characterizing extra-EU trade between EU member states and external partners. The dataset comprises 3,907,059 bilateral flows observed from 1995 to 2023 at the HS2 level (Table 1). Intra-EU flows are excluded from all statistics and figures, so the descriptive analysis focuses exclusively on the EU's external trade policy and avoids conflating internal integration with preferential trade agreements (PTAs).

On average, exports from EU members to external partners amount to USD 11.6 million per (i–j–p–t) flow, with a median of USD 14.8 thousand. Imports average USD 12.5 million with a median of USD 25[4].This large mean–median gap reflects substantial dispersion and many zeros (36.9% of export cells; 49.3% of import cells). Continuous regressors (NTBs, RCAs, preference ratios) also display wide dispersion, motivating their inclusion in the empirical model.

Table 1 – Descriptive statistics (extra-EU, HS2, i–j–p–t panel, 1995–2023)

Variable	Obs	Mean	Median	Std. Dev.	Min	Max	Missing
Trade flows							
Exports (X_{ijpt})	3,907,059	11.6 million $	14,769 $	187.2 million $	0	35.0 billion $	1,441,700
Imports (M_{ijpt})	3,907,059	12.5 million $	25 $	240.9 million $	0	72.0 billion $	1,927,200
Continuous variables							
NTBs	2,246,937	183.15	159.97	97.81	1.84	1131.95	888,565
ln_RCA_i	3,114,202	0.61	0.5	0.53	0	4.30	21,300
ln_RCA_j	3,093,257	0.47	0.14	0.74	0	6.29	42,245
ln_ratio_X	2,953,762	-1.83	-1.69	2.25	-17.84	14.00	181,740
ln_ratio_M	2,987,355	-2.19	-1.87	2.37	-18.60	9.76	148,147

Notes: Extra-EU trade only. Observations are exporter–importer–product–year cells. Trade flows in current USD; zeros retained for PPML. NTBs are ad-valorem equivalents (%) from ESCAP–World Bank. RCA uses ln(1+RCA) to keep zero-export cases. ln_ratio_X and ln_ratio_M are log ratios of FTA to non-FTA trade shares; ratios set to missing when the denominator is zero. "Missing" refers to unavailable data, not sample exclusion.

Regarding agreements coverage, about 12% of flows are linked to Euro-Med, 6% to Latin American, 4% to Western Balkan (SAA), and less than 4% to EPAs. Early bilateral agreements with Mexico and Chile account for around 3% of flows, while second-generation bilateral agreements (Canada, Korea, Japan, UK, Vietnam) represent just above 2%. For rules of origin, around 12% of flows fall under diagonal cumulation (PEM) and 14% under bilateral cumulation; the rest occur outside any cumulation regime.

In dynamics, annual growth rates (Figure 1) rise steadily with interruption in 2009 global financial crisis, 2012 sovereign debt crisis, and 2020 Covid-19 pandemic. Figure 2 documents the progressive expansion of flows covered by extra-EU FTAs – here *FTA* refers only to agreements between the EU and non-EU partners; it excludes the Single Market and Customs Union while non-FTA flows still dominate external trade in levels (notably with the United States, China, Russia, and MERCOSUR), PTA-covered exchanges have grown markedly since the mid-2000s, with a stronger rise on the import side.

At the sectoral level, EU exports concentrate in a few HS2 chapters (machinery, vehicles, electrical equipment, pharmaceuticals, and mineral fuels) accounting for over half of total flows. On the import side, composition varies by bloc: fuels dominate Sub-Saharan Africa, while machinery/vehicles feature prominently in Euro-Med and Gen-2 bilateral (Figure 3).

[4] Exports and imports values correspond to the flows recorded in our dataset, and thus, not precisely the overall trade flows recorded in the EU overall current account.

Figure 1. Annual growth rate of EU flows

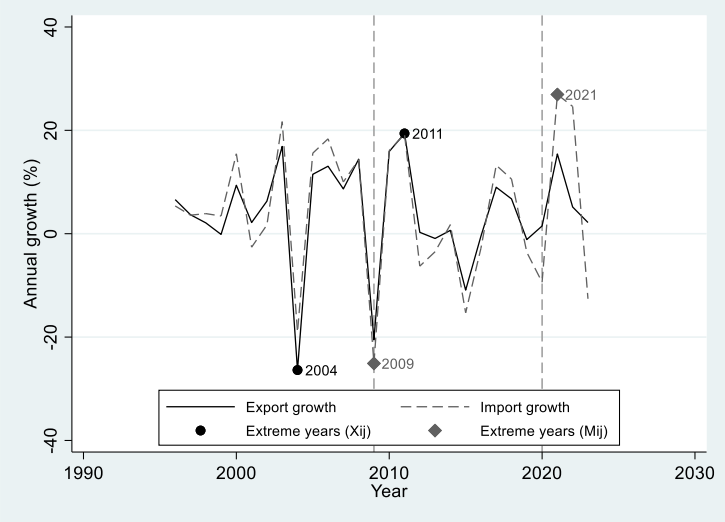
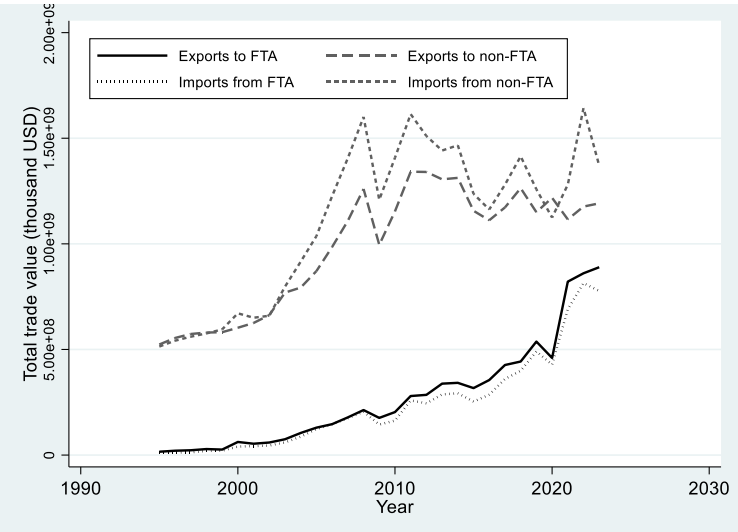


Figure 2. Evolution of EU trade by FTA status (1995–2023)



Note: Intra-EU excluded. "FTA" = all extra-EU PTAs in force with non-EU partners.

Non-tariff barriers (NTBs) remain a key trade-cost component. Our NTB measure is not a legal count of provisions; it is an empirical ad-valorem surcharge observed in flows. It thus reflects logistics, administrative procedures, SPS/TBT standards, language/regulation/currency frictions, etc., beyond what is written in PTAs. Figure 4 shows marked heterogeneity: Euro-Med partners display relatively low/stable NTBs since the late 1990s; EPAs and Latin America remain high even post-entry into force; SAAs trend downward with convergence; Gen-2 bilateral show the lowest levels, consistent with deeper regulatory compatibility.

