Regional Integration and Trade Adaptation in a Fragmented World

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Abstract

The renewed prominence of tariffs and trade fragmentation raises a question that extends beyond any particular episode: when trade barriers reshape opportunities among suppliers, which economies are better positioned to seize them? We use the first round of the US–China trade war as an observable historical episode to study this question. In 2018, the United States raised tariffs on a broad set of imports from China through lists adopted under Section 301. Using annual country-product trade data for 138 low- and middle-income economies from 2012 to 2024, we compare the evolution of exports to the United States in products included in and excluded from these lists and examine whether the response differs according to characteristics observed before the episode. We find no robust evidence that greater regional export orientation compensates for the advantages associated with economic size, measured by pre-episode GDP. Within emerging economies, however, greater prior regional orientation exhibits a relatively persistent association with a stronger export-value response. The comparison of export value, export presence, and previously active trade relationships is more consistent with an expansion of existing relationships than with the widespread emergence of new export relationships. The evidence does not allow the magnitudes for 2018–2024 to be mechanically extrapolated to current trade tensions, but it points to a more general lesson: creating reallocation opportunities does not guarantee that they will be seized, and their benefits may be distributed very unevenly across countries.

Keywords: Trade fragmentation; regional integration; trade reallocation; difference-in-differences; Section 301; emerging economies.

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[1] The views expressed in this paper are solely those of the author. Any errors or omissions are the author's own. Comments and suggestions are welcome at paulestrada2@icloud.com.

1. Introduction

Trade fragmentation has again become a central feature of the world economy. US tariffs increased substantially during 2025, and trade policy uncertainty rose again; the World Trade Organization reports that the 2025 data show a renewed intensification of fragmentation, largely associated with greater trade tensions and further decoupling between the United States and China (WTO, 2026). This context reopens a question already raised by the first trade war: when a barrier changes relative access conditions in a large market, which third countries are actually positioned to take advantage of the resulting opportunities?

The episode that began in 2018 provides a particularly useful empirical setting because it can now be observed over several years. The United States then raised tariffs on a broad set of products from China through lists adopted under Section 301. This change altered relative access conditions in the US market, but the trade lost by one supplier is not automatically distributed among its competitors. Some economies can expand sales, others respond only weakly, and others face constraints that prevent them from seizing the opportunity. Recent studies of Asia return specifically to the 2018–2019 tariff round to draw evidence on the reallocation that may accompany current trade disruptions, while cautioning that gains are not universal (Donato and Kitsios, 2026).

This paper studies that heterogeneity. The economic question is whether third-country suppliers display different trade responses to the change in barriers against China and whether these differences are related to characteristics that predate the episode. Prior export specialization, economic size, and regional export orientation are three plausible dimensions. Specialization identifies products with a relatively important presence in the national export basket; size summarizes aggregate scale; and regional orientation describes export destinations before the tariff increase. These measures do not directly capture all of a country's competitive advantages or productive capabilities.

Economic size is one such prior condition. One possible hypothesis is that greater scale is associated with conditions that facilitate meeting additional foreign demand, although GDP does not directly measure productive capacity, infrastructure, or financing. Alesina et al. (1997) link the advantages of national size to access to trade. This intuition supports considering scale and external linkages jointly, without establishing that GDP alone measures the ability to respond to a trade opportunity. Regional linkages, in turn, could facilitate sourcing, learning, or marketing and reduce some disadvantages of scale; they could also reinforce the advantages of large economies or transmit disruptions. We therefore consider four possibilities: integration may partially substitute for scale, complement it, accompany a favorable response that is relatively common across sizes, or exhibit no systematic relationship.

To study these possibilities, we use BACI, which provides bilateral trade values by country, product, and year.[2] We follow the same country-product combinations from 2012 to 2024. Products are identified at the six-digit level of the Harmonized System (HS6) and mapped to the US Section 301 lists. The main sample comprises 138 economies classified by the World Bank as low, lower-middle, or upper-middle income for fiscal year 2018. We refer to this universe as emerging economies; it is not a selection of small countries.

The empirical strategy is organized as a difference-in-differences design. We compare the evolution of third-country exports to the United States in products exposed and unexposed to the lists before and after 2018. We then ask whether this post-episode difference is systematically larger or smaller depending on the country's prior specialization in the product, its economic size, and its regional orientation before the episode. We estimate expected trade value using Poisson pseudo-maximum likelihood (PPML), which retains the many observations with zero exports, and use event studies to trace the dynamics and assess differences preceding the episode. Thus, difference-in-differences defines the counterfactual comparison; PPML

[2] BACI is the CEPII database that reconciles bilateral trade reports and provides information by exporting country, importing country, product, and year. We use its trade-value measure; see Gaulier and Zignago (2010).

estimates the conditional mean; and the event study extends the comparison over time and allows us to assess the plausibility of identification.

The results first show that the potential opportunity was broad across products, but its capture was much more concentrated across countries. The five countries with the largest mass of positive gains account for 56.67%, and the top twenty for 87.92%, whereas the top twenty products account for only 3.36%. This pattern captures a central idea: creating a trade opportunity through a barrier against a competitor does not imply that all third countries can seize it.

The evidence does not robustly support the more demanding hypothesis that regional integration compensates for the advantages associated with size. The difference in the integration gradient between smaller and larger economies is imprecise and changes sign across specifications. Within the emerging-economy sample, however, an additional, more persistent finding emerges: greater prior regional orientation is associated with a stronger export-value response, even when specialization and size are considered jointly. This association is not universal: it becomes less stable when the universe is expanded to include high-income countries and is sensitive to the outcome measure and inference.

The comparison of export value, export presence, and previously active trade relationships helps characterize the adjustment. Regional orientation does not exhibit an equivalent positive gradient in the probability of recording exports. Taken together, the evidence is more consistent with an expansion of existing trade relationships than with the widespread emergence of new export relationships. This interpretation is not a causal decomposition of the intensive and extensive margins.

The design also has important limitations. Some pre-episode differences are statistically detectable under particular clustering choices; the smallest third of countries accounts for only about 0.30% of initial exports to the United States, compared with approximately 96% for the largest third; and the integration measure captures regional export orientation rather than productive integration directly. These limitations preclude interpreting the associations as causal effects of "increasing integration."

The contemporary relevance of the exercise lies precisely in these limitations and regularities. The paper's data end in 2024 and therefore do not estimate the effects of tariff changes in 2025–2026. Nor do we assume that the current episode reproduces the same rates, products, partners, or macroeconomic conditions as in 2018. What the first trade war does provide is historical evidence on a question that has again become central: why reallocation opportunities created by fragmentation may be distributed very unevenly, and which prior conditions accompany a greater capacity to adapt.

The remainder of the paper places the question in the literature, develops the conceptual framework, and describes the tariff episode, data, and empirical strategy. It then presents stylized facts, results, and robustness checks, examines different forms of trade adjustment, and offers a brief descriptive account of South America and Central America. The discussion and conclusion return to the lessons this historical evidence offers for interpreting today's more fragmented trade environment, without mechanically extrapolating its magnitudes.

2. Related Literature

The literature on trade reallocation provides the closest starting point. Fajgelbaum et al. study third-country exporters' responses to the trade-war tariffs and find substantial cross-country differences associated with national components of elasticities, not only with specialization patterns. Our analysis focuses on prior size and regional integration as pre-episode characteristics that may accompany different responses. The comparison proposed here allows us to study these prior conditions using trade values destined for the United States. Identifying structural elasticities or adjustment across all destinations would require a different object of analysis and strategy (Fajgelbaum et al., 2021, revised 2023).

Fragmentation is also studied at the aggregate level. Fernández-Villaverde, Mineyama, and Song construct a fragmentation index and analyze macroeconomic responses using time-series models. Bonadio et al. identify blocs from changes in trade costs and use a quantitative model to assess the observed reorganization. These approaches measure different objects: an aggregate fragmentation shock and a reconfiguration of costs across partners. Here we examine exposure to specific tariff lists and country-product heterogeneity; we do not infer a change in world real income from nominal exports (Fernández-Villaverde et al., 2024, revised 2025); (Bonadio et al., 2025).

The distinction between production reallocation and rerouting is especially relevant for connector countries. Schulze and Xin combine trade, investment, and input-output linkages to study six Asian economies. Their evidence for Vietnam points to an increase in domestic content in strategic-sector exports, whereas the mechanisms are less clearly identified in the other cases. Our universe is broader, but BACI does not allow domestic and foreign content to be separated. A gain in US market share is therefore not interpreted here as evidence of additional domestic production or transshipment (Schulze and Xin, 2025).

Research on regional integration and networks helps formulate possible mechanisms. Ehlers et al. document links between trade and banking integration and describe regional integration in emerging economies as complementary to global integration. Machado Parente and Moreau examine barriers, infrastructure, and fragmentation scenarios for Latin America and the Caribbean. Our exercise differs from both: it uses regional export orientation before 2018 to explain heterogeneity in a trade response, without estimating an integration reform or regional general-equilibrium scenarios (Ehlers et al., 2025); (Machado Parente and Moreau, 2024).

The question of scale relates to Alesina, Spolaore, and Wacziarg, whose model links country size and access to trade: the advantages of size depend on the trade regime. That argument does not establish that a high regional share substitutes for size in the face of any shock. Aizenman, Ito, and Saadaoui, in turn, study growth and international positioning in a long-run panel, incorporating integration agreements and geoeconomic linkages. We share their interest in the conditions accompanying heterogeneous responses, but our outcome is country-product trade value, and our regional measure is not an index of openness, geopolitical connectivity, or agreements (Alesina et al., 1997); (Aizenman et al., 2026, August revision).

Our proposed contribution is limited: to distinguish empirically an association between integration and trade adaptation from the more demanding hypothesis that integration compensates for size. The available evidence allows us to discuss the former within a set of countries and for a specific outcome, but does not support the latter. We do not present this combination as a contribution whose novelty has been exhaustively established against the entire literature.

Table 1 summarizes the closest related studies and identifies the part of the question addressed by each.

Table 1. Selected related studies and their connection to the research question.

Study	Scope/data	Methodology	Relevant question or finding
Fajgelbaum et al. (2021, revised 2023)	Third-country trade during the trade war	Analysis of export responses and elasticities	Heterogeneous third-country responses and adjustment across destinations
Fernández-Villaverde et al. (2024, revised 2025)	Aggregate fragmentation	Index and time-series models	Macroeconomic responses to fragmentation
Bonadio et al. (2025)	Trade reorganization across blocs	Quantitative trade model	Cost changes and trade reorganization
Schulze and Xin (2025)	Six Asian economies; trade, investment, and input-output linkages	Combined analysis of these sources	Distinction between domestic content and rerouting
Ehlers et al. (2025)	Trade and banking integration in emerging economies	Analysis of trade and banking linkages	Regional integration as a potential buffer against fragmentation
Machado Parente and Moreau (2024)	Latin America and the Caribbean	Analysis of barriers and fragmentation scenarios	Conditions and constraints of regional integration
Alesina et al. (1997)	National size and trade openness	Theoretical model	The advantages of size depend on access to trade
Donato and Kitsios (2026)	ASEAN; trade and investment	Descriptive analysis and difference-in-differences	The 2018–2019 round as evidence for interpreting new trade disruptions

Note: The table summarizes studies used to motivate the question; it is not intended as an exhaustive literature review. *Source:* Author's compilation based on the cited studies.

3. Conceptual Framework

Standard trade theory and gravity provide the initial theoretical foundation: a supplier's access conditions depend on the barriers it faces relative to those facing other suppliers. Anderson and van Wincoop (2003) provide a starting reference for studying trade frictions in a gravity framework. We use this intuition to interpret the tariff increase under Section 301 as an increase in relative barriers against China in exposed products. The US tariff episode creates a potential opportunity for reallocation toward third countries; it does not, of course, guarantee that their sales will rise or that they will receive, one for one, the trade China loses. The economic sequence is higher relative barriers against China → potential opportunity for third countries → heterogeneous responses across countries.

To distinguish market size from supplier share, we use the following accounting identity. It follows from defining share as the supplier's value divided by the market total and does not require attribution to a particular model or author:

$$X_{ipt}^{US} = E_{pt}^{US} s_{ipt}, \quad (1)$$

where X is the value exported by country i to the United States, E is the total value imported by the United States of product p from all suppliers—including China—in year t, and s is supplier i's share of that value when E is positive. X and E are expressed in the same monetary units; s is a proportion. A change in export value may accompany changes in the total market, the supplier's share, or both. The identity organizes the intuition: selling more may reflect a larger market, a greater share, or both. It is not structurally estimated. It

leads us to ask which pre-episode characteristics accompany different export-value responses, without empirically separating these components.

The three pre-episode characteristics have distinct economic motivations. Revealed comparative advantage proxies for prior revealed specialization: it describes trade composition without observing productivity or technology. Size, measured by log GDP, summarizes aggregate scale; it does not directly measure productive capacity, financing, or infrastructure. The integration measure used here is regional export orientation. Production linkages, learning, or lower access costs may be mechanisms behind different responses, but this share does not measure them. We do not need to derive all three variables from a single theory or model firms' entry decisions to formulate these hypotheses.

These motivations suggest four possibilities: integration may partially substitute for scale; complement it; accompany a favorable response that is relatively common across sizes; or exhibit no systematic relationship. To represent these possibilities parsimoniously, we write the component of the log contrast associated with exposure to tariffs on China as

$$h(a, s, g) = b + \theta_a a + \theta_s s + \theta_g g + \theta_{sg} sg, \tag{2}$$

where a is prior revealed comparative advantage, which is dimensionless; s is log 2017 GDP in USD; and g is the prior regional share, between zero and one. h is dimensionless and describes heterogeneity in a conditional response ratio. This parsimonious form allows integration to modify the relationship with size without imposing a sign. It provides a bridge to the empirical specification, rather than a structural trade function.