Figure 3. Top five HS2 chapters imported, by the EU (1995–2023)

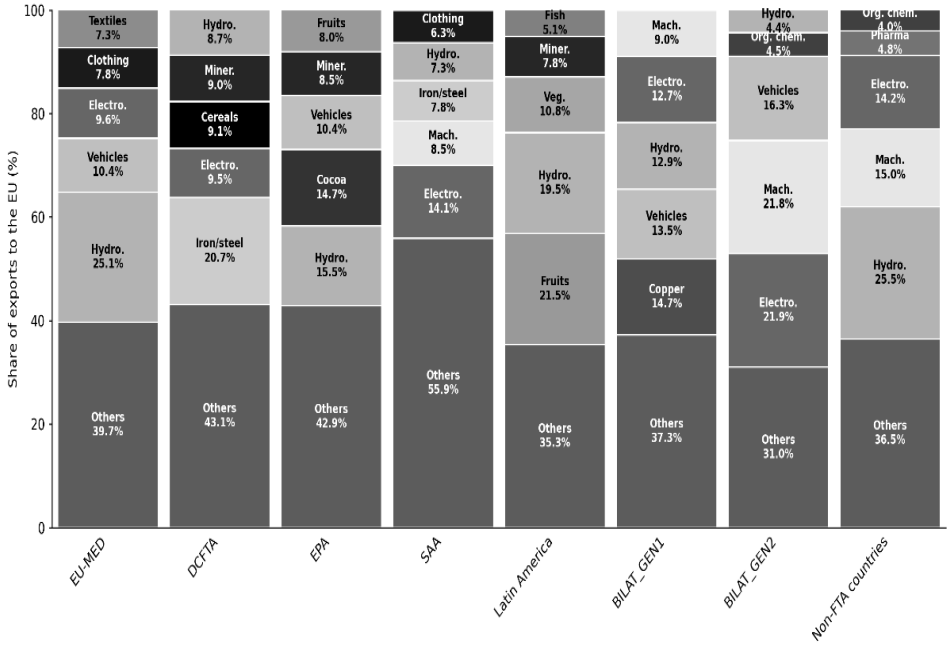
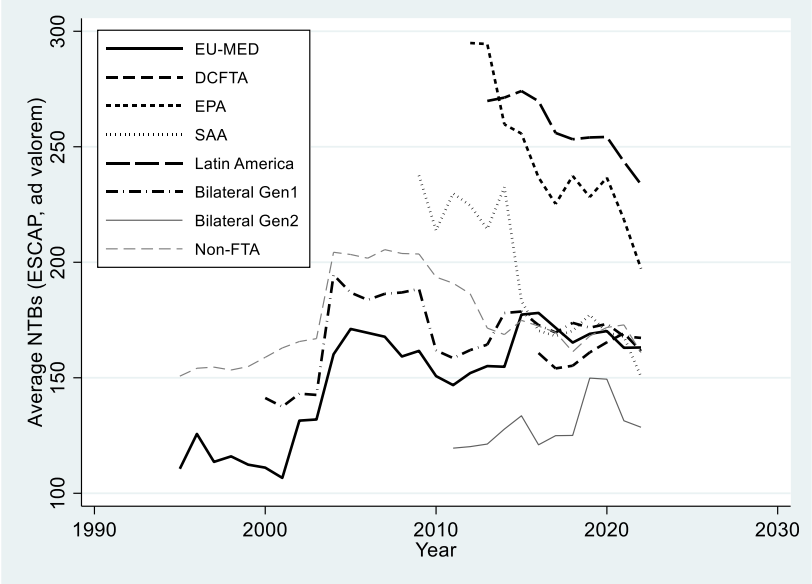


Figure 4. Evolution of average NTB ad-valorem equivalents by FTA bloc, 1995–2023



Notes: Extra-EU only. Source: ESCAP–World Bank Trade Cost Database. Series are simple (unweighted) annual means of bilateral NTB AVEs within each bloc and include pre- and post-entry-into-force periods.

Rules of origin (RoO) shape the effective use of preference. Table 2 shows that cumulation regimes increase the likelihood of observing a positive flow. Without cumulation, only 62.5% of export and 50.6% of import cells are non-zero; under bilateral cumulation, these shares rise to 69.8% (exports) and 59.9% (imports). Diagonal (PEM) cumulation yield 68.1% (exports) and 51.7% (imports). This indicates a facilitating role – particularly bilateral cumulation – in reducing compliance costs and supporting preference utilization.

In levels, the largest volumes remain outside any cumulation framework, mainly due to major non-FTA partners (United States, China). Still, sizable flows also occur under bilateral cumulation – exceeding USD 1.2 billion in machinery alone – while diagonal (PEM) remains smaller in absolute value but essential for regional industrial exchanges.

Table 2 – Presence of a flow by cumulation regime (1995–2023) (% of non-zero observations)

Cumulation regime	Exports (non-zero, %)	Imports (non-zero, %)
No cumulation	62.5	50.6
Bilateral cumulation	69.8	59.9
Diagonal cumulation (PEM)	68.1	51.7

Notes: Shares computed over all exporter–importer–year (i–j–t) combinations, aggregated over HS2 products. The cumulation regime varies by pair and year (not by product). Extra-EU trade, 1995–2023.

Two additional dimensions complete the picture. First, RCA distributions reveal structural asymmetries: EU exporters are concentrated around moderate levels, whereas EPA/Euro-Med/Latin America partners show stronger specialization in primary goods; SAAs and Gen-2 bilateral look closer to the EU profile, suggesting higher complementarities. Second, preference vs. non-preference trade ratios have increased since the mid-2000s, with an acceleration around Gen-2 PTAs (Korea, Canada, Japan, Vietnam, UK), pointing to a partial – but incomplete – reallocation toward PTA partners.

Overall, the dataset shows pronounced heterogeneity across countries, blocs, and products, persistent zeros, and shock-driven breaks in trend. These features justify the use of a four-index PPML gravity with rich fixed effects and careful variable construction to ensure robust identification.

2. ESTIMATION RESULTS

Table 3 reports PPML estimates for EU exports and imports in the baseline specification (columns 1–2) and an extended version with bloc×NTB interactions (columns 3–4). Coefficients are semi-elasticities: for a dummy (e.g. an FTA bloc), the percentage effect is $100 \times \left(e^{\beta} - 1\right)$. For clarity, we discuss effects in percentage terms.

Baseline results reveal marked heterogeneity across blocs and a clear directional asymmetry. On exports, only two blocs are positive and significant: bilateral generation-1 (Mexico, Chile) raises EU exports by +23.6% ($e^{0.2118} - 1$), and Latin America by +12.4%. These gains are consistent with long-standing frameworks combining tariff preferences with regulatory/technical cooperation (Cherry 2018; Forizs & Nilsson 2017). By contrast, EPAs (–22.1%) and DCFTAs (–18.0%) reduce EU exports (Berends, 2016; Ostashko et al., 2022); SAAs are negative but not significant; bilateral generation-2 (Canada, Korea, Japan, Vietnam, UK) shows no

average export impact – likely reflecting recent entry into force and protracted adjustment.