Compensation requires more than a positive association with integration: that association must be more favorable among smaller economies. We first compare high and low integration among smaller countries, then repeat the comparison at the larger size. The difference between the two comparisons is C3. For two size profiles s_L<s_H and integration profiles g_L<g_H, we define

$$\begin{aligned} C_1 &= h(a, s_L, g_H) - h(a, s_L, g_L), \\ C_2 &= h(a, s_H, g_H) - h(a, s_H, g_L), \\ C_3 &= C_1 - C_2 = \theta_{sg}(s_L - s_H)(g_H - g_L). \end{aligned} \tag{3}$$

All three contrasts are in log units. C_1 and C_2 compare high and low integration in smaller and larger economies, respectively; C_3 asks whether this difference is larger for the smaller profile. The 25th percentile (P25) represents a relatively low level of regional integration within the sample distribution, whereas the 75th percentile (P75) represents a relatively high level. Size profiles are likewise defined by the 25th and 75th percentiles of their own distribution. Approximately one-quarter and three-quarters of the distribution used in estimation fall below these values, respectively. Revealed specialization is held at its median. These are not categories added to the estimator. In this representation, a positive C_3 corresponds to a relatively steeper integration slope for the smaller profile; nevertheless, it must be read alongside C_1, C_2, their uncertainty, and the support for the profiles. It does not demonstrate that a gap in levels closes or that a country could obtain this outcome through an intervention.

Compensation is therefore assessed by asking whether the response improves more with integration among smaller economies than among larger ones. We call this variation in the response with integration the gradient. A common positive association with integration may exist without differential compensation. The interpretation remains on the log scale of C1–C3 and does not turn the sign of an isolated interaction into a structural conclusion about export levels.

The analysis deliberately focuses on reallocation or adaptation in third-country suppliers' trade value. It does not seek to identify separately the channels of prices, tariff pass-through, physical quantities, exchange rates, terms of trade, or welfare, whose assessment would require different information and identification strategies. These channels may be part of the overall economic adjustment. This scope keeps the research

question, available data, and specific estimated outcome (the estimand) aligned. Nor do we estimate structural elasticities or general equilibrium. Rigor depends on conclusions respecting this scope; an additional variable should serve identification rather than an attempt to represent every possible channel.

4. Institutional Context: Tariffs under Section 301

The episode begins with the United States imposing additional tariffs on imports originating in China in 2018. The first list covered 818 lines of the eight-digit US tariff classification (HTS8), with an additional rate of 25% from July 6; the second covered 279 lines at the same rate from August 23. The third initially took effect on September 24 at a rate of 10% and underwent documented modifications. Official notices are the source of the lists and dates used here (USTR, 2018a); (USTR, 2018b); (USTR, 2018c).

To distinguish treated and untreated products, we identify the union of the tariff lists and map it to the 2012 version of the Harmonized System (HS2012). This selection defines the baseline. An HS6 product is classified as exposed when the concordance links it to any included tariff line, even if that line covers only part of the six-digit product. This is what a partial source means: it does not imply that every variety within an HS6 product faces the same tariff. The indicator identifies exposure without reconstructing annual effective rates or subsequent exclusions. Because tariffs are defined at a more detailed level than the observed trade values, it does not measure a uniform treatment intensity. Products outside the union form the untreated comparison group. The concordance and the documentary discrepancy in the third list are described in Appendix A.

Processing the information allows each country-product combination to be followed by year and a pre-episode period to be distinguished from a post-episode period beginning in 2018. This annual exposure convention does not imply that the tariff was in force throughout that year. The check excluding 2018 examines this temporal aggregation without constructing an annual treatment fraction. Nor do we consider products outside the lists immune to all policy or demand changes after 2018.

Reallocation may take several forms. A third country might gain buyers through domestic production, redirect existing exports, or participate in supply chains incorporating Chinese content. Growth in its sales to the United States alone does not distinguish among these possibilities. Still less does it establish a welfare benefit: trade value may change through prices, quantities, or composition. For the same reason, countries' exports to China are used as a diagnostic of simultaneous patterns, rather than as a symmetric causal outcome of US tariffs.

5. Data and Variable Construction

The panel uses BACI HS2012, version V202601, for 2012–2024. BACI harmonizes bilateral reports and provides reconciled product-level flows; Gaulier and Zignago (2010) describe its construction. We work with values in thousands of current USD. The FY2018 income classification and GDP variables are taken from the versions of the World Bank sources used to build the panel. Regional integration is identified through geographic assignments in the database, retaining the regions defined during its construction and supplementary rules based on the United Nations statistical classification of countries and areas (M49); these are not replaced with blocs defined from subsequent outcomes.

The main sample includes 138 low- and middle-income economies, excluding the United States and China as third-country exporters. The robustness universe retains 206 countries, including 68 high-income countries. In both cases, we use 5,202 products and thirteen years. The main panel contains 9,332,388 country-product-year opportunities; 88.40% have zero exports to the United States. We do not filter by RCA, positive exports, or minimum size. Table 2 distinguishes this universe from the sample used by the joint model.

Table 2. Data and design.

Dimension	Value	Unit or definition
Main-sample countries	138	countries
Products	5,202	HS2012
Conceptual panel	9,332,388	country-product-year
Zeros in conceptual panel	0.8840	proportion
Robustness universe	206	third countries
Untreated products	1,562	HS2012
Initial year	2012	year
Final year	2024	year
Treated products	3,640	HS2012
Prior share of US imports in treated products	0.7142	proportion
M5: eligible observations	9,124,245	observations
M5: observations used	2,479,753	observations
M5: countries used	134	countries
M5: products used	5,182	HS2012
M5: removals due to all-zero FE groups	6,644,492	observations
M5: covariate-ineligible	208,143	observations
M5: zeros in estimation sample	0.5636	proportion
RCA	—	Continuous; cumulative values for 2015–2017
Size	—	Log 2017 GDP in USD
Integration	—	Regional share over assignable destinations; 2015–2017
Sources	—	BACI; USTR/UNSD; WDI; prior regional assignment

Note: 138 low- and middle-income economies, 2012–2024; HS2012 products. Proportions range from zero to one. M5 is the joint model of specialization, size, and integration, with country-product and country-year fixed effects. Its estimation sample requires available characteristics and removes all-zero groups; it differs from the conceptual universe. GDP is measured in 2017 and trade characteristics in 2015–2017.

Source: Author's calculations using BACI, World Bank data, and tariff lists.

We denote by X_{ipt}^{US} the value of country i's exports of product p to the United States in year t. Missing flows in the universe of opportunities are coded as zero in accordance with the database construction for the intended comparisons. This convention does not turn a missing covariate into zero or treat every absent record as a perfect measure of the economic absence of trade. It allows these opportunities to be retained in the comparison of subsequent changes, without conflating an absent flow with missing information on country characteristics.

To describe prior specialization, let V_{ip}^{pre} be the value of product p exported by i to all destinations, accumulated over 2015–2017; V_i^{pre} its total across products; and V_{wp}^{pre} and V_w^{pre} the corresponding world values. We use

$$a_{ip} = RCA_{ip}^{pre} = \frac{V_{ip}^{pre}/V_i^{pre}}{V_{wp}^{pre}/V_w^{pre}}. \quad (4)$$

All four values are expressed in thousands of current USD, and the ratio is dimensionless. RCA above one indicates that the product accounts for a greater share of the national export basket than of the world basket. The world denominator includes all exporters in the source aggregate, including the United States, China,

and special identifiers with flows. This is not an average of annual RCA values. A zero numerator yields zero RCA if the denominators are valid; an invalid world denominator remains NA. This affects 414 pairs in the main universe, corresponding to three codes. RCA is a revealed measure of specialization, not a direct observation of technology or spare capacity.

Economic size, rather than the size of foreign trade, is defined as

$$s_i = \log\left(GDP_{i,2017}\right), \tag{5}$$

with GDP in USD and the natural logarithm. A one-unit increase in s corresponds to multiplying GDP by e; it does not define a small-country category. Eritrea, North Korea, and South Sudan were identified as lacking 2017 GDP data in the main sample; these values are not imputed. Income used to classify the sample and GDP used to measure size serve different purposes.

Observed regional integration is

$$g_i = \frac{\sum_{j \in \mathcal{R}(i),\, j \neq i} V_{ij}^{pre}}{\sum_{j \in \mathcal{A},\, j \neq i} V_{ij}^{pre}}, \tag{6}$$

where V_{ij}^{pre} sums bilateral exports of all products in 2015–2017, $\mathcal{R}(i)$ contains destinations assigned to i's region, and $\mathcal{A}$ contains all destinations with an assignable region. Numerator and denominator use the same monetary units; g is a proportion. We exclude domestic trade and leave identifier 490/S19 without a region. Lower and upper bounds allow the unassigned component to be examined without inventing its location. No minimum coverage requirement is imposed on the main sample.

This variable measures where exports go, not how much is traded relative to GDP. A high regional export share may coexist with low or high overall openness. Nor is it equivalent to participation in regional production chains: it does not identify imported inputs, foreign content, or interfirm linkages. We call it regional integration for continuity with the research question, understanding its scope as regional export orientation.

Finally, China's prior position in the US market is described by the following representation

$$c_p = \frac{\sum_{t=2}^{2017} X_{Cpt}^{US}}{\sum_{t=201}^{2017} \sum_{k \in \mathcal{W}} X_{kpt}^{US}}, \tag{7}$$

where $\mathcal{W}$ includes all suppliers in the world aggregate. It is a product-level share of import value, not a tariff or an aggregate national exposure measure. We identified 5,189 products with a valid denominator and thirteen without one. We keep this measure separate; it is not multiplied by RCA to construct an index or included as though it were an estimated regressor in every equation. All pre-episode measures remain fixed in the panel. Their repetition in 2012–2014 does not imply that they describe contemporaneous information for those years.

6. Empirical Strategy

6.1. Identification through Difference-in-Differences

The Section 301 lists identify which products were exposed to the tariff increase on China before subsequent outcomes are observed. For each third country, we observe exports to the United States in two product groups—exposed and unexposed—and two periods—before and after 2018. The logic of difference-in-differences is to compare the post-episode change in exposed products with the change in unexposed products, after accounting for persistent differences absorbed by the fixed effects. Observing that treated-product exports grew after 2018 is therefore insufficient: the question is whether their evolution differed from a contemporaneous benchmark.

The intuition can be expressed as a double difference. First, we calculate how much a third country's exports in exposed products change between the pre- and post-episode periods. We then calculate the equivalent change in unexposed products. The difference between these two changes is the core of the design. Under the identification assumptions, the second change approximates how the relative difference would have evolved in the absence of the episode. The event studies presented below allow us to examine whether this comparison already exhibited systematic movements before 2018.

The heterogeneity analysis takes this logic one step further. We ask not only whether there is a post-episode difference between exposed and unexposed products, but also whether that difference varies systematically with characteristics fixed before the shock: the country's specialization in the product, its economic size, and its regional orientation. Thus, a positive association with integration means that the post-episode exposed–unexposed difference is larger among countries with greater prior regional orientation; it does not mean that raising this share by itself causes an equivalent increase in exports.

The difference-in-differences counterfactual asks how the difference between the two groups would have evolved without the episode, after the corresponding dimensions are absorbed by fixed effects. The interactions ask whether this treated–untreated difference evolves differently according to RCA, size, and integration observed before the shock. The required comparability is conditional: neither the lists nor country characteristics are randomly assigned.

In this sense, the proposed analytical sequence is **economic question → DiD counterfactual → PPML estimator → heterogeneity → event study / identification assessment**. DiD defines the comparison; PPML estimates its conditional mean with a nonnegative trade outcome and many zeros. The event study extends the same comparison over time and allows us to examine whether differences were already visible before 2018. These are components of the proposed analysis, not independent methodologies that validate one another.

Structure C, with country-product and country-year fixed effects, controls for permanent country-product differences and country-year changes common to each exporter's products. Structure B retains country-product effects and replaces country-year with product-year effects, absorbing changes common to the suppliers of each product. It does not simply add controls to C. Because treatment is common within a product-year, B absorbs its average contrast; the interactions may retain variation across countries within the same product-year, allowing conditional heterogeneity to be identified. This possibility does not ensure causality. Pre-episode differences, whose assessment is sensitive to the inference structure, remain part of the evaluation of the design.

Table 3 organizes the models' questions before presenting their equations. Each step adds an economic dimension; model M6 retains the original compensation test.

Table 3. Model architecture and questions.

Model with country-product and country-year fixed effects	Question	Alternative with country-product and product-year fixed effects
M1	Is there an average post-episode difference between exposed and unexposed products?	Not identifiable: product-year effects absorb average treatment
M2	Does this difference vary with prior revealed specialization?	B2
M3	Does it vary with economic size?	B3
M4	Does it vary with prior regional integration?	B4
M5	What happens when specialization, size, and integration are considered jointly?	B5
M6	Does the association with integration vary with size? Is there compensation?	B6

Note: FE denotes fixed effects. C includes country-product and country-year effects; it controls for persistent differences in each trade relationship and annual changes common to each country's products. B includes country-product and product-year effects; it controls for annual changes common to all suppliers of a product. Interactions with prior characteristics may vary across countries within the same product-year. M2–M6 and B2–B6 retain the identifiable lower-order terms; B6 also includes Post×size×integration. There is no B1 model that identifies the average contrast. Appendix B details samples and convergence.