Table 3. PPML estimation results for EU exports and imports (1995–2023)

	(1)	(2)	(3)	(4)
Variables	X (Baseline)	M (Baseline)	X (FTA × NTB)	M (FTA × NTB)
Preferential Trade Agreements (PTAs)				
Euro-Med Agreements	0.054	0.605***	0.013	0.607***
	(0.06)	(0.12)	(0.12)	(0.21)
Deep & Comprehensive FTAs (DCFTA)	−0.198***	−0.122	−0.312**	0.064
	(0.06)	(0.10)	(0.12)	(0.17)
Economic Partnership Agreements (EPA)	−0.251***	−0.153	−0.618***	−0.318
	(0.07)	(0.11)	(0.10)	(0.35)
Stabilization & Association Agreements (SAA)	−0.116	0.314***	−0.260**	−0.122
	(0.07)	(0.10)	(0.11)	(0.17)
Latin American Agreements	0.117**	−0.016	0.327**	−0.310
	(0.05)	(0.07)	(0.15)	(0.24)
Bilateral Agreements – Gen. 1 (Mexico, Chile)	0.212***	0.494***	0.018	0.468
	(0.07)	(0.13)	(0.21)	(0.35)
Bilateral Agreements – Gen. 2 (Canada, Korea, Japan, UK, Vietnam)	0.003	−0.222***	−0.018	−0.089
	(0.07)	(0.08)	(0.18)	(0.18)
Institutional Variables				
Non-Tariff Barriers (NTB)	−0.0069***	−0.0127***	−0.0071***	−0.0127***
	(0.00)	(0.00)	(0.00)	(0.00)
Bilateral Cumulation	0.104***	0.041	0.104***	0.041
	(0.03)	(0.06)	(0.03)	(0.06)
Diagonal Cumulation (PEM)	0.087**	0.149**	0.090***	0.149**
	(0.04)	(0.06)	(0.03)	(0.06)
Structural Variables				
Exporter RCA (ln_RCA_i)	1.773***	0.441***	1.773***	0.441***
	(0.06)	(0.04)	(0.06)	(0.04)
Partner RCA (ln_RCA_j)	0.188***	1.799***	0.188***	1.799***
	(0.03)	(0.02)	(0.03)	(0.02)
Export Preference Ratio (ln_ratio_x)	0.039	0.058***	0.039	0.058***
	(0.02)	(0.02)	(0.02)	(0.02)
Import Preference Ratio (ln_ratio_m)	0.028***	0.016	0.028***	0.016
	(0.01)	(0.02)	(0.01)	(0.02)
Interactions: FTA × NTB				
Euro-Med × NTB	—	—	0.0004	−0.0000
			(0.00)	(0.00)
DCFTA × NTB	—	—	0.0013	−0.0022
			(0.00)	(0.00)
EPA × NTB	—	—	0.0033***	0.0015
			(0.00)	(0.00)
SAA × NTB	—	—	0.0015**	0.0052***
			(0.00)	(0.00)
Latin America × NTB	—	—	−0.0013	0.0020
			(0.00)	(0.00)
Bilateral Gen. 1 × NTB	—	—	0.0017	0.0002
			(0.00)	(0.00)
Bilateral Gen. 2 × NTB	—	—	0.0002	−0.0013
			(0.00)	(0.00)
Observations	2,026,609	2,026,335	2,026,609	2,026,335
Pseudo R^2	0.908	0.919	0.908	0.919
Chi^2	1941.22	8629.41	2022.46	8760.07

Notes: PPML estimates on extra-EU flows at HS2; separate equations for exports (X) and imports (M). Fixed effects: country-pair, product (HS2), year (baseline); Standard errors clustered by country pair; results robust to two-way clustering (pair×product). Coefficients are semi-elasticities; percentage effects reported as 100×(e^β-1). Significance: p<0.10, p<0.05, p<0.01. Model labels in the columns: "X (baseline)", "M (baseline)", "X (bloc×NTB)", "M (bloc×NTB)". Structural and institutional covariates also shape PTA effectiveness.

On imports, EU trade is far more responsive to PTAs. The Euro-Mediterranean bloc yields the strongest effect (+83.2%), consistent with Péridy (2005) and Cieślik & Hagemejer (2009), who found positive post-Barcelona impacts mainly on EU imports. The result confirms the attractiveness of the EU market for Southern-Mediterranean exporters and the effectiveness of tariff-dismantling schemes.

SAAs also show significant import gains (+36.8%), echoing Grieveson et al. (2021) and Reiter & Stehrer (2018), who highlight their catalytic role through FDI and regional-value-chain integration. First-generation bilateral agreements yield +63.9%, consistent with their legal depth and long enforcement. By contrast, second-generation bilateral display a negative import effect (≈ –20%), possibly reflecting transitional lags, technical-standard complexity, or under-utilization of preferences. Other blocs (EPA, DCFTA, Latin America) remain weak or insignificant, pointing to structural asymmetries in enforcement.

This import–export asymmetry is consistent with partial ex-post assessments (Freund & Portugal-Perez, 2012; Linarello, 2018), which argue that access to the EU market provides stronger incentives for partner exports than EU exporters find abroad. Economically, this pattern reflects asymmetric specialization: EU advantages lie in technologically complex sectors (machinery, vehicles, pharmaceuticals) where regulatory frictions dominate, while partners specialize in tariff-sensitive goods (agriculture, textiles) that benefit more directly from liberalization. Aggregate asymmetries thus mirror underlying specialization.

Rules of origin (RoO) display an institutional asymmetry. Bilateral cumulation, typical of transitional frameworks such as Euro-Med, SAA, and DCFTA, benefits EU exports (+10.9%) but not imports, since EU producers more easily satisfy origin criteria. Diagonal cumulation (PEM), by contrast, promotes both flows (+9.1% exports; +16% imports), around 7–10 points stronger than bilateral regimes. This confirms the integrative role of PEM regional sourcing and harmonization (Augier et al., 2004; Brunelin et al., 2019; Park & Pak, 2021).

Revealed comparative advantages (RCA) are strongly positive: EU RCA (+477%) drives exports, partner RCA (+507%) drives imports, showing that structural specialization amplifies trade irrespective of legal preferences (Márquez-Ramos & Martínez-Zarzoso, 2014).

Preference ratios (continuous indicators of PTA vs. non-PTA trade) are modest but significant: the export ratio affects imports (+5.9%), while the import ratio affects exports (+2.8%). They capture actual preference use beyond binary creation/diversion measures (Carrère, 2006; Endoh, 1999).