6.2. PPML Estimation, Heterogeneity, and Fixed Effects

We define

$$D_{pt} = Treated_p \times Post_t, \qquad Post_t = \mathbf{1}\{t \geq 2018\}. \tag{8}$$

Treated identifies the products included in the baseline Section 301 lists and remains fixed for each product in the panel; D is a unit-free indicator. The proposed economic counterfactual compares the evolution of exposed and unexposed products, net of the differences absorbed by the fixed effects in estimation. A causal interpretation would require the relevant differences in their conditional means to follow the path imposed by the model in the absence of the episode. Product classification is not random, and the controls do not guarantee this assumption of conditional parallel evolution in the absence of the episode.

The model is estimated by Poisson pseudo-maximum likelihood with an exponential conditional mean. This form relates controls and characteristics to expected trade value and accommodates nonnegative exports without removing all zeros in advance. PPML is widely used to estimate gravity equations because it does not require a log transformation of the outcome, and its justification depends on the conditional mean rather than on exports following a Poisson distribution. Santos Silva and Tenreyro (2006) explain why least-squares estimation of the logarithm relies on different conditions when the dispersion of trade varies across observations (heteroskedasticity). PPML implements the DiD comparison; it does not by itself resolve its identification assumptions.

The baseline joint equation, M5, is

$$E\left[X_{ipt}^{US} \mid \mathcal{Z}\right] = \exp\left[\alpha_{ip} + \gamma_{it} + \beta D_{pt} + \theta_a D_{pt} a_{ip} + \theta_s D_{pt} s_i + \theta_g D_{pt} g_i + \rho_a Post_t a_{ip}\right]. \tag{9}$$

$\mathcal{Z}$ denotes the included regressors and fixed effects. The mean is in thousands of USD; the terms in the exponential index are interpreted on the log scale of that mean. α_{ip} absorbs time-invariant country-product differences; γ_{it} absorbs shocks common to each country's products in each year. We call this structure C. Post×RCA remains because it can vary across products within a country; Post×size and Post×integration are absorbed by country-year effects. The main effects of the prior variables are absorbed by country-product effects.

The sequence begins with M1, which includes only D in addition to the fixed effects; M2, M3, and M4 separately incorporate RCA, size, and integration, with their identifiable lower-order terms. M5 combines them. M6 adds D×size×integration to M5 while retaining the lower-order interactions. Covariates are neither centered nor winsorized. In the interacted models, β evaluates the covariates at zero and is not an average effect representative of the observed countries.

Structure B uses country-product and product-year effects. Its joint equation, B5, is

$$E\left[X_{ipt}^{US} \mid \mathcal{Z}\right] = \exp\left[\alpha_{ip} + \lambda_{pt} + \theta_a D_{pt} a_{ip} + \theta_s D_{pt} s_i + \theta_g D_{pt} g_i + Post_t\left(\rho_a a_{ip} + \rho_s s_i + \rho_g g_i\right)\right]. \quad (10)$$

λ_{pt} captures every component common to product p in year t. It therefore absorbs D, and no average effect is reported under B. Interactions with characteristics that differ across countries may retain variation: they compare relative responses across exporters within the same product-year, accounting for prior country-product differences and the lower-order terms specified above. B6 adds both Dsg and Post×sg. B does not additionally contain country-year effects; it is an alternative structure controlling for a different source of shocks, rather than a specification that dominates C in every respect.

6.3. Event Studies, Pre-trends, and Inference

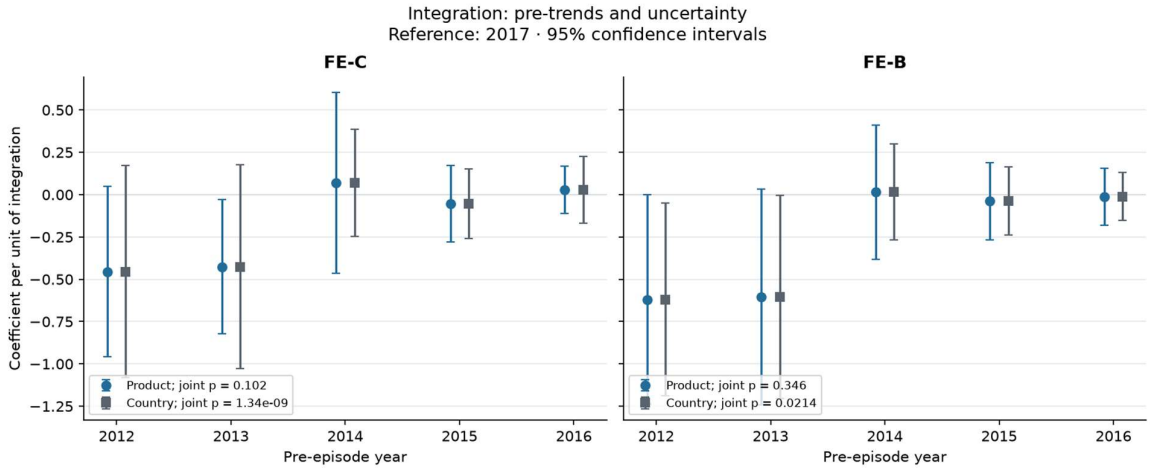
The P75–P25 difference in regional integration is the estimated difference between economies at the 75th and 25th percentiles of regional orientation, holding other characteristics at their medians where appropriate. P75–P25 is not a model: the models are M1–M6 and their alternatives B2–B6. Equivalent comparisons are made between the percentiles of size and RCA. Size and integration use unique countries in the estimation sample; RCA uses country-product pairs in that sample. For a log contrast Δh, we report

$$100\,[\exp(\Delta h) - 1]. \quad (11)$$

The unit is a percentage of a conditional response ratio. It is not a percentage-point change in a share, an aggregate export difference, or a prediction of what would happen under an intervention on g. Intervals are obtained from the estimated contrasts and their covariances. Comparable robustness checks retain the reference values of the main models; the product-country integration measure uses its own percentiles because it is a different variable.

The event-study specifications replace interactions with Post with annual interactions, omitting 2017. In addition to each characteristic's interaction with treated product and year, its interaction with year is included whenever it is not absorbed by the fixed effects. A general evolution associated with that characteristic is thus not automatically conflated with the difference specific to treated products. The pre-trend test jointly tests the five 2012–2016 coefficients in the corresponding family, using their full covariance matrix. For integration, the p-value under C is 0.1022 with product clustering and approximately 1.34×10^{-9} with country clustering; under B, it is 0.3457 with product clustering and 0.0214 with country clustering. Figure 1 shows the discrepancy. We do not treat non-rejection with product clustering as proof of parallel trends.

Figure 1. Integration pre-trends under fixed-effect structures B and C.



Note: Integration event studies for emerging economies, 2012–2024, with 2017 as the reference year. Pre-episode coefficients are differences in the response per unit of integration on a log scale; a positive value indicates a larger difference relative to the omitted year, not a causal effect. Intervals are 95% confidence intervals with standard errors clustered by product and by country. C includes country-product and country-year fixed effects; B includes country-product and product-year effects. Table C1 reports joint tests and cases of invalid inference.

Source: Author's calculations.

Size continues to exhibit adverse pre-trend evidence: under B, the null is rejected with product clustering (p=0.0260), but not with country clustering (p=0.1566), and the two-way block is invalid. Concerns persist under C. RCA has less adverse diagnostics under B, but this difference does not establish exogeneity. The assessment preceding the main results continues to treat size as associational heterogeneity and does not make B a general validation of causal effects.

The main clustering is by HS2012 product, allowing dependence across countries and years within a product; country clustering is presented as an alternative allowing a different residual dependence structure. Country-year effects do not, by definition, eliminate all remaining country-level correlation. Two-way clustering is used only when the block required for the contrast is valid. Indefinite matrices are not repaired. The validity of a particular combination does not validate the full matrix or other tests of the model.

The estimation sample requires information on the included characteristics. In addition, the estimator recursively removes observations belonging to fixed-effect groups with exports always equal to zero. The joint model M5 uses 2,479,753 observations, 134 countries, and 5,182 products; B5 uses 2,467,173 observations, with the same country and product counts. These removals are documented without redefining the conceptual universe. Convergence and numerical checks do not amount to an exhaustive test for the absence of all regressor-induced separation. The appendices provide further details; the main analysis retains their substantive implication: the associations are estimated on uneven effective support.

7. Stylized Facts

Tariff exposure covers a large fraction of initial trade (Table 2). Table A1 summarizes the trade changes and shares described below. The 3,640 treated products accounted for 71.42% of cumulative US imports in 2015–2017. This coverage does not mean that China uniformly dominated their markets: China's average product-level share was 18.36% in treated products and 23.65% in untreated products. The pre-episode distributions of China's share in treated and untreated products cross. The simple average across products and the weighted aggregate share describe different dimensions and should not be used interchangeably.

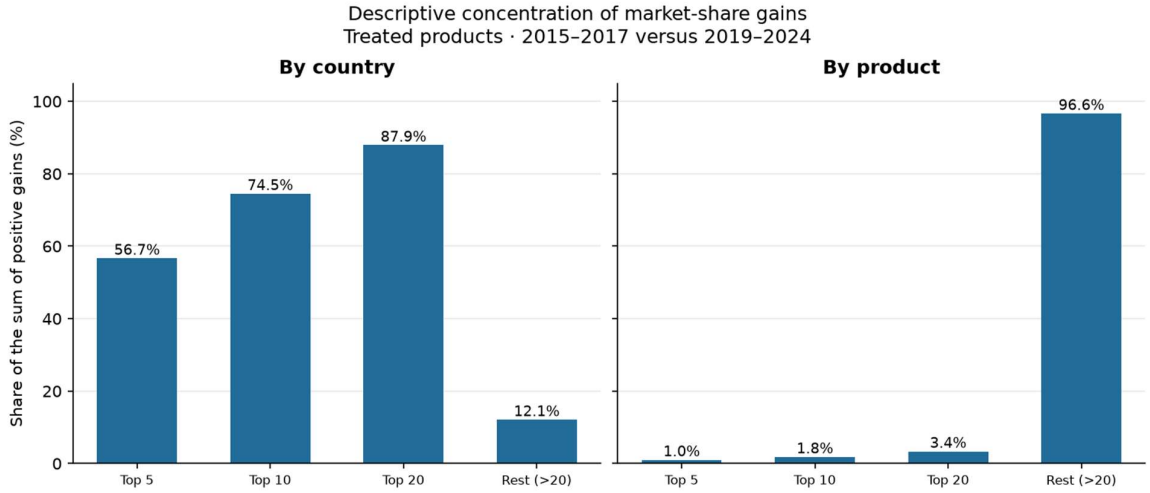
China's weighted share in treated products fell from 19.60% in 2017 to 11.36% in 2024. It also fell in untreated products, from 27.25% to 20.63%. Comparing average annual values in 2015–2017 and 2019–2024, emerging-economy exports to the United States increased by 44.28% in treated products and 37.03%

in untreated products. Unlike the post-episode indicator in the main model, this comparison excludes 2018 as a transition year. Values are nominal, and the changes do not isolate the tariff's impact.

To examine how market-share gains are distributed, the descriptive analysis calculates each country-product pair's share of US purchases from all suppliers other than China. It compares average annual post-episode shares with their pre-episode average, requiring valid denominators in all three initial and six final years. Among treated products, the mean change is 0.0217 percentage points, the median is zero, and 14.35% of valid pairs gain share. The positive mean thus coexists with a response concentrated in a fraction of the opportunities.

Figure 2 shows this concentration along two dimensions. The top five countries account for 56.67% of the mass of positive gains, and the top twenty for 87.92%. By contrast, the top twenty products account for 3.36%. Under this metric, gains are more concentrated by origin than by product. Each country-product share change contributes without monetary weighting; losses are kept separate. Thus, 87.92% is neither a dollar share nor the fraction of China's overall decline attributable to these exporters.

Figure 2. Concentration of positive market-share gains.



Note: Emerging-economy country-product pairs with valid shares, treated products; average shares for 2015–2017 and 2019–2024. Positive changes are accumulated separately, without monetary weighting; losses are not netted out. The top-five, top-ten, and top-twenty groups are cumulative; the remainder excludes the top twenty. The share denominator is purchases from all BACI suppliers other than China. A positive contribution indicates a descriptive market-share gain, not dollars captured or trade causally transferred from China.

Source: Author's calculations using BACI data.

Descriptive groupings by revealed specialization do not show a systematic increase in average market-share gains as specialization rises. The size-integration matrix uses 135 countries with valid values for both variables and shows larger mean changes in the largest tercile across all three integration columns. This is an unadjusted comparison that does not anticipate the sign of the econometric interactions. Finally, exports to China also grow: by 65.55% for treated products and 135.83% for untreated products over the same descriptive periods. Simultaneous growth toward both destinations precludes mechanically inferring that sales to the United States were obtained by reducing those to China.

8. Results

Table 4 presents the average exposure contrast in M1 and the interquartile heterogeneity contrasts, separately and jointly. Intervals based on product and country clustering are shown together. The table contains thirteen comparisons; models with the size×integration interaction are discussed subsequently, and their contrasts are reported in the appendices.

Table 4. Main PPML contrasts.

Specification	Fixed effects	Estimated comparison	%	Log SE product	CI % product	Log SE country	CI % country	Observations
M1	C	Average exposure	14.75	0.058554	[2.30; 28.70]	0.096399	[-5.17; 38.84]	2,482,058
M2	C	RCA P75–P25	-0.0008	0.000105	[-0.0214; 0.0198]	0.000121	[-0.0248; 0.0232]	2,482,058
M3	C	Size P75–P25	-2.27	0.066337	[-14.19; 11.30]	0.177727	[-31.24; 38.90]	2,479,753
M4	C	Integration P75–P25	32.37	0.099938	[8.82; 61.02]	0.166800	[-4.82; 84.10]	2,482,058
M5	C	RCA P75–P25	0.0030	0.000124	[-0.0212; 0.0272]	0.000143	[-0.0253; 0.0313]	2,479,753
M5	C	Size P75–P25	8.04	0.068445	[-5.52; 23.56]	0.180348	[-24.37; 54.36]	2,479,753
M5	C	Integration P75–P25	34.85	0.097080	[11.48; 63.12]	0.144569	[1.32; 79.49]	2,479,753
B2	B	RCA P75–P25	-0.0035	0.000129	[-0.0288; 0.0217]	0.000096	[-0.0225; 0.0155]	2,469,500
B3	B	Size P75–P25	-0.54	0.125405	[-22.22; 27.18]	0.126479	[-22.55; 27.73]	2,467,173
B4	B	Integration P75–P25	35.18	0.093885	[12.46; 62.50]	0.146191	[1.24; 80.50]	2,469,500
B5	B	RCA P75–P25	0.0019	0.000114	[-0.0203; 0.0242]	0.000125	[-0.0228; 0.0267]	2,467,173
B5	B	Size P75–P25	10.24	0.118886	[-12.68; 39.18]	0.154745	[-18.83; 49.72]	2,467,173
B5	B	Integration P75–P25	38.53	0.104471	[12.87; 70.01]	0.158165	[1.31; 89.41]	2,467,173

Note: Each contrast compares the relative response of treated and untreated products. M1 summarizes their post-episode difference; the remaining rows compare this response at the 75th and 25th percentiles of a characteristic, holding the others at their reference values. The log difference is calculated first and then transformed using $100[\exp(\Delta h)-1]$. A positive value indicates a larger relative response, not aggregate growth or the effect of changing a characteristic. M2/B2, M3/B3, and M4/B4 consider specialization, size, and integration separately; M5/B5 combine them (Table 3). FE: fixed effects; C = country-product + country-year; B = country-product + product-year. SE: standard error; CI: 95% confidence interval. SEs are on the log scale and CIs in percent. Standard errors are clustered by product or country; N denotes observations used from 2012–2024. Country and product counts and p-values are in Appendices B and E.

Source: Author's calculations.

Do exposed products exhibit a larger post-episode response? Model M1 estimates a difference of 14.75%. Its product-clustered interval ranges from 2.30% to 28.70%, whereas its country-clustered interval spans −5.17% to 38.84%. The point estimate suggests a larger nominal response for exposed products in the emerging-economy universe, but its precision depends on the residual dependence allowed. Further concerns arise from the baseline model's pre-trends and sensitivity to sample and definition choices. We do not interpret this as a robust causal effect of Section 301.

The most persistent evidence concerns integration. To interpret its magnitude, we compare a profile with relatively low regional orientation—P25, approximately 14.51% of its exports—with a high-orientation profile—P75, approximately 64.72%—holding specialization and size at their reference values. The question is how much the relative response of treated versus untreated products differs between these profiles. In joint model M5, this difference is 34.85%; its product-clustered interval is [11.48%; 63.12%] and its country-clustered interval is [1.32%; 79.49%]. In model B5, it reaches 38.53%, with intervals of [12.87%; 70.01%] and [1.31%; 89.41%], respectively (Table 4). These are broad comparisons within observed values, not the effect of administratively raising the regional share from P25 to P75.

The agreement in sign between C and B is informative because the latter absorbs common product-year shocks. However, integration pre-trends remain sensitive to the clustering of standard errors. Moreover, the result is not stable in the universe of 206 countries, the log(1+value) specification is imprecise, the product-level regional measure has limited coverage, and export presence does not increase systematically with integration. These limitations define the finding's scope: a relatively stable conditional association between integration and the response in value within emerging economies.

In model M4, which includes integration separately, the integration contrast is 32.37%, but the country-clustered interval includes zero. In model B4, it reaches 35.18%, and both intervals exclude zero. Thus, even within PPML, precision differs across specifications. The combined evidence does not justify describing every individual exercise as conclusive.

The trade response does not vary robustly with prior revealed specialization. Its interquartile contrasts are small and imprecise both when it is included alone and when it is included jointly with size and integration. Keeping the variable continuous avoids replacing this evidence with a threshold selected after observing the results. The conclusion concerns these tests and this measure of specialization; it does not establish that productive capabilities lack structural importance.

Size likewise shows no stable pattern. The individual contrast is −2.27% under C and −0.54% under B; in the joint model, it becomes 8.04% and 10.24%, with intervals that include zero. The change in sign when other dimensions are incorporated, together with adverse pre-trends, precludes attributing a causal advantage to small or large economies. Descriptive tercile comparisons do not replace this adjusted evidence.

The original question requires determining whether the favorable association with integration is greater among small than large economies. C3 compares precisely these two differences; a positive integration coefficient alone does not answer that question. In model M6, C3 is 0.2140 log units; its product-clustered interval is [−0.0824; 0.5104] and its country-clustered interval is [−0.4963; 0.9244]. In model B6, it becomes −0.0276, with intervals of [−0.5206; 0.4654] and [−0.5749; 0.5198]. Comparable robustness checks in Table D1 likewise do not exclude zero under product or country clustering. We therefore find no firm support for compensation specifically for smaller size. Imprecision does not prove that C3 is exactly zero or rule out every compensatory mechanism; it indicates that the hypothesis is not supported by the tests conducted.

9. Robustness and Forms of Trade Adjustment

The robustness checks examine whether the main results persist when measurement choices, the period, the universe of countries, or the definition of the regional variable change. The second part of the section also examines how trade adjustment occurs: whether it appears primarily as higher export value in existing

relationships or as the emergence of new export relationships. In the literature, these dimensions are often linked to the intensive and extensive margins, but they are not estimated here as a causal decomposition.

The robustness checks were specified before estimation and address concrete threats. The clean concordance examines classification ambiguity; excluding 2018 addresses partial annual exposure; excluding 2020–2021 addresses the pandemic period; integration bounds address unassigned destinations; and excluding the five largest exporters addresses concentration among large exporters. Expanding to 206 countries examines generalizability. Replacing value with presence or log(1+value) examines distinct outcomes. None of these comparisons replaces the pre-trend tests in Table C1. Table 5 distinguishes PPML results for emerging economies from changes in the country universe, measure, and observed outcome. Equivalent comparisons retain the percentiles of the main models, so their magnitudes do not change simply because the low- or high-integration profile is redefined in each exercise.

Table 5. Association between regional orientation and the export response: robustness checks and alternative outcomes.

A. Export value in emerging economies — DiD-PPML estimates

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (%)	95% CI clustered by product	95% CI clustered by country	Observations
Baseline	M5	Country-product and country-year	34.85	[11.48; 63.12]	[1.32; 79.49]	2,479,753
Baseline	B5	Country-product and product-year	38.53	[12.87; 70.01]	[1.31; 89.41]	2,467,173
Clean mapping	M5	Country-product and country-year	32.96	[8.82; 62.44]	[0.28; 76.28]	2,252,607
Clean mapping	B5	Country-product and product-year	37.93	[11.16; 71.15]	[2.27; 86.03]	2,242,060
Excluding 2018	M5	Country-product and country-year	38.83	[12.73; 70.96]	[1.05; 90.72]	2,241,508
Excluding 2018	B5	Country-product and product-year	43.24	[14.02; 79.95]	[1.67; 101.80]	2,230,245
Excluding 2020–2021	M5	Country-product and country-year	29.72	[6.15; 58.53]	[-2.74; 73.01]	2,001,416
Excluding 2020–2021	B5	Country-product and product-year	40.72	[12.38; 76.20]	[2.31; 93.54]	1,991,610
Lower bound	M5	Country-product and country-year	35.75	[11.94; 64.62]	[1.54; 81.50]	2,479,753
Lower bound	B5	Country-product and product-year	39.64	[13.36; 72.02]	[1.59; 91.94]	2,467,173
Upper bound	M5	Country-product and country-year	34.62	[11.37; 62.74]	[1.51; 78.53]	2,479,753
Upper bound	B5	Country-product and product-year	38.03	[12.69; 69.07]	[1.09; 88.48]	2,467,173
Existing relationships	M5	Country-product and country-year	36.44	[12.83; 65.01]	[3.02; 80.71]	1,540,894
Excluding the five largest	M5	Country-product and country-year	85.88	[44.80; 138.61]	[24.66; 177.16]	2,190,542

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (%)	95% CI clustered by product	95% CI clustered by country	Observations
Excluding the five largest	B5	Country-product and product-year	85.06	[32.52; 158.41]	[29.70; 164.04]	2,167,995

B. Export value in the expanded universe of 206 countries — DiD-PPML estimates

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (%)	95% CI clustered by product	95% CI clustered by country	Observations
All 206	M5	Country-product and country-year	-10.60	[-30.19; 14.48]	[-26.78; 9.15]	4,718,041
All 206	B5	Country-product and product-year	14.34	[-16.76; 57.08]	[-8.24; 42.49]	4,711,019

C. PPML, product-country integration — percentage of a conditional ratio; measure-specific percentiles

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (%)	95% CI clustered by product	95% CI clustered by country	Observations
Product-country integration	M4	C	23.28	[-2.47; 55.81]	[-26.20; 105.91]	2,370,379
Product-country integration	B4	B	39.75	[-1.91; 99.08]	[-15.82; 131.98]	2,358,957

D. log(1+value in thousands of USD) — log(1+value) units

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (log)	95% CI clustered by product	95% CI clustered by country	Observations
log(1+value)	M5	Country-product and country-year	0.00211	[-0.00383; 0.00805]	[-0.01626; 0.02048]	9,124,245
log(1+value)	B5	Country-product and product-year	0.00210	[-0.00385; 0.00804]	[-0.01627; 0.02046]	9,124,245

E. Export presence LPM — percentage points

Robustness check	Reference specification	Fixed effects	Estimated difference between high and low integration (p.p.)	95% CI clustered by product	95% CI clustered by country	Observations
Presence LPM	M5	Country-product and country-year	-0.075	[-0.207; 0.056]	[-0.441; 0.291]	9,124,245
Presence LPM	B5	Country-product and product-year	-0.075	[-0.207; 0.056]	[-0.441; 0.291]	9,124,245

Note: The relative export response in treated versus untreated products is compared between a profile at the 75th percentile (P75) of prior regional orientation and one at the 25th percentile (P25). P25 and P75 are the values below which 25% and 75% of the reference distribution lie, respectively; other characteristics are held at their reference values. These are P75–P25 differences in regional integration, using the main model's reference values except for the product-country measure, which uses its own percentiles. CIs are 95% confidence intervals with standard errors clustered by product and country; N is the estimation sample. C = country-product + country-year fixed effects; B = country-product + product-year effects. Panels A/B/C: percentage of a PPML conditional ratio; D: log(1+value) units; E: percentage points of presence. LPM denotes the linear probability model. A positive value indicates a larger response in each panel's outcome, without automatic equivalence across scales or a causal interpretation. The period is 2012–2024 unless otherwise indicated; existing relationships require activity in 2015–2017. Tables E2 and E3 report standard errors, p-values, two-way validity, and samples.

Source: Author's calculations.

The clean concordance, exclusion of 2018, and lower and upper integration bounds preserve the positive sign within emerging economies. It also persists when 2020–2021 is excluded, although C's country-clustered interval includes zero. These checks reduce concerns about specific measurement or time-window choices; they do not automatically correct prior divergence between profiles.

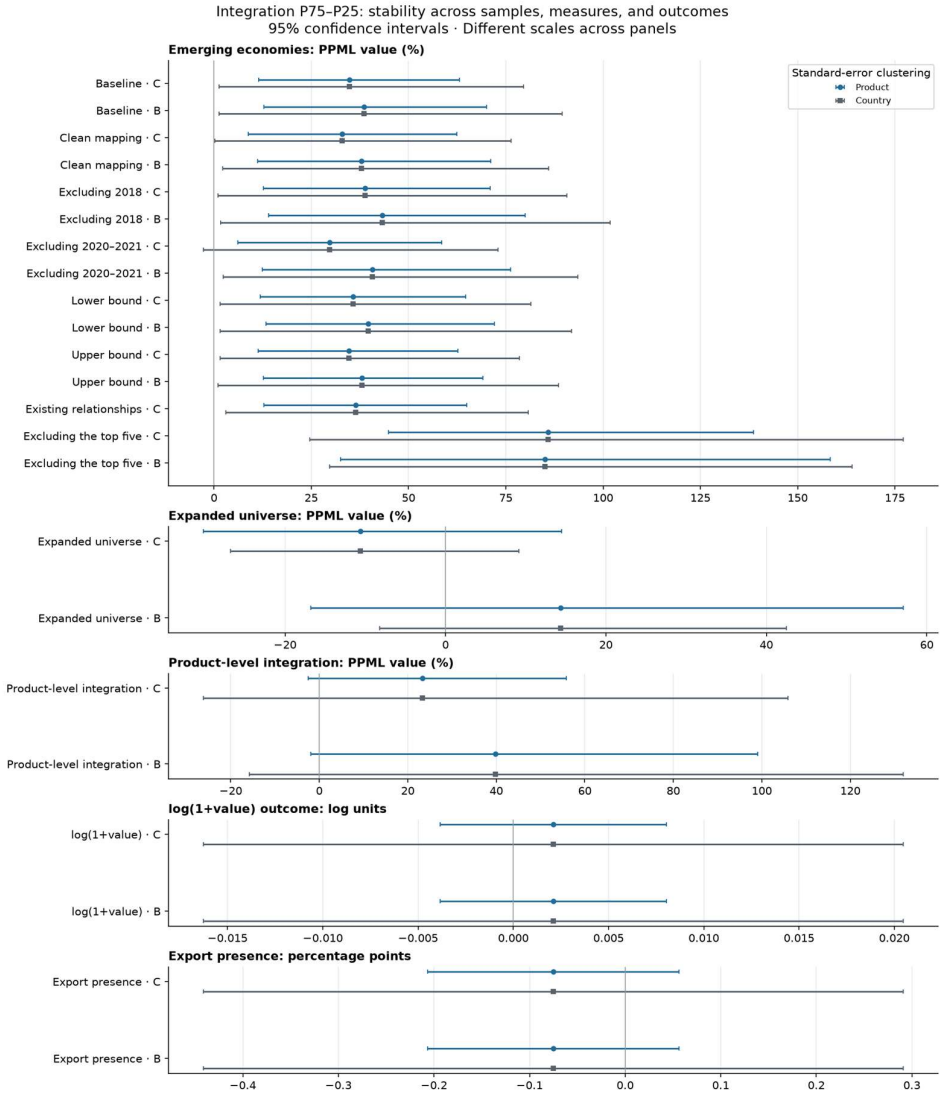
Expanding the analysis to 206 third countries that can supply the US market, including high-income countries, yields a different result. The integration contrast is −10.60% under C and 14.34% under B; both are imprecise. This sensitivity precludes describing the relationship as universal. Composition and support change, so the difference cannot be attributed to a particular cause, such as high income, without additional analysis that is not undertaken here.