Non-tariff barriers (NTBs) are significantly negative on both sides (–0.0069 for exports, –0.0127 for imports, i.e. –0.7% and –1.3% per additional ad-valorem point), confirming that even within PTAs, regulatory costs remain binding. The stronger import effect suggests EU technical standards constrain third-country exporters more than partner rules constrain EU firms (Fugazza, 2013; Dhingra et al., 2023).

The extended specification with bloc × NTB interactions refines these results. On exports, adding interactions accentuates asymmetries: EPA (–46.1%), DCFTA (–26.8%), and SAA (–22.9%) turn sharply negative, whereas Latin America remains positive (+38.8%). Only two interactions – EPA×NTB (+0.0033) and SAA×NTB

(+0.0015) – are significant, indicating limited NTB mitigation insufficient to offset the direct adverse impacts. On imports, results largely mirror the baseline: Euro-Med remains dominant (+83.5%), while SAA×NTB (+0.0052) signals lower NTB sensitivity through regulatory convergence. Other blocs show no significant interactions, suggesting most PTAs lack the institutional depth or regulatory alignment needed to reduce frictions (Laget et al., 2020; Mattoo et al., 2022).

Taken together, these results confirm that the trade impact of EU PTAs depends jointly on structural specialization and institutional design. The import–export asymmetry arises from productive structures, while heterogeneity across blocs reflects enforcement capacity and legal depth. Older, deeper, and better-implemented agreements deliver the largest gains; newer or shallower ones show limited results. Overall, tariff liberalization alone no longer explains trade creation – once NTBs and RoO are included, they capture most variation in trade performance.

3. RESULTS BY RULES OF ORIGIN, COMPLEXITY, AND PRODUCT GROUPS

The baseline specification already provides a highly disaggregated view at the HS-chapter level, where each product category enters separately in the gravity model. Yet, chapter-level estimates may still obscure structural regularities across groups of products sharing similar institutional or sectoral features. To address this, HS chapters are reorganized into broader categories – first by the complexity of their rules of origin (RoO), and second by HS sections – to capture more homogeneous patterns of preference utilization. This regrouping helps reveal institutional asymmetries and sector-specific dynamics that remain invisible at the chapter level.

3.1. Effects of the complexity of rules of origin

Table 4 classifies HS2 chapters according to the restrictiveness of their rules of origin, following the R-index developed by de Melo et al. (2005). Products are grouped into three categories based on their most binding rule:

- Group 1 (low complexity): raw or lightly processed goods with simple origin requirements and general tolerance clauses.
- Group 2 (moderate complexity): intermediate products subject to tariff-shift or regional value-content rules, generally around 40–50%, with moderate flexibility.
- Group 3 (high complexity): high-value-added goods such as textiles and machinery, characterized by stringent transformation thresholds, technical requirements, and limited cumulation.

Building on this classification, Table 5 presents the estimation results by RoO complexity groups. The results reveal strong heterogeneity across product types and trade blocs, indicating that the restrictiveness of origin rules critically shapes the effectiveness of EU trade agreements.

For low-complexity products (Group 1), no FTA significantly affects EU exports, while Latin American and second-generation bilateral agreements increase imports by about 30–35%. This suggests that tariff preferences are effectively activated on the partner side in primary sectors where origin requirements are simple and compliance costs are limited.

Table 4. Classification of HS chapters by rules of origin (RoO) complexity

Group	*Associated R-index*	*Simplified description*	*HS2 chapters*	*Typical examples*
1- Low	R = 1–2	Simple RoO: wholly obtained, minimal transformation; general tolerance often applicable	01–07, 09–10, 12, 14	Agriculture, minerals, raw products
2- Moderate	R = 3–4	Moderate RoO: tariff shift and/or Regional Value Contents (RVC) > 40%; relatively flexible sectoral rules	08, 13, 16, 25–26, 40, 60, 74–76, 79–81	Agri-food, plastics, basic chemicals
3- High	R = 5–7	Strict RoO: tariff shift at chapter level, RVC ≤ 40%; technical requirements; cumulative rules; tolerance rarely applicable	Remaining chapters (total = 47)	Textiles, machinery, vehicles, electronics

For intermediate-complexity products (Group 2), trade effects are more balanced. First-generation bilateral agreements stimulate both flows significantly, with exports rising by over 55% and imports by about 33%. Latin American agreements also boost exports strongly (around +45%). Conversely, DCFTAs reduce both exports (–24%) and imports (–29%), reflecting persistent administrative frictions or asymmetric implementation.

For high-complexity products (Group 3), most significant effects concern imports. Euro-Med agreements increase imports by about 97%, first-generation bilateral by 69%, and SAAs by 32%. On the export side, only Latin American (+12%) and first-generation bilateral agreements (+24%) show positive and significant results, whereas DCFTA (–17.5%) and EPA (–24.9%) reduce EU exports. These outcomes illustrate that restrictive RoOs and institutional barriers weigh particularly heavily on complex, high-value-added goods.

The role of cumulation regimes further clarifies these patterns. Bilateral cumulation mainly benefits the EU, with significant export effects across all groups (up to +16%), but no significant import effects for complex products. In contrast, diagonal cumulation (PEM) yields positive and significant coefficients in both directions, particularly for intermediate goods (+21% exports, +42% imports), confirming its integrative and harmonizing role.

As expected, NTBs remain systematically negative, with magnitudes increasing with product complexity. For technical or high-value-added goods, a 1% rise in regulatory costs reduces exports by about 0.7% and imports by 1.3%, confirming that such sectors are more sensitive to regulatory frictions.

Finally, revealed comparative advantages (RCA) exert a strong amplifying effect. EU specialization raises exports by nearly +500% in the most complex sectors, while partner RCA drives imports by about +550%, reflecting asymmetric integration into value chains. Preference-ratio variables have more moderate but significant effects, mainly for complex goods, suggesting that preference intensity matters most in sectors with higher compliance costs.

Overall, these results confirm that the economic activation of EU agreements depends not only on their legal existence but also on their institutional design and sectoral compatibility. For high-complexity goods, agreements such as Euro-Med, SAA, and bilateral Gen 1 favour imports, indicating that partner countries are effectively joining EU value chains. In contrast, EU exports remain constrained by

restrictive RoOs and technical standards. For moderately complex goods, trade effects are more symmetrical, particularly under Latin American and Gen 1 bilateral, where flexible RoOs and compatible productive structures facilitate reciprocal gains. In low-complexity sectors, benefits mainly accrue to partners, as EU specialization in primary goods is limited.