The product-level regional measure faces a data-availability limitation before its coefficients can be interpreted. Only 403,708 of 717,876 pairs have an assigned measure, a retention rate of approximately 56.24%. Before estimation, a minimum coverage requirement had been set to prevent the joint analysis from relying on an excessively different sample. The rule for proceeding to the joint equations was not met: at least 80% of eligible rows and 90% of countries relative to the corresponding aggregate measure. Only the individual equations M4/B4 were estimated, with positive contrasts but product- and country-clustered intervals that include zero. The loss of conceptual availability is not the same as the loss of effective PPML rows; the two must be distinguished.

Simultaneously excluding Mexico, India, Vietnam, Malaysia, and Thailand—the five largest initial exporters to the United States under the prior rule—preserves the positive association with integration and increases its estimated magnitude. This suggests that the result does not depend exclusively on those five countries, but it does not make the restricted sample the new baseline specification. The average exposure contrast, by contrast, weakens and becomes less precise. The log(1+value) transformation, with value in thousands of USD, also yields imprecise integration contrasts. Its coefficients are not PPML percentages and are not interpreted as differences in physical quantities.

Figure 3 summarizes which analytical changes preserve the association and which limit its scope.

Figure 3. Integration across robustness checks and distinct estimands.



Note: P75–P25 comparison of regional orientation, with other characteristics at their reference values; emerging economies and the expansion to 206 countries are shown in separate panels. The period is 2012–2024 unless otherwise indicated. Scales distinguish percentages of PPML conditional ratios, log(1+value) units, and percentage points of presence. Intervals are 95% confidence intervals; Table 5 identifies controls, samples, and clustering. A positive value describes a larger relative response in each outcome; the panels do not estimate a single interchangeable effect.

Source: Author's calculations.

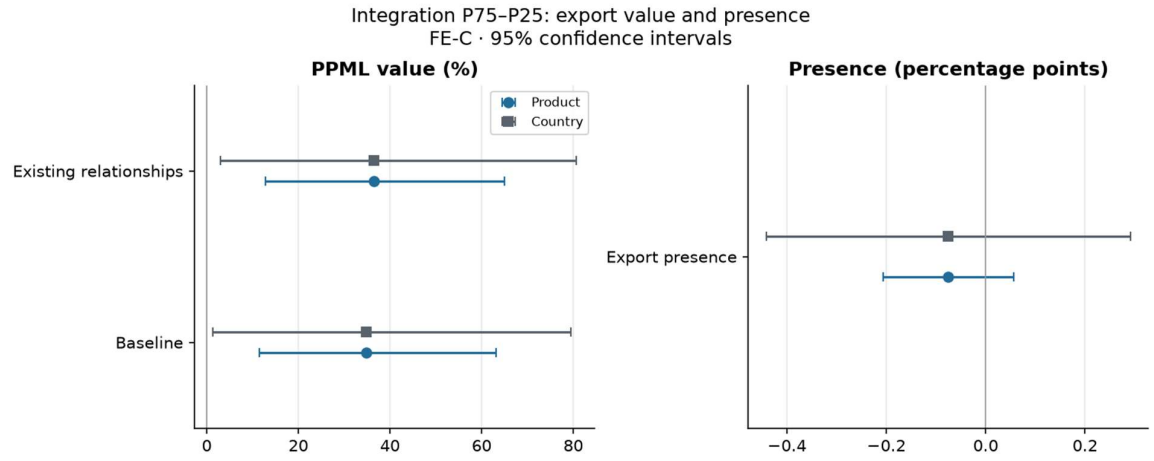
Comparing export presence and export value allows us to ask whether the response reflects more relationships with trade or changes in value within existing relationships. This distinction between margins helps interpret which form of adaptation is consistent with the evidence. The linear probability model of presence (LPM) uses an indicator for positive exports and retains opportunities without trade. Presence means that the pair exports in a given year; it does not identify only its first entry. In the joint model, the integration contrast is approximately −0.075 percentage points under C and B, with intervals that include zero. Export presence does not increase with integration as the response in value does. Moreover, a large fraction of individual predictions falls outside [0,1], so we interpret the slopes as diagnostic linear projections rather than structural probabilities.

When PPML is restricted to relationships with some activity toward the United States during 2015–2017, the joint integration contrast is 36.44%, with a product-clustered interval of [12.83%; 65.01%] and a country-clustered interval of [3.02%; 80.71%]. Together with the absence of a positive gradient in presence, this

pattern is more consistent with adjustment or scaling along existing trade relationships than with a broad expansion of export presence. The comparison uses different observed outcomes and samples; it is not a causal decomposition of the intensive and extensive margins, nor does it allow coefficients to be subtracted to allocate contributions.

Figure 4 compares these forms of adjustment without equating their units.

Figure 4. Value, export presence, and previously active relationships.



Note: P75–P25 difference in regional integration, comparing export value, an indicator for positive exports, and value in relationships active in 2015–2017. The estimation period is 2012–2024, for emerging economies. Percentages of PPML conditional ratios and percentage points from the linear presence model are shown on separate scales; intervals are 95% confidence intervals. The two fixed-effect architectures are described in Table 3. A positive value indicates a larger response in the corresponding outcome, not a causal decomposition of entry and expansion.

Source: Author's calculations.

10. The Recent Experience of South America and Central America

This section offers a brief descriptive account of South America and Central America, two regions particularly relevant for discussing how economies of different scale, specialization, and regional orientation experienced the episode. It uses a predefined geographic set of 19 countries: twelve in South America and seven in the Central American isthmus. The comparison does not seek to construct a regional control group or make the analysis revolve around a particular country. Selection is geographic and does not depend on trade responses; it is not a causal control group. Mexico and the Caribbean are excluded by this geographic definition. Seventeen countries belong to the emerging-economy universe. Chile and Uruguay complete the South American comparison as descriptive high-income benchmarks under the fiscal year 2018 classification, outside the main econometric sample. Table A3 presents all 19 profiles using the same variables and windows, situating the following examples within the full set.

10.1. South America

South American economies entered the episode with different scales and trade orientations. In 2017, Brazil's GDP was USD 2,063.52 billion, whereas Suriname's was USD 3.59 billion. Paraguay's prior regional share reached 55.35%, compared with 16.41% in Peru. Specialization is also unevenly distributed across products, as shown by the proportion with RCA of at least one in Table A3. None of these measures alone summarizes the scope for a trade response.

Treated exports to the United States increased by 59.83% in Paraguay and 14.44% in Peru between the pre- and post-episode annual averages; untreated exports grew by 43.64% and 31.67%, respectively. Lower regional orientation thus coexisted with a positive response, whereas Bolivia's relatively high orientation coexisted with a decline, examined below. These comparisons describe trajectories; they do not rank

countries by the effectiveness of integration. Diversity is not limited to these examples: Suriname and Venezuela, both with low prior regional orientation, recorded changes of opposite signs in treated products. The comparisons do not isolate the national or sectoral factors accompanying these trajectories.

Bolivia's GDP was USD 45.93 billion in 2017: above the emerging-economy median of USD 18.33 billion, although below the South American median of USD 110.18 billion (Table 6). Its prior regional export orientation was 50.52%, placing it at approximately the 64.5th percentile of the emerging-economy distribution. This percentile counts countries with a value less than or equal to Bolivia's, without trade weighting. RCA was at least one in 3.29% of its valid products. The profile thus combines relatively high regional orientation with revealed specialization in a small fraction of products; it does not measure productive capacity or network integration.

Between the annual averages for 2015–2017 and 2019–2024, the value of Bolivian exports to the United States fell by 72.02% in treated products and 28.34% in untreated products. Toward China, the nominal value of Bolivian exports increased by 92.82% in treated products and 29.23% in untreated products, respectively. These are not physical quantities or trade volumes. They are descriptive changes in nominal values, not effects of Section 301 or estimates of diversion between destinations. Nor does the difference between these rates reproduce the global model's conditional contrast. Bolivia is the focal case of the illustration; its individual trajectory neither proves nor refutes the global association with integration.

Bolivia's trajectory should be interpreted in light of a particular bilateral context. Beginning in 2008, relations with the United States underwent a period of sharp diplomatic deterioration, and Bolivia subsequently lost ATPA/ATPDEA trade preferences. The evolution of its exports to the United States may therefore reflect long-standing bilateral conditions outside this paper's empirical design.

Official statements document the reciprocal expulsions of ambassadors in September 2008 (US Department of State, 2008a, 2008b). A prolonged period without an exchange of ambassadors followed, documented through 2025 by Klein (2025); the historical record of chiefs of mission distinguishes this situation from a formal severance of diplomatic relations (United States Department of State, Office of the Historian, n.d.). Suspension of Bolivia's designation as an ATPA/ATPDEA beneficiary took effect on December 15, 2008 (White House, 2008). All these events substantially predate the 2018 tariffs. They do not identify the cause of the observed decline or allow it to be attributed to a government, an ideology, the expulsions, or the loss of preferences.

Table 6 presents the focal profile's values, keeping prior position distinct from subsequent response.

Table 6. Bolivia: prior conditions and descriptive evolution of export value.

Indicator	Bolivia	Descriptive benchmark
2017 GDP, USD billions	45.93	Emerging-economy median: 18.33; South American: 110.18
Prior regional exports / assignable destinations	50.52%	Emerging-economy percentile: 64.5
Valid products with RCA≥1	3.29%	171 of 5,199 products
Exports to the United States, treated products	−72.02%	Change between annual averages
Exports to the United States, untreated products	−28.34%	Change between annual averages
Exports to China, treated products	+92.82%	Change between annual averages
Exports to China, untreated products	+29.23%	Change between annual averages

Note: GDP is for 2017; integration and specialization are for 2015–2017. Trade changes compare 2019–2024 with 2015–2017 and are expressed in nominal value. A positive value indicates a higher post-episode average, not a tariff effect. The percentile counts countries with values less than or equal to Bolivia's. The emerging-economy GDP median uses 135 countries with valid data and three with missing data; the South American median uses twelve countries, including Chile and Uruguay. The medians give equal weight to each country and are neither arithmetic means nor trade aggregates.

Source: Author's calculations using BACI and World Bank data.

10.2. Central America

Central America also combines economies of different sizes and orientations. Belize's GDP was USD 2.27 billion in 2017, and Guatemala's was USD 71.65 billion. Prior regional orientation was 26.57% in Costa Rica and 51.43% in Panama. Table A3 allows these conditions to be compared with those of the other five economies without treating the region as a homogeneous bloc.

Subsequent responses varied. Costa Rica recorded increases of 58.15% in treated exports to the United States and 76.44% in untreated exports. Panama recorded declines of 57.35% and 78.46%, respectively. In El Salvador, treated exports increased by 37.23% and untreated exports fell by 13.05%. These examples, within the full geographic set, show why high regional orientation does not automatically determine a favorable response. Nor does lower orientation preclude increases. These are changes in nominal value between 2015–2017 and 2019–2024, without adjustment for the global model's controls or a regional causal interpretation.

11. Discussion

Renewed trade fragmentation gives this historical evidence additional relevance. The WTO (2026) identifies a further intensification of fragmentation in the 2025 data, while recent BIS and IMF analyses show that economies are adjusting supply chains, destinations, and sourcing in response to tariffs and geoeconomic tensions. This does not make the 2018 round an experiment equivalent to the current setting: the measures, partners, sectors, and macroeconomic conditions differ. It does, however, allow an observed episode to illuminate an important regularity: reallocation opportunities may be broad across products and, at the same time, highly concentrated across countries.

The results distinguish two claims that could be conflated. High prior regional integration may accompany a larger nominal response without this gradient being particularly strong among small countries. The first relationship appears with some persistence within emerging economies; the second receives no robust support. Maintaining this distinction avoids turning an additional finding into retrospective confirmation of the initial hypothesis.

Measurement also shapes what we learn. Regional orientation may capture access to networks, specialization, geography, or institutional characteristics that we do not observe directly. The result does not identify which component explains the association, nor does it imply that administratively raising the

regional share would produce the estimated response. Stability under geographic bounds is useful for a specific source of measurement uncertainty, but it does not turn an export share into a direct measure of productive integration.

For small economies, the support problem deserves separate attention. The three size terciles contain 45 countries each, but account for 0.2983%, 3.7002%, and 96.0015% of prior trade with the United States. M5 uses 320,736 observations from the smallest tercile, 639,509 from the middle tercile, and 1,519,508 from the largest. Table A2 reports these counts, which clearly distinguish

$$\text{number of countries} \neq \text{trade mass} \neq \text{effective econometric information.} \tag{12}$$

The expression summarizes three objects with different units: countries, shares of trade value, and contributions to parameter identification. Neither trade mass nor the number of rows used is, by itself, an exact measure of statistical information; the latter also depends on variation in regressors, fixed effects, and the conditional mean. The limited initial presence of small countries helps explain why many nominally included countries do not imply uniform precision regarding their responses. They are not excluded on this basis, and PPML is not presented as an average of effects with equal country weights.

The comparison of value and presence further suggests that adaptation should not be confused with widespread entry by new exporters. Nominal flows reveal where recorded trade changes but leave open questions about quantities actually produced, the origin of value added, and adjustment costs. Identifying those mechanisms would require other measurements and designs; the current results do not substitute for them.

The more general idea that pre-shock conditions help interpret heterogeneous responses also appears in another field. Burger, Warnock, and Warnock study portfolio flows' prior distance from a benchmark level and its predictive power in the face of global shocks. Their subject is financial vulnerability, not export reallocation; we do not use that finding as evidence of the regional mechanism or equate trade performance with macroeconomic resilience (Burger et al., 2026).

Finally, the analysis has a specific temporal and institutional scope. The tariff measures adopted under Section 301 serve to study adaptation to a change in barriers between two large economies. The period after 2018 includes other shocks, and the indicator does not reconstruct all tariff policies. The relative evidence from this episode does not allow us to quantify net gains from fragmentation for the world or make recommendations on integration. Its value lies in defining which associations survive, where they cease to do so, and which hypotheses remain unsupported.

12. Conclusion

Trade fragmentation again raises a question that the first trade war allows us to study with several years of hindsight: when a barrier changes relative opportunities among suppliers, which economies are positioned to seize them? Our analysis of 138 low- and middle-income economies from 2012 to 2024 shows that exposure to Section 301 opened a broad potential opportunity across products, but market-share gains were highly concentrated across countries. The emergence of a trade opportunity alone does not guarantee that it will be seized.

The paper's more demanding hypothesis receives no robust support. We find no stable evidence that greater regional export orientation compensates for the advantages associated with economic size. The contrast comparing the integration gradient between smaller and larger profiles is imprecise and changes sign across the two main fixed-effect architectures. This negative finding is substantive: a favorable association with integration does not demonstrate that integration substitutes for scale.

At the same time, a more persistent regularity emerges within emerging economies. Greater prior regional orientation is associated with a stronger export-value response in exposed products, even when specialization and size are considered jointly. The baseline magnitude is close to 35% when comparing the 75th and 25th

percentiles of integration in the joint model, although inference depends on clustering choices, and the result becomes less stable when the universe is expanded to include high-income countries or the observed outcome is changed. We therefore interpret this evidence as a conditional association within the sample, rather than as the causal effect of increasing integration.

The comparison of forms of adjustment adds an important qualification. Regional orientation does not exhibit an equivalent positive gradient in the emergence of new export relationships. The results are more consistent with trade expansion through existing relationships than with a broad expansion of export presence. This interpretation is not a causal decomposition of the intensive and extensive margins.

The regional experience reinforces the same caution. South America and Central America display highly heterogeneous trajectories among economies with similar or different levels of regional orientation. Bolivia, analyzed within the South American experience, combines relatively high prior regional orientation with a sharp decline in treated exports to the United States; its trajectory also unfolds against a bilateral historical background whose effects the design does not identify causally. No national case should be read as a prediction from the global coefficient.

What can this evidence teach us about the current environment? Not that the effects of 2018–2024 will recur mechanically. The paper's data end in 2024 and do not estimate the effects of the measures adopted in 2025–2026. The more general lesson is different: barriers that weaken one supplier's position may create opportunities for third countries, but the ability to seize them is heterogeneous and may be concentrated in a few economies. Prior regional orientation appears as a characteristic associated with that capacity to adapt within the emerging-economy sample, but not as a proven substitute for size or a deterministic mechanism.

In a world where trade and geoeconomic tensions are again reshaping supply chains and destinations, distinguishing opportunity from the capacity to respond is central. The Section 301 episode serves in this paper as an empirical setting for studying that distinction. Extending the evidence to the new round of measures will require data after 2024 and a design that explicitly recognizes the greater breadth, simultaneity, and heterogeneity of current shocks.

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Appendices

A. Data, Concordances, and Construction

The concordance links HTS8 lines in the lists to HS2017 and the official HS2017–HS2012 correlation table. It retains one-to-many and many-to-one mappings and partial sources. The mapping yields 3,643 treated HS2012 codes; three—271012, 271019, and 271020—are absent from the main BACI universe. The data tables therefore use 3,640 treated and 1,562 untreated products. The clean-mapping robustness check excludes ambiguous products without recoding them as controls.

The enumeration used for the third list contains 5,767 HTS8 lines after incorporating its explicit modifications. The subsequent summary count of 5,733 has not been reconciled with that enumeration. The figure of 5,734 initial complete lines belongs to a different count and does not resolve the discrepancy. These counts are not directly interchangeable. The enumeration used to assign exposure is retained rather than replaced by the aggregate summary.

Regions retain the geographic assignments and their supplements based on the United Nations M49 classification. If R_i is assigned intraregional value, A_i is value destined for assignable destinations, and U_i is value destined for unassignable destinations, all accumulated over 2015–2017 and excluding domestic trade, coverage is $A_i/(A_i+U_i)$. The regional-share bounds are $R_i/(A_i+U_i)$ and $(R_i+U_i)/(A_i+U_i)$. These are proportions, conditional on positive denominators; they reflect extreme assignments of the unknown component rather than its estimated location. S19 remains without a region.

The income classification is FY2018, and the WDI variables are retained without updating. BACI V202601 is used for 2012–2024. The period covered by the methodological paper by Gaulier and Zignago (2010) differs from the years of the panel used here.

Table A1 summarizes the main descriptive facts used in the text. Table A2 documents uneven support by size.

Table A1. Descriptive facts on trade and market shares

Measure	Group	Statistic	Value	Unit	Valid units
China's prior share, product-level mean	Untreated products	Mean	23.6527	%	1554
China's prior share, product-level mean	Treated products	Mean	18.3593	%	3635
Change in value to the US	Treated products	Change between 2015–2017 and 2019–2024 averages	44.2787	%	138
Change in value to the US	Untreated products	Change between 2015–2017 and 2019–2024 averages	37.0315	%	138
Change in value to China	Treated products	Change between 2015–2017 and 2019–2024 averages	65.5478	%	138
Change in value to China	Untreated products	Change between 2015–2017 and 2019–2024 averages	135.8265	%	138
Share change / presence of gains	Treated products	Mean change	0.0217	p.p.	491970
Share change / presence of gains	Treated products	Median change	0.0000	p.p.	491970
Share change / presence of gains	Treated products	Proportion with an increase	14.3529	%	491970
China's weighted share in 2017	Untreated products	Aggregate share	27.25	%	1550
China's weighted share in 2024	Untreated products	Aggregate share	20.63	%	1532
China's weighted share in 2017	Treated products	Aggregate share	19.60	%	3624
China's weighted share in 2024	Treated products	Aggregate share	11.36	%	3600

Note: p.p. denotes percentage points. Nominal trade: averages for 2015–2017 and 2019–2024; China's prior share: 2015–2017. Share changes use valid country-product pairs and all suppliers other than China in the denominator. The mean and median change summarize variation in shares; the proportion with an increase counts pairs with gains. These are descriptions without causal adjustment.

Source: Author's calculations using BACI data.

Table A2. Countries, initial trade, and observations used

Size tercile	Countries	Share of prior US trade (%)	M5 observations
Smallest	45	0.2983	320,736
Middle	45	3.7002	639,509
Largest	45	96.0015	1,519,508

Note: Predefined descriptive groups based on 135 countries with valid characteristics; prior trade covers 2015–2017. M5 uses 2012–2024, with country-product and country-year fixed effects. Rows and trade mass do not measure econometric information exactly or create a new classification of small countries.

Source: Author's calculations using BACI and World Bank data.

Table A3 presents the regional profiles described in Section 10.

Table A3. Prior conditions and descriptive changes in South America and Central America.

Region / country	2017 GDP (USD billions)	Prior regional orientation (%)	Products with RCA≥1 (%)	Treated exports to the US (%)	Untreated exports to the US (%)
South America / Argentina	643.63	32.53	9.58	11.22	75.36
South America / Bolivia	45.93	50.52	3.29	-72.02	-28.34
South America / Brazil	2,063.51	19.86	11.81	15.42	61.36
South America / Chile*	276.15	15.88	7.81	46.29	32.34
South America / Colombia	311.87	32.06	8.31	5.62	35.63
South America / Ecuador	104.47	24.57	5.19	9.16	76.62
South America / Guyana	4.75	9.78	2.23	639.14	56.61
South America / Peru	211.01	16.41	9.33	14.44	31.67
South America / Paraguay	39.00	55.35	3.69	59.83	43.64
South America / Suriname	3.59	3.39	2.15	65.50	-87.53
South America / Uruguay*	65.01	33.38	6.52	29.84	48.92
South America / Venezuela	115.89	7.74	1.21	-82.74	-92.73
Central America / Belize	2.27	15.02	5.92	-39.54	18.72
Central America / Costa Rica	60.52	26.57	9.10	58.15	76.44
Central America / Guatemala	71.65	37.54	12.71	5.00	11.95
Central America / Honduras	23.14	22.57	8.50	13.81	10.47
Central America / Nicaragua	13.79	28.79	6.16	55.22	26.26
Central America / Panama	64.33	51.43	16.56	-57.35	-78.46
Central America / El Salvador	24.98	46.34	11.79	37.23	-13.05

Note: Predefined geographic selection of 19 economies; *Chile and Uruguay are descriptive high-income benchmarks outside the main emerging-economy sample. Regional orientation and RCA: 2015–2017; RCA≥1 is expressed as a proportion of valid products. Export changes compare annual averages for 2019–2024 and 2015–2017 in nominal value. A positive value indicates a higher post-episode average, not a tariff effect. Countries are not weighted, and no regional counterfactual is constructed.*

Source: Author's calculations using BACI and World Bank data.

New instances of export presence require absence in 2015–2017 and some positive exports in 2018–2024. This window differs from that used for trade and share changes, whose post-episode period is 2019–2024.

B. Specifications and Model Architecture

Table 3 presents the questions; Table B1 documents the sample and numerical convergence of the eleven models. C denotes country-product + country-year effects; B denotes country-product + product-year effects. M6 adds D×size×integration to M5. B6 adds that interaction and Post×size×integration to B5. Identifiable lower-order terms are retained, as shown by the equations in the main text.

Table B1. Sample and convergence of the main models

Model	Fixed effects	Observations	Countries	Products	Eligible	Removed	Converged
M1	C	2482058	137	5182	9332388	6850330	Yes
M2	C	2482058	137	5182	9327006	6844948	Yes
M3	C	2479753	134	5182	9129510	6649757	Yes
M4	C	2482058	137	5182	9332388	6850330	Yes
M5	C	2479753	134	5182	9124245	6644492	Yes
M6	C	2479753	134	5182	9124245	6644492	Yes
B2	B	2469500	137	5182	9327006	6857506	Yes
B3	B	2467173	134	5182	9129510	6662337	Yes
B4	B	2469500	137	5182	9332388	6862888	Yes
B5	B	2467173	134	5182	9124245	6657072	Yes
B6	B	2467173	134	5182	9124245	6657072	Yes

Note: C includes country-product and country-year fixed effects; B includes country-product and product-year effects. Outcome: value in thousands of current USD, 2012–2024. N denotes observations used; removals correspond to all-zero groups. Convergence establishes neither causal identification nor the exhaustive absence of separation.

Source: Author's calculations.

C. Inference and Pre-trends

Inference uses adjustments for the number of clusters, G/(G−1), without an additional adjustment for the number of parameters, and t intervals. Two-way clustering uses the minimum number of clusters for its adjustment and degrees-of-freedom conventions. A joint test requires the full restriction block; a scalar contrast is assessed through its projected variance L′VL. The full matrix, active block, and projected block are distinguished. P-values for invalid contrasts are not obtained through spectral repair.

The joint test of integration leads under B also rejects in the valid two-way alternative; under C, that block is invalid. Size presents a different combination: the B lead block is invalid under two-way clustering, whereas the C block is valid. This distinction prevents inferring the validity of one contrast from another. Diagnostics are presented in Table C1.

M5 starts with 9,124,245 covariate-eligible rows and removes 6,644,492 belonging to groups with an all-zero outcome. The 208,143 ineligible records are counted separately. Zeros still account for 56.36% of the estimation sample. Zeros are not manually removed to obtain convergence; Table B1 reports rows used and removed by equation. Removal is not interpreted as an error to be corrected by excluding small countries.

For the linear presence model, predictions outside the unit interval reach 38.77% in the joint C equation and 39.48% in B. They are not truncated. Existing relationships require a positive sum of exports to the United States in 2015–2017 and retain subsequent zeros where applicable. This selection on prior activity changes support and does not turn the model into a causal effect on the intensive margin.

Table C1 jointly tests the five pre-episode years 2012–2016, with 2017 omitted. The null hypothesis is that their coefficients are jointly zero. A small p-value indicates incompatibility with that restriction; it does not by itself identify the economic source of the divergence.