Table 5. PPML estimation results by RoO complexity groups (Low, Moderate, High)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Exports – Low	Imports – Low	Exports – Moderate	Imports – Moderate	Exports – High	Imports – High
Preferential Trade Agreements (PTAs)						
Euro-Med Agreements	−0.140	−0.093	0.128	−0.194	0.063	0.679***
	(0.16)	(0.16)	(0.11)	(0.14)	(0.07)	(0.13)
Deep & Comprehensive FTAs (DCFTA)	−0.015	−0.090	−0.279***	−0.342***	−0.193***	0.024
	(0.14)	(0.18)	(0.08)	(0.13)	(0.06)	(0.11)
Economic Partnership Agreements (EPA)	−0.048	0.060	0.139	0.040	−0.286***	−0.200
	(0.12)	(0.11)	(0.11)	(0.10)	(0.07)	(0.13)
Stabilization & Association Agreements (SAA)	−0.094	0.222	−0.019	0.211	−0.127	0.280**
	(0.13)	(0.19)	(0.16)	(0.16)	(0.08)	(0.13)
Latin American Agreements	−0.124	0.260***	0.369***	−0.009	0.115**	−0.026
	(0.15)	(0.07)	(0.07)	(0.10)	(0.06)	(0.10)
Bilateral Agreements – Gen. 1 (Mexico, Chile)	−0.481	0.170	0.441***	0.286*	0.215***	0.525***
	(0.32)	(0.12)	(0.12)	(0.16)	(0.07)	(0.15)
Bilateral Agreements – Gen. 2 (Canada, Korea, Japan, UK, Vietnam)	−0.171	0.301**	0.042	−0.095	0.000	−0.245***
	(0.16)	(0.14)	(0.07)	(0.10)	(0.07)	(0.08)
Institutional Variables						
Non-Tariff Barriers (NTB)	−0.004***	−0.012***	−0.008***	−0.010***	−0.007***	−0.013***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bilateral Cumulation	0.112	0.174*	0.192***	0.349***	0.075**	0.136**
	(0.09)	(0.11)	(0.06)	(0.08)	(0.04)	(0.07)
Diagonal Cumulation (PEM)	0.152**	0.176*	0.045*	0.150**	0.104***	0.021
	(0.07)	(0.10)	(0.03)	(0.06)	(0.03)	(0.06)
Structural Variables						
Exporter RCA	1.677***	0.273***	1.648***	0.384***	1.802***	0.481***
	(0.09)	(0.08)	(0.06)	(0.07)	(0.07)	(0.06)
Partner RCA	−0.117**	1.491***	−0.035	1.640***	0.226***	1.872***
	(0.05)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)
Export Preference Ratio	0.018	0.054***	−0.013	0.045***	0.040	0.063**
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.03)
Import Preference Ratio	−0.018	0.007	0.007	−0.001	0.033***	0.019
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)
Observations	288,394	291,022	354,233	352,869	1,379,536	1,379,353
Pseudo R^2	0.746	0.874	0.841	0.861	0.915	0.928
Chi^2	453.11	2003.07	984.14	2108.16	1910.35	6592.04

Notes: Columns (1)–(6) report PPML estimates for EU exports (X) and imports (M) by RoO complexity group: low (Group 1), moderate (Group 2), and high (Group 3). Coefficients are PPML semi-elasticities, interpreted as percentage changes in trade flows $e^{\beta} - 1$.
*All estimations include exporter–importer pair, HS2 product, and year fixed effects. Standard errors clustered by country pair (in parentheses). p < 0.1, ** p < 0.05, *** p < 0.01.*

Taken together, the analysis demonstrates that restrictive RoOs can nullify the expected gains from tariff preferences, whereas flexible cumulation and institutional depth – especially under PEM – are essential to achieve balanced and effective trade integration.

3.2. Results by HS sections

To complement the analysis based on rules of origin (RoO) complexity, this subsection examines the effects of preferential trade agreements (PTAs) through a sectoral aggregation based on the Harmonized System (HS) sections. Seventy-one HS2 chapters are grouped into eleven broad industrial categories, covering the main dimensions of extra-EU trade. Unlike the RoO-based typology, this approach reflects more directly the productive structures of partner economies and the regulatory or technical characteristics specific to each industry. The sectors include agriculture and food products, raw materials, chemical and plastic industries, textiles, base metals, and capital goods such as machinery and transport equipment (Table 6).

Table 6. HS sections included in the analysis

HS Section	*HS Chapters*	*Broad description*	*Typical products*
Section 1	01–05	Live animals and animal products	Meat, dairy, fish
Section 2	06–14	Vegetable products	Fruits, cereals, coffee, and tea
Section 3	15	Animal and vegetable fats, oils	Vegetable oils, margarine
Section 4	16–24	Prepared foodstuffs, beverages, tobacco	Processed food, beverages, and tobacco
Section 5	25–27	Mineral products	Ores, crude oil, coal
Section 6	28–38	Chemical products	Basic chemicals, pharmaceuticals, fertilizers
Section 7	39–40	Plastics and rubber	Plastics, rubber articles
Section 11	50–63	Textiles and textile articles	Fibres, fabrics, garments
Section 15	72–83	Base metals and articles thereof	Iron/steel, aluminium, copper, tools
Section 16	84–85	Machinery and electrical equipment	Industrial machinery, electronics
Section 17	86–89	Transport equipment	Vehicles, aircraft, ships

Building on this classification, Table 7 reports the estimation results for EU exports by HS section. The findings reveal pronounced sectoral heterogeneity and show that institutional design and productive specialization jointly shape the effectiveness of EU trade agreements. Latin American and first-generation bilateral agreements stand out for their consistent and significant positive impact across a wide range of industries, including foodstuffs, chemicals, plastics, metals, machinery, and vehicles. By contrast, Euro-Mediterranean agreements display a more mixed pattern, with strong complementarities in chemicals (+41 %) and metals (+29 %) but significant export declines in agriculture and plastics. DCFTAs and EPAs yield predominantly negative coefficients across most industrial sectors, particularly in machinery and vehicles (–34 % to –46 %), reflecting weak enforceability and persistent regulatory asymmetries. Stabilization and Association Agreements (SAAs) with the Western Balkans also show partial activation, with declines in several manufacturing sectors but some positive results in paper and light industries.

Turning to institutional mechanisms, cumulation regimes have a clear influence on export performance. Bilateral cumulation tends to stimulate EU exports in simpler or moderately complex industries such as agriculture, food, plastics, and paper, with gains ranging from +12 % to +23 %. In contrast, diagonal cumulation under the Pan-Euro-Med Convention generates stronger and more balanced effects in capital- and technology-intensive sectors – chemicals (+25 %), metals (+38 %), machinery (+9 %), and vehicles (+23 %) – confirming its essential role in facilitating regional value-chain integration.

Table 7. PPML estimation results by HS section – EU exports (1995–2023)

Variables	Sec. 1	Sec. 2	Sec. 3	Sec. 4	Sec. 5	Sec. 6	Sec. 7	Sec. 11	Sec. 15	Sec. 16	Sec. 17
PTAs											
Euro-Med Agreements	−0.524***	0.116	−0.313	−0.206**	0.347**	0.030	−0.155**	−0.061	0.258*	−0.008	0.073
	(0.127)	(0.213)	(0.307)	(0.095)	(0.167)	(0.065)	(0.072)	(0.092)	(0.141)	(0.066)	(0.153)
DCFTA	−0.200	−0.061	−0.620***	−0.106	0.323	−0.169	−0.423***	−0.136	−0.270***	−0.351***	−0.124
	(0.188)	(0.134)	(0.203)	(0.133)	(0.236)	(0.106)	(0.058)	(0.125)	(0.068)	(0.076)	(0.118)
EPA	−0.050	−0.022	−0.514***	0.031	0.382**	−0.296***	−0.052	0.045	−0.030	−0.307***	−0.621***
	(0.157)	(0.112)	(0.183)	(0.081)	(0.181)	(0.073)	(0.055)	(0.126)	(0.053)	(0.066)	(0.109)
SAA	−0.074	−0.447***	−0.151	−0.273**	0.098	−0.084	−0.023	0.197	0.011	−0.226***	−0.183*
	(0.182)	(0.131)	(0.216)	(0.126)	(0.468)	(0.087)	(0.073)	(0.144)	(0.105)	(0.068)	(0.098)
Latin American Agreements	−0.185	0.255**	0.251**	0.460***	0.208	0.093	0.281***	0.218**	0.194***	0.106**	0.010
	(0.201)	(0.101)	(0.110)	(0.098)	(0.227)	(0.058)	(0.048)	(0.090)	(0.073)	(0.052)	(0.225)
Bilateral Agreements – Gen 1	−0.750**	0.047	0.476*	0.452***	1.277**	0.001	0.245***	0.179	0.248***	0.119*	0.542**
	(0.345)	(0.246)	(0.282)	(0.160)	(0.550)	(0.113)	(0.077)	(0.200)	(0.089)	(0.069)	(0.227)
Bilateral Agreements – Gen 2	−0.212	−0.074	−0.017	−0.196*	0.136	−0.147	−0.119*	−0.061	0.016	−0.034	0.228
	(0.197)	(0.128)	(0.138)	(0.116)	(0.353)	(0.114)	(0.063)	(0.113)	(0.061)	(0.060)	(0.157)
Institutional & Structural Variables											
Non-Tariff Barriers (NTB)	−0.003**	−0.006***	−0.005***	−0.003***	−0.009***	−0.004***	−0.007***	−0.006***	−0.008***	−0.007***	−0.012***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Exporter RCA ($\ln\_RCA_i$)	1.655***	1.689***	1.627***	1.684***	1.544***	1.709***	1.750***	1.632***	1.663***	2.064***	1.826***
	(0.134)	(0.088)	(0.166)	(0.096)	(0.146)	(0.076)	(0.121)	(0.073)	(0.077)	(0.148)	(0.098)
Partner RCA ($\ln\_RCA_i$)	0.095*	−0.379***	0.088	0.087**	−0.239*	0.259***	0.109*	−0.304***	−0.102**	0.554***	0.413***
	(0.051)	(0.073)	(0.068)	(0.044)	(0.123)	(0.062)	(0.058)	(0.078)	(0.047)	(0.079)	(0.085)
Diagonal Cumulation (lag 1)	0.129	0.116	−0.206	0.225***	0.175	−0.079	0.210***	0.055	0.324***	0.087*	0.099
	(0.083)	(0.104)	(0.190)	(0.075)	(0.111)	(0.056)	(0.039)	(0.075)	(0.055)	(0.047)	(0.070)
Bilateral Cumulation (lag 1)	0.142*	0.115*	−0.020	0.121**	0.090	0.091	0.171***	0.207***	0.022	0.147***	0.092
	(0.080)	(0.065)	(0.102)	(0.059)	(0.091)	(0.059)	(0.030)	(0.060)	(0.039)	(0.034)	(0.057)
Export Preference Ratio	0.025	−0.013	0.021	−0.034	−0.017	0.059	0.035	0.043	0.008	−0.039	0.034
	(0.025)	(0.032)	(0.045)	(0.043)	(0.037)	(0.043)	(0.048)	(0.033)	(0.034)	(0.058)	(0.030)
Import Preference Ratio	−0.023	−0.006	0.027	0.011	0.007	−0.003	−0.008	−0.025	0.006	0.017	−0.041**
	(0.017)	(0.017)	(0.024)	(0.011)	(0.020)	(0.014)	(0.028)	(0.023)	(0.015)	(0.037)	(0.019)
Observations	127,412	238,200	26,373	261,159	83,550	322,601	61,300	410,979	302,916	61,300	115,500
Pseudo R^2	0.801	0.765	0.937	0.859	0.897	0.931	0.973	0.866	0.901	0.970	0.929
Chi^2	221.89	513.55	193.37	446.26	235.29	1127.82	468.38	958.40	637.38	642.95	644.88

Notes: Export equation (X). PPML with exporter–importer pair, HS2 product, and year fixed effects. Coefficients are semi-elasticities; interpret as $100 \times (e^{\beta} - 1)\%$*. Standard errors clustered by bilateral pair (in parentheses). Significance: * p<0.10, ** p<0.05, *** p<0.01.*

Table 8. PPML estimation results by HS section – EU imports (1995–2023)