Table C1. Joint pre-trend tests and validity

Family / fixed effects	Clustering	Joint p	df1	df2	Full matrix PSD	Valid block	Observations	Countries	Products
Average (C)	Country	0.00099	5	136	Yes	Yes	2482058	137	5182
Average (C)	Product	0.28110	5	5181	Yes	Yes	2482058	137	5182
Average (C)	Two-way	1.23e-05	5	136	No	Yes	2482058	137	5182
Average excluding 2018 (C)	Country	0.00087	5	136	Yes	Yes	2243444	137	5182
Average excluding 2018 (C)	Product	0.28115	5	5181	Yes	Yes	2243444	137	5182
Average excluding 2018 (C)	Two-way	9.22e-06	5	136	No	Yes	2243444	137	5182
Integration (C)	Country	1.34e-09	5	136	Yes	Yes	2482058	137	5182
Integration (C)	Product	0.10215	5	5181	Yes	Yes	2482058	137	5182
Integration (C)	Two-way	Invalid	5	136	No	No	2482058	137	5182
Specialization (C)	Country	0.24420	5	136	Yes	Yes	2482058	137	5182
Specialization (C)	Product	0.36363	5	5181	Yes	Yes	2482058	137	5182
Specialization (C)	Two-way	0.20167	5	136	No	Yes	2482058	137	5182
Size (C)	Country	0.04632	5	133	Yes	Yes	2479753	134	5182
Size (C)	Product	0.00020	5	5181	Yes	Yes	2479753	134	5182
Size (C)	Two-way	0.00832	5	133	No	Yes	2479753	134	5182
Integration (B)	Country	0.02138	5	136	Yes	Yes	2469500	137	5182
Integration (B)	Product	0.34572	5	5181	Yes	Yes	2469500	137	5182
Integration (B)	Two-way	5.25e-13	5	136	No	Yes	2469500	137	5182
Specialization (B)	Country	0.48856	5	136	Yes	Yes	2469500	137	5182
Specialization (B)	Product	0.65727	5	5181	Yes	Yes	2469500	137	5182
Specialization (B)	Two-way	0.62543	5	136	No	Yes	2469500	137	5182

Family / fixed effects	Clustering	Joint p	df1	df2	Full matrix PSD	Valid block	Observations	Countries	Products
Size (B)	Country	0.15655	5	133	Yes	Yes	2467173	134	5182
Size (B)	Product	0.02600	5	5181	Yes	Yes	2467173	134	5182
Size (B)	Two-way	Invalid	5	133	No	No	2467173	134	5182

Note: “Average” denotes the average contrast; “excluding 2018” excludes the episode's initial year. Integration refers to regional orientation. df1 and df2 are the degrees of freedom of the F test; PSD denotes a positive semidefinite matrix. The full matrix and the test block are distinct objects: a non-PSD full matrix does not automatically invalidate every block. P-values for invalid blocks are suppressed without repairs. All these estimations record convergence.

Source: Author's calculations.

Table C2 allows the magnitude of each pre-episode difference to be assessed alongside the joint test.

Table C2. Annual pre-episode coefficients and uncertainty

Fixed effects	Characteristic	Year	Coefficient	SE product	95% CI product	SE country	95% CI country
C	RCA	2012	-0.00039	0.00064	[-0.00165; 0.00087]	0.00062	[-0.00162; 0.00084]
C	RCA	2013	-0.00023	0.00043	[-0.00108; 0.00061]	0.00039	[-0.00100; 0.00053]
C	RCA	2014	0.00029	0.00026	[-0.00022; 0.00080]	0.00026	[-0.00024; 0.00081]
C	RCA	2015	-5.14e-05	0.00011	[-0.00026; 0.00016]	0.00012	[-0.00028; 0.00018]
C	RCA	2016	-3.82e-05	6.35e-05	[-0.00016; 8.63e-05]	6.92e-05	[-0.00017; 9.86e-05]
C	Size	2012	-0.09226	0.03704	[-0.16487; -0.01964]	0.04560	[-0.18245; -0.00206]
C	Size	2013	-0.07981	0.03066	[-0.13991; -0.01971]	0.04433	[-0.16749; 0.00787]
C	Size	2014	-0.03426	0.03322	[-0.09938; 0.03086]	0.02687	[-0.08741; 0.01889]
C	Size	2015	0.02505	0.01964	[-0.01344; 0.06355]	0.02083	[-0.01614; 0.06624]
C	Size	2016	-0.00925	0.01342	[-0.03555; 0.01705]	0.01866	[-0.04616; 0.02766]
C	Integration	2012	-0.45493	0.25618	[-0.95716; 0.04730]	0.31674	[-1.08131; 0.17145]
C	Integration	2013	-0.42556	0.20265	[-0.82283; -0.02828]	0.30534	[-1.02938; 0.17827]
C	Integration	2014	0.06970	0.27254	[-0.46459; 0.60399]	0.15994	[-0.24660; 0.38599]
C	Integration	2015	-0.05320	0.11603	[-0.28066; 0.17426]	0.10314	[-0.25716; 0.15076]
C	Integration	2016	0.02787	0.07152	[-0.11234; 0.16807]	0.09927	[-0.16845; 0.22418]
B	RCA	2012	-0.00017	0.00026	[-0.00068; 0.00034]	0.00023	[-0.00062; 0.00029]
B	RCA	2013	-0.00023	0.00014	[-0.00051; 5.32e-05]	0.00014	[-0.00050; 4.68e-05]

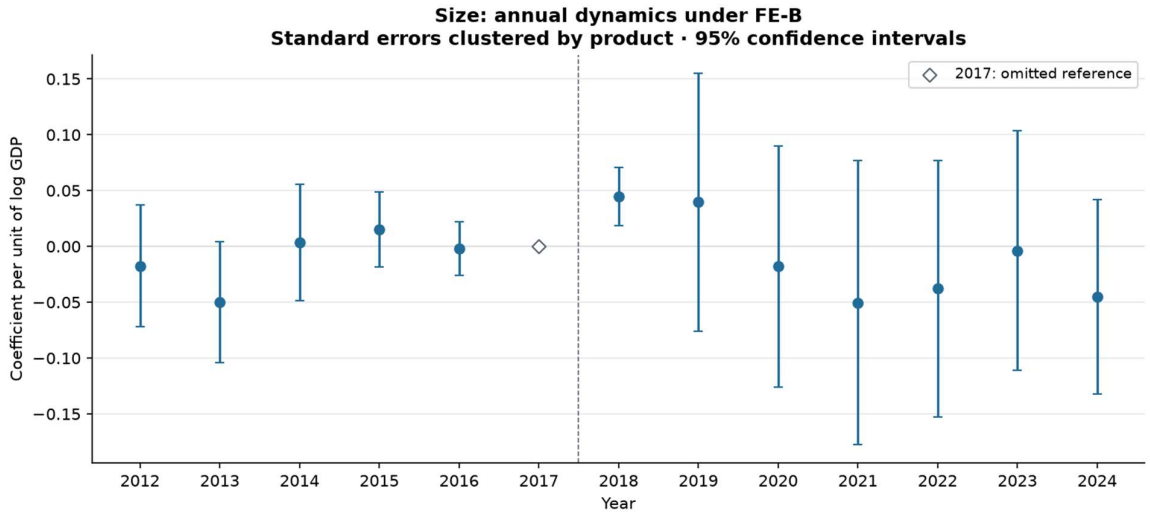
Fixed effects	Characteristic	Year	Coefficient	SE product	95% CI product	SE country	95% CI country
B	RCA	2014	-0.00020	0.00014	[-0.00048; 7.91e-05]	0.00012	[-0.00044; 4.15e-05]
B	RCA	2015	-0.00015	0.00013	[-0.00041; 9.64e-05]	0.00012	[-0.00039; 8.1e-05]
B	RCA	2016	-0.00013	0.00015	[-0.00043; 0.00017]	0.00011	[-0.00036; 9.51e-05]
B	Size	2012	-0.01762	0.02776	[-0.07204; 0.03681]	0.04360	[-0.10385; 0.06862]
B	Size	2013	-0.05006	0.02752	[-0.10402; 0.00389]	0.04839	[-0.14577; 0.04564]
B	Size	2014	0.00342	0.02668	[-0.04889; 0.05574]	0.03647	[-0.06871; 0.07556]
B	Size	2015	0.01512	0.01700	[-0.01822; 0.04846]	0.02964	[-0.04351; 0.07375]
B	Size	2016	-0.00204	0.01213	[-0.02582; 0.02174]	0.01739	[-0.03644; 0.03236]
B	Integration	2012	-0.61958	0.31544	[-1.23799; -0.00118]	0.28833	[-1.18977; -0.04939]
B	Integration	2013	-0.60443	0.32437	[-1.24033; 0.03148]	0.30404	[-1.20568; -0.00318]
B	Integration	2014	0.01456	0.20236	[-0.38216; 0.41128]	0.14331	[-0.26885; 0.29797]
B	Integration	2015	-0.03831	0.11680	[-0.26728; 0.19066]	0.10197	[-0.23995; 0.16334]
B	Integration	2016	-0.01097	0.08596	[-0.17949; 0.15755]	0.07242	[-0.15419; 0.13225]

Note: Coefficients of the log index per unit of a characteristic; these are neither percentages nor differences between the 75th and 25th percentiles of a characteristic. SE: standard error. Intervals are 95% confidence intervals; the reference year is 2017. Samples and joint tests are in Table C1.

Source: Author's calculations.

Figure C1 illustrates size pre-trends with country-product and product-year fixed effects.

Figure C1. Size pre-trends, country-product and product-year fixed effects.



Source: Author's calculations. Table C1 documents evidence of pre-episode differences and the invalidity of the joint two-way-clustered test for size with country-product and product-year fixed effects.

D. Compensation and Profiles

Table D1 compares compensation across the planned checks.

Table D1. Compensation: C3 contrast and uncertainty.

Robustness check	Model	Fixed effects	C3 log	CI product	CI country
Baseline	M6	C	0.2140	[-0.0824; 0.5104]	[-0.4963; 0.9244]
Baseline	B6	B	-0.0276	[-0.5206; 0.4654]	[-0.5749; 0.5198]
Clean mapping	M6	C	0.1571	[-0.1412; 0.4554]	[-0.5812; 0.8954]
Clean mapping	B6	B	0.0268	[-0.4589; 0.5125]	[-0.5923; 0.6459]
Excluding 2018	M6	C	0.2276	[-0.1007; 0.5560]	[-0.5655; 1.0207]
Excluding 2018	B6	B	-0.0257	[-0.5823; 0.5309]	[-0.6298; 0.5784]
Excluding 2020–2021	M6	C	0.3059	[-0.0184; 0.6303]	[-0.4202; 1.0320]
Excluding 2020–2021	B6	B	-0.0530	[-0.6025; 0.4966]	[-0.5715; 0.4656]
All 206	M6	C	0.0872	[-0.2140; 0.3884]	[-0.3717; 0.5461]
All 206	B6	B	0.2538	[-0.0140; 0.5216]	[-0.1666; 0.6742]
Lower bound	M6	C	0.2141	[-0.0829; 0.5111]	[-0.4997; 0.9279]
Lower bound	B6	B	-0.0274	[-0.5261; 0.4712]	[-0.5790; 0.5241]
Upper bound	M6	C	0.2107	[-0.0862; 0.5075]	[-0.4960; 0.9174]
Upper bound	B6	B	-0.0370	[-0.5344; 0.4604]	[-0.5969; 0.5229]

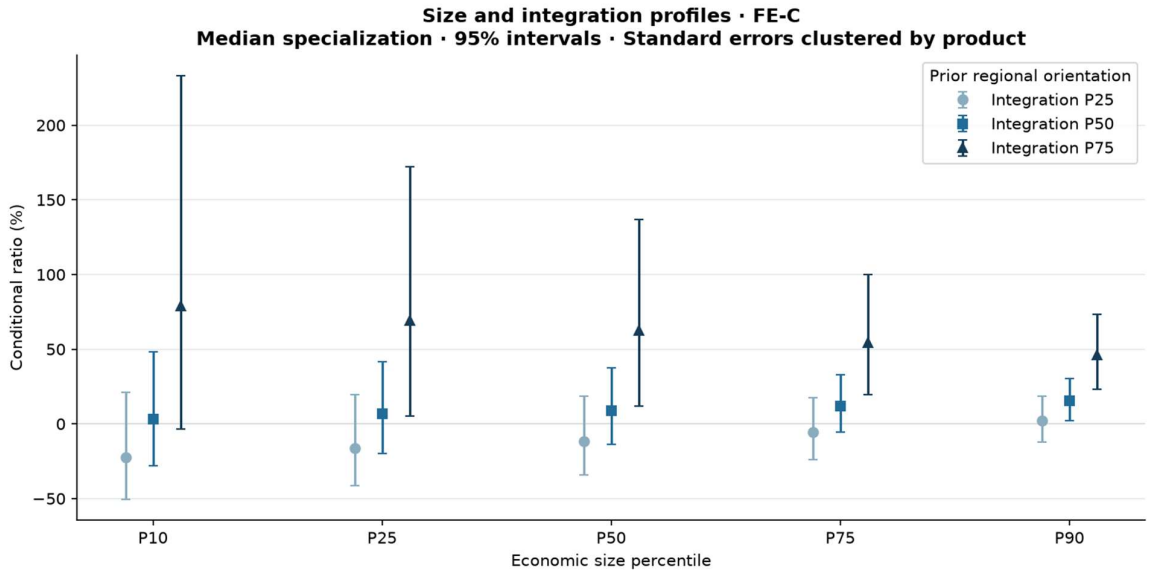
Note: C3 is in log units, with 95% confidence intervals and the main model's reference percentiles. It compares the P75–P25 integration difference at size P25 minus the same difference at size P75. Reference values are s_L=22.5937, s_H=25.0016, g_L=0.14505, and g_H=0.64721. All intervals shown include zero.