	Sec. 1	Sec. 2	Sec. 3	Sec. 4	Sec. 5	Sec. 6	Sec. 7	Sec. 11	Sec. 15	Sec. 16	Sec. 17
PTAs											
Euro-Med Agreements	−0.345**	0.050	−0.330*	0.543***	0.205*	0.195	0.211*	−0.056	−0.152	0.218	0.959***
	(0.157)	(0.099)	(0.200)	(0.174)	(0.124)	(0.122)	(0.127)	(0.111)	(0.212)	(0.145)	(0.266)
DCFTA	0.022	0.134	−0.117	0.148	−0.165	−0.370**	0.053	−0.109	0.047	−0.168	−0.274*
	(0.183)	(0.143)	(0.198)	(0.098)	(0.239)	(0.159)	(0.208)	(0.164)	(0.119)	(0.109)	(0.156)
EPA	0.294**	−0.016	−0.128	0.140	−0.174	−0.166	−0.451***	−0.398***	−0.005	−0.490**	−0.155
	(0.132)	(0.085)	(0.389)	(0.106)	(0.179)	(0.216)	(0.083)	(0.134)	(0.118)	(0.244)	(0.232)
SAA	0.112	0.268**	0.250	0.300*	0.767***	−0.143	0.118	0.183	0.216*	0.203	0.138
	(0.297)	(0.135)	(0.335)	(0.180)	(0.267)	(0.203)	(0.157)	(0.141)	(0.118)	(0.183)	(0.168)
Latin American Agreements	0.189*	−0.099	0.019	0.104	0.177	−0.227	0.148	−0.173	0.128	−0.228	−0.313
	(0.107)	(0.092)	(0.284)	(0.083)	(0.128)	(0.155)	(0.269)	(0.120)	(0.129)	(0.329)	(0.346)
Bilateral Agreements – Gen 1	0.163	0.285***	0.469	0.632***	0.084	0.273	0.794***	−0.365**	0.399*	0.584***	0.842***
	(0.165)	(0.092)	(0.424)	(0.138)	(0.242)	(0.180)	(0.172)	(0.183)	(0.217)	(0.120)	(0.205)
Bilateral Agreements – Gen 2	0.200	0.422***	0.036	0.475***	0.312***	−0.136	−0.236**	−0.131	−0.168	−0.342***	−0.107
	(0.160)	(0.154)	(0.296)	(0.119)	(0.119)	(0.148)	(0.109)	(0.147)	(0.116)	(0.096)	(0.107)
Institutional & Structural Variables											
Non-Tariff Barriers (NTB)	0.012***	−0.011***	−0.014***	−0.007***	−0.005***	−0.010***	−0.009***	−0.016***	−0.012***	−0.011***	−0.015***
	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Exporter RCA ($\ln\_RCA_i$)	0.447***	0.065	0.028	−0.005	−0.093	−0.009	0.132	0.089	0.291***	0.254***	0.250**
	(0.111)	(0.086)	(0.175)	(0.086)	(0.105)	(0.119)	(0.106)	(0.085)	(0.091)	(0.066)	(0.113)
Partner RCA ($\ln\_RCA_i$)	0.184*	0.016	0.159	−0.173**	−0.107	0.013	0.020	0.093*	0.172**	0.098**	0.033
	(0.102)	(0.063)	(0.132)	(0.072)	(0.086)	(0.094)	(0.087)	(0.054)	(0.068)	(0.046)	(0.080)
Diagonal Cumulation (lag 1)	0.291***	0.086	0.680***	0.300***	−0.011	0.449***	0.379***	0.105	0.489***	0.681***	0.979***
	(0.099)	(0.083)	(0.185)	(0.062)	(0.100)	(0.101)	(0.115)	(0.071)	(0.073)	(0.096)	(0.105)
Bilateral Cumulation (lag 1)	1.485***	1.337***	1.310***	1.428***	1.776***	1.779***	1.729***	1.609***	1.657***	2.019***	1.804***
	(0.058)	(0.038)	(0.107)	(0.044)	(0.054)	(0.051)	(0.058)	(0.065)	(0.038)	(0.089)	(0.075)
Export Preference Ratio ($\ln\_ratio_x$)	0.036**	0.060***	0.039	0.048***	0.003	0.039	0.045	0.077***	0.080***	0.089***	0.082***
	(0.017)	(0.015)	(0.044)	(0.016)	(0.016)	(0.032)	(0.037)	(0.021)	(0.021)	(0.027)	(0.021)
Import Preference Ratio ($\ln\_ratio_m$)	0.023	−0.065***	−0.057	−0.015	0.022	−0.022	0.026	−0.118**	−0.057***	−0.153***	−0.080***
	(0.028)	(0.019)	(0.040)	(0.019)	(0.015)	(0.023)	(0.034)	(0.048)	(0.017)	(0.030)	(0.025)
Observations	126 115	241 973	25 502	260 010	80 922	317 826	60 478	410 028	300 251	61 178	112 839
Pseudo R^2	0.922	0.886	0.937	0.872	0.958	0.932	0.966	0.951	0.907	0.980	0.918
Chi² du modèle	1251.58	1925.83	364.26	1341.25	1229.73	1487.46	1322.04	1030.81	2266.41	1264.32	1949.99

*Notes: Columns (1)–(11) report PPML estimates for EU imports (M) by HS section, corresponding to official groupings of HS2 chapters. Coefficients are PPML semi-elasticities, interpreted as percentage changes in trade flows $e^{\beta} - 1$. All estimations include exporter–importer pair, HS2 product, and year fixed effects. Standard errors clustered by country pair (in parentheses). p < 0.1, ** p < 0.05, *** p < 0.01.*

Non-tariff barriers (NTBs) remain systematically negative across all HS sections, and the magnitude of their trade-reducing effect increases with technical or regulatory intensity. Revealed comparative advantage (RCA) exerts a strong and stable positive effect on EU exports, indicating that specialization and productive complementarity significantly amplify the trade-enhancing impact of PTAs. Preference-ratio variables, by contrast, display weaker and less consistent significance, suggesting that higher observed shares of preferential trade do not automatically translate into proportional export gains.

The results for EU imports, reported in Table 8, display a larger number and higher magnitude of significant effects than those for exports, confirming the import–export asymmetry already identified at the HS-chapter level. Euro-Med and SAA blocs drive the strongest import activation, particularly in foodstuffs (+72 %), chemicals (+23 %), plastics (+24 %), and vehicles (+161 %), reflecting the progressive integration of Southern Mediterranean and Balkan producers into EU industrial value chains. First-generation bilateral agreements also generate robust import gains across several high-value-added industries, ranging from +33 % for agricultural products to +132 % for vehicles. EPAs show weaker performance in manufacturing but significant positive effects in primary sectors such as agriculture (+34 %), consistent with their structural focus on commodity exports. DCFTAs yield limited or negative coefficients (–24 % to –31 %), confirming the delayed and uneven implementation of these recent frameworks. Second-generation bilateral agreements (Canada, Korea, Japan, Vietnam, and the UK) produce positive effects in harmonized sectors such as food, chemicals, and plastics (+35–61 %), where standards and regulatory frameworks are already closely aligned with those of the EU.

At the institutional level, diagonal cumulation again proves more effective and consistent than bilateral cumulation. It significantly enhances imports in metals (+34 %), machinery (+29 %), and vehicles (+28 %), confirming its structuring role in cross-border industrial supply chains. Bilateral cumulation remains relevant in less complex sectors such as agriculture, paper, and light industries, though its effects are generally smaller. NTBs continue to exert a strong negative influence across all industries, particularly in regulated or high-technology sectors, while RCA variables maintain their positive and significant relationship with trade intensity, emphasizing the role of comparative advantage and complementarity in activating preferences.

Taken together, the sectoral estimations confirm a clear import–export asymmetry in the effects of EU trade agreements. Preferential frameworks tend to boost imports more than exports, reflecting both tariff structures and structural specialization: partner countries predominantly export products that directly benefit from tariff preferences – such as agricultural, intermediate, or assembly goods – whereas EU exports remain concentrated in highly regulated, high-value sectors constrained by non-tariff barriers and rules of origin. Marked heterogeneity also emerges across blocs: agreements with greater institutional depth and longer implementation periods – such as Euro-Med, SAAs, and bilateral FTAs – generate the most consistent effects, while newer or weaker frameworks like EPAs and DCFTAs display limited or negative outcomes due to insufficient enforcement, regulatory asymmetries, or weak industrial capacities in partner economies.

Institutional provisions thus play a central role. Diagonal cumulation under the Pan-Euro-Med framework systematically produces stronger and more balanced effects than bilateral cumulation, facilitating regional value-chain integration and partly offsetting the trade-reducing impact of NTBs. Revealed comparative advantage further reinforces these effects, as productive specialization and complementarity between partners enhance the capacity to benefit from preferential regimes, particularly in capital- and technology-intensive sectors. Overall, the results confirm that tariff liberalization alone is insufficient to sustain long-term trade gains. EU trade agreements deliver significant results only when tariff preferences are combined with flexible rules of origin, regulatory convergence, and credible enforcement mechanisms. Trade policy is therefore most effective when legal frameworks align with partners' productive structures and institutional depth ensures full preference utilization. Simplifying RoOs, deepening technical cooperation, and supporting partner upgrading appear crucial to broadening and balancing the overall impact of EU preferential trade policy.

4. CONCLUSION AND POLICY IMPLICATIONS

This article has assessed the effectiveness of the EU's PTAs with its main partners over the period 1995–2023, using a highly disaggregated gravity model estimated by Poisson Pseudo-Maximum Likelihood (PPML) with three-way fixed effects. This approach captures heterogeneity across countries, sectors, and time, while incorporating key structural determinants such as rules of origin (RoOs), non-tariff barriers (NTBs), revealed comparative advantages (RCAs), and cumulation regimes. By regrouping HS chapters by RoO complexity and HS sections, the analysis further tests the robustness of these effects across comparable product groups.

Three main findings emerge. First, the effectiveness of PTAs critically depends on the institutional design of RoOs. Diagonal cumulation under the Pan-Euro-Med (PEM) Convention consistently generates stronger and more balanced effects across exports and imports, particularly in sectors integrated into regional value chains. In contrast, bilateral cumulation benefits EU exporters disproportionately, confirming that the institutional depth and flexibility of RoOs are as important as tariff elimination itself.

Second, trade impacts vary widely across sectors. Intermediate and high-value-added industries – such as chemicals, plastics, machinery, and vehicles – emerge as the main beneficiaries of EU PTAs, while primary goods and less processed products remain largely excluded due to restrictive RoOs, persistent NTBs, or limited productive complementarities.

Third, a persistent import-exports asymmetry characterizes EU trade agreements, particularly in the Euro-Mediterranean and Balkan regions. Imports from partner countries increase systematically, while EU exports remain constrained by regulatory frictions and structural specialization patterns. This suggests that EU's trade policy, though effective in opening its market, is less successful in promoting the external competitiveness of European firms.

The results also reveal a paradox: newer and deeper agreements – such as DCFTAs and second-generation FTAs – have not yet produced stronger trade effects than older frameworks like Euro-Med or Latin America agreements. Their limited

performance reflects transition costs, delayed implementation, and the fact that many partner countries were already highly integrated into global trade.

Finally, we acknowledge one scope limitation relative to canonical structural-gravity practice. While exporter×year and importer×year fixed effects are typically used to absorb time-varying multilateral resistance, implementing them at our HS2 scale is computationally prohibitive and prone to separation/collinearity. We therefore retain the pair, product, and time PPML design, which is standard in large product-level panels, aligns with our product-centric question, and preserves identification for pair–year policy variables (PTA blocs, NTB ad-valorem, lagged cumulation). This choice does not alter our central conclusion that institutional design and regulatory frictions are the primary drivers of the observed trade responses.

From a policy perspective tariff liberalization alone is no longer sufficient. Future agreements should focus on reducing regulatory frictions and simplifying RoOs – particularly through broader diagonal cumulation and clearer certification procedures. The 2021 revision of the PEM Convention illustrates how institutional refinements can significantly strengthen preference utilization. A more targeted, sector-sensitive approach is also required: the weak impact of PTAs on EU exports, even in sectors of strong comparative advantage, calls for deeper regulatory convergence, mutual recognition of standards, and enhanced export support. In this context, EU support for regional integration – such as the African Continental Free Trade Area (AfCFTA)– could indirectly enhance the effectiveness of existing bilateral frameworks by reducing fragmentation and regulatory asymmetries across partner economies.

Several extensions could further enrich the analysis. Future work could examine the dynamic effects of PTAs; employ finer product disaggregation; investigate intra-EU heterogeneity between large and smaller exporters; and link trade flows with value-added or preference-utilization data to assess whether PTAs foster genuine integration into global value chains. In addition, augmenting the specification with applied bilateral tariffs would help contrast tariff liberalization with non-tariff/institutional channels, and incorporating a formal agreement-depth measure (e.g., WTO-plus/X provisions) would triangulate the institutional mechanism and its interaction with RoO and NTBs.

Beyond its substantive results, the paper's methodological contribution lies in combining a four-way PPML gravity model at the HS chapter level with institutional regroupings by RoO complexity and HS sections. This dual approach reveals institutional and sectoral asymmetries often overlooked in aggregate analyses and offers a more nuanced and realistic assessment of EU trade performance. In conclusion, EU preferential trade agreements are not ineffective but highly conditional. They deliver tangible gains only when institutional provisions, sectoral structures, and productive complementarities align. Tariff liberalization alone is insufficient: a more differentiated, institutionally deep, and sector-sensitive trade strategy is required for the EU to achieve balanced and sustainable integration with its external partners.

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L'impact de la nouvelle politique commerciale de l'UE : Une évaluation désagrégée par produits

Résumé – Cet article évalue les effets de la politique commerciale préférentielle de l'Union européenne sur la période 1995–2023, couvrant les accords avec les partenaires méditerranéens, d'Afrique subsaharienne, d'Amérique latine, des Balkans occidentaux, du Partenariat oriental, ainsi que les accords bilatéraux récents (Canada, Corée, Japon, Vietnam, Royaume-Uni). Nous estimons un modèle de gravité au niveau produit (HS2) par PPML avec effets fixes de haute dimension, en intégrant les barrières non tarifaires (BNT), les règles d'origine (cumul bilatéral vs diagonal/Pan-Euro-Med), l'avantage comparatif révélé (RCA) et des ratios d'intensité des préférences. Trois résultats se dégagent. Premièrement, les APT de l'UE présentent une asymétrie import–export persistante : la plupart des accords augmentent significativement les importations de l'UE, tandis que l'effet moyen sur les exportations est faible ou négatif. Deuxièmement, la conception institutionnelle compte : le cumul diagonal produit des effets plus forts et plus équilibrés que les régimes bilatéraux, alors que les BNT freinent systématiquement les échanges, surtout pour les biens complexes et fortement réglementés. Troisièmement, les impacts sont sectoriels : les gains sont plus marqués dans les secteurs intensifs en chaînes de valeur (chimie, plastiques, machines, véhicules), notamment du côté des importations, tandis que les produits primaires et faiblement transformés en bénéficient moins. Globalement, l'efficacité de la politique commerciale de l'UE dépend moins de la suppression des droits de douane que de la profondeur institutionnelle, de la convergence réglementaire et de l'alignement sectoriel. La politique devrait privilégier des règles d'origine plus simples et flexibles (cumul diagonal élargi) et la réduction des BNT afin de convertir les préférences juridiques en un accès effectif au marché.

Mots-clés

Accords commerciaux préférentiels
Politique commerciale de l'Union européenne
Règles d'origine
Barrières non tarifaires
Modèle de gravité