Source: Author's calculations.

The M6/B6 profile assessment comprises 25 predefined combinations and identifies nodes with weak support. Figures D1 and D2 present the 15 combinations of size P10, P25, P50, P75, and P90 and integration

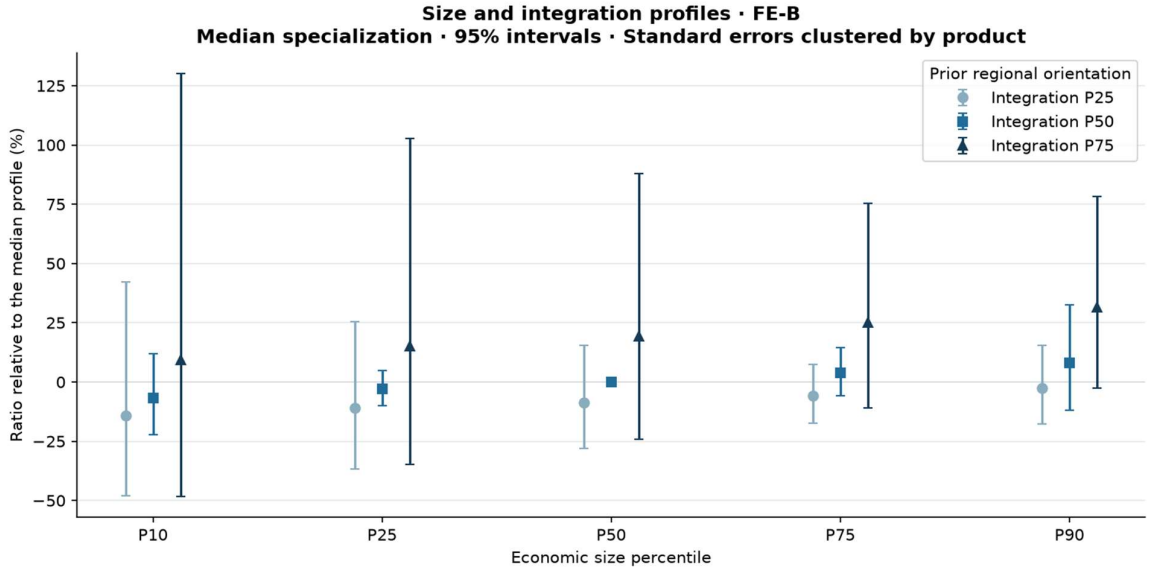
P25, P50, and P75, with specialization at its median. Each structure has one weak node under the neighborhood and convex-hull rule fixed before interpretation. Figure D1 shows the total conditional contrast with country-product and country-year fixed effects, whereas Figure D2 shows a profile relative to the median point with country-product and product-year fixed effects: the common level is absorbed. Normalization of the B profile occurs after estimation and does not imply centered regressors. Weakly supported regions are not connected as though they were uniformly supported evidence.

Figure D1. Size-integration profiles, country-product and country-year fixed effects.



Source: Author's calculations. Conditional profile; interpret alongside support, covariances, and contrasts C1–C3.

Figure D2. Size-integration profiles, country-product and product-year fixed effects.



Source: Author's calculations. Profile relative to the median reference, with no identified average effect.

Table D2 complements the intervals in Table D1 with standard errors, p-values, and the sample.

Table D2. Precision and sample for C3

Robustness check	Model	SE product	p product	SE country	p country	Observations	Countries	Products
Baseline	M6	0.15119	0.15694	0.35913	0.55222	2479753	134	5182
Baseline	B6	0.25147	0.91262	0.27673	0.92072	2467173	134	5182
Clean mapping	M6	0.15216	0.30202	0.37326	0.67459	2252607	134	4802
Clean mapping	B6	0.24776	0.91380	0.31299	0.93184	2242060	134	4802
Excluding 2018	M6	0.16749	0.17421	0.40098	0.57123	2241508	134	5182
Excluding 2018	B6	0.28393	0.92790	0.30543	0.93309	2230245	134	5182
Excluding 2020-2021	M6	0.16546	0.06453	0.36709	0.40614	2001416	134	5179
Excluding 2020-2021	B6	0.28032	0.85015	0.26216	0.84021	1991610	134	5179
Universe of 206 countries	M6	0.15364	0.57048	0.23269	0.70834	4718041	198	5199
Universe of 206 countries	B6	0.13660	0.06321	0.21318	0.23525	4711019	198	5199
Lower bound	M6	0.15149	0.15760	0.36087	0.55396	2479753	134	5182
Lower bound	B6	0.25437	0.91408	0.27884	0.92174	2467173	134	5182
Upper bound	M6	0.15141	0.16416	0.35729	0.55644	2479753	134	5182
Upper bound	B6	0.25373	0.88408	0.28307	0.89622	2467173	134	5182

Note: SE denotes standard error; p is the test's p-value. C3 and standard errors are in log units. The test is of C3=0; a positive value indicates a larger integration difference for the smaller-size profile. M6 includes country-product and country-year fixed effects; B6 includes country-product and product-year effects. Reference percentiles and results are in Table D1.

Source: Author's calculations.

E. Additional Robustness and Inference Results

Table E1 supplements Table 4. Table E2 reports inference for the 23 integration comparisons in Table 5, including two-way clustering when valid. Table E3 documents their samples and convergence.

Table E1. Main contrasts: log scale and p-values

Model	Estimated comparison	Log difference	p product	p country	Countries	Products
M1	Average exposure	0.137551	0.01885	0.15591	137	5182
M2	Specialization P75–P25	-7.87e-06	0.94031	0.94833	137	5182

Model	Estimated comparison	Log difference	p product	p country	Countries	Products
M3	Size P75–P25	-0.022966	0.72920	0.89738	134	5182
M4	Integration P75–P25	0.280427	0.00503	0.09502	137	5182
M5	Specialization P75–P25	2.99e-05	0.80913	0.83516	134	5182
M5	Size P75–P25	0.077368	0.25838	0.66862	134	5182
M5	Integration P75–P25	0.299022	0.00208	0.04054	134	5182
B2	Specialization P75–P25	-3.55e-05	0.78314	0.71242	137	5182
B3	Size P75–P25	-0.005429	0.96547	0.96583	134	5182
B4	Integration P75–P25	0.301451	0.00133	0.04111	137	5182
B5	Specialization P75–P25	1.94e-05	0.86408	0.87657	134	5182
B5	Size P75–P25	0.097499	0.41219	0.52973	134	5182
B5	Integration P75–P25	0.325889	0.00182	0.04131	134	5182

Note: Fixed effects, observations, standard errors, and intervals are in Table 4; these report the same contrast, not additional tests. p tests zero on the log scale.

Source: Author's calculations.

Table E2. Integration: contrasts and supplementary inference

Robustness check	Model	Clustering	Scale	Estimated comparison	SE	95% CI	p	Valid
Baseline	M5	Product	log mean	0.299022	0.097080	[0.108704; 0.489340]	0.00208	Yes
Baseline	M5	Country	log mean	0.299022	0.144569	[0.013071; 0.584973]	0.04054	Yes
Baseline	M5	Two-way	log mean	0.299022	0.140646	[0.020830; 0.577214]	0.03535	Yes
Baseline	B5	Product	log mean	0.325889	0.104471	[0.121082; 0.530696]	0.00182	Yes
Baseline	B5	Country	log mean	0.325889	0.158165	[0.013045; 0.638733]	0.04131	Yes
Baseline	B5	Two-way	log mean	0.325889	0.114786	[0.098847; 0.552932]	0.00523	Yes
Clean mapping	M5	Product	log mean	0.284855	0.102164	[0.084566; 0.485144]	0.00532	Yes
Clean mapping	M5	Country	log mean	0.284855	0.142604	[0.002789; 0.566921]	0.04781	Yes
Clean mapping	M5	Two-way	log mean	0.284855	0.138601	[0.010707; 0.559003]	0.04182	Yes
Clean mapping	B5	Product	log mean	0.321595	0.110052	[0.105843; 0.537348]	0.00349	Yes
Clean mapping	B5	Country	log mean	0.321595	0.151239	[0.022450; 0.620741]	0.03532	Yes
Clean mapping	B5	Two-way	log mean	0.321595	0.107752	[0.108466; 0.534725]	0.00338	Yes

Robustness check	Model	Clustering	Scale	Estimated comparison	SE	95% CI	p	Valid
Excluding 2018	M5	Product	log mean	0.328052	0.106220	[0.119816; 0.536287]	0.00202	Yes
Excluding 2018	M5	Country	log mean	0.328052	0.160553	[0.010484; 0.645619]	0.04300	Yes
Excluding 2018	M5	Two-way	log mean	0.328052	0.155908	[0.019671; 0.636432]	0.03725	Yes
Excluding 2018	B5	Product	log mean	0.359338	0.116381	[0.131181; 0.587495]	0.00203	Yes
Excluding 2018	B5	Country	log mean	0.359338	0.173304	[0.016549; 0.702127]	0.04006	Yes
Excluding 2018	B5	Two-way	log mean	0.359338	0.124762	[0.112564; 0.606112]	0.00463	Yes
Excluding 2020-2021	M5	Product	log mean	0.260212	0.102290	[0.059680; 0.460744]	0.01099	Yes
Excluding 2020-2021	M5	Country	log mean	0.260212	0.145588	[-0.027755; 0.548179]	0.07616	Yes
Excluding 2020-2021	M5	Two-way	log mean	0.260212	0.140829	[-0.018342; 0.538767]	0.06687	Yes
Excluding 2020-2021	B5	Product	log mean	0.341600	0.114699	[0.116742; 0.566457]	0.00291	Yes
Excluding 2020-2021	B5	Country	log mean	0.341600	0.161142	[0.022867; 0.660333]	0.03587	Yes
Excluding 2020-2021	B5	Two-way	log mean	0.341600	0.114415	[0.115291; 0.567908]	0.00337	Yes
Universe of 206 countries	M5	Product	log mean	-0.112066	0.126159	[-0.359390; 0.135259]	0.37443	Yes
Universe of 206 countries	M5	Country	log mean	-0.112066	0.101210	[-0.311660; 0.087529]	0.26953	Yes
Universe of 206 countries	M5	Two-way	log mean	-0.112066	0.145082	[-0.398178; 0.174047]	0.44078	Yes
Universe of 206 countries	B5	Product	log mean	0.134045	0.161979	[-0.183502; 0.451592]	0.40797	Yes
Universe of 206 countries	B5	Country	log mean	0.134045	0.111580	[-0.086000; 0.354090]	0.23106	Yes
Universe of 206 countries	B5	Two-way	log mean	0.134045	0.162043	[-0.185515; 0.453606]	0.40911	Yes
Lower bound	M5	Product	log mean	0.305661	0.098362	[0.112831; 0.498492]	0.00190	Yes
Lower bound	M5	Country	log mean	0.305661	0.146824	[0.015248; 0.596074]	0.03928	Yes
Lower bound	M5	Two-way	log mean	0.305661	0.142593	[0.023618; 0.587705]	0.03389	Yes
Lower bound	B5	Product	log mean	0.333905	0.106374	[0.125367; 0.542444]	0.00170	Yes
Lower bound	B5	Country	log mean	0.333905	0.160831	[0.015788; 0.652023]	0.03981	Yes
Lower bound	B5	Two-way	log mean	0.333905	0.116249	[0.103969; 0.563842]	0.00474	Yes
Upper bound	M5	Product	log mean	0.297302	0.096741	[0.107649; 0.486955]	0.00213	Yes
Upper bound	M5	Country	log mean	0.297302	0.142725	[0.014997; 0.579607]	0.03916	Yes
Upper bound	M5	Two-way	log mean	0.297302	0.139124	[0.022119; 0.572484]	0.03443	Yes

Robustness check	Model	Clustering	Scale	Estimated comparison	SE	95% CI	p	Valid
Upper bound	B5	Product	log mean	0.322324	0.103462	[0.119494; 0.525154]	0.00185	Yes
Upper bound	B5	Country	log mean	0.322324	0.157492	[0.010811; 0.633837]	0.04267	Yes
Upper bound	B5	Two-way	log mean	0.322324	0.112603	[0.099600; 0.545048]	0.00488	Yes
Existing relationships	M5	Product	log mean	0.310750	0.096948	[0.120690; 0.500810]	0.00136	Yes
Existing relationships	M5	Country	log mean	0.310750	0.142062	[0.029758; 0.591743]	0.03046	Yes
Existing relationships	M5	Two-way	log mean	0.310750	0.137897	[0.037995; 0.583506]	0.02586	Yes
Excluding the top five	M5	Product	log mean	0.619920	0.127390	[0.370180; 0.869659]	1.17e-06	Yes
Excluding the top five	M5	Country	log mean	0.619920	0.201911	[0.220404; 1.019435]	0.00261	Yes
Excluding the top five	M5	Two-way	log mean	0.619920	0.188042	[0.247846; 0.991993]	0.00127	Yes
Excluding the top five	B5	Product	log mean	0.615487	0.170318	[0.281591; 0.949383]	0.00030	Yes
Excluding the top five	B5	Country	log mean	0.615487	0.179642	[0.260035; 0.970939]	0.00082	Yes
Excluding the top five	B5	Two-way	log mean	0.615487	0.132690	[0.352938; 0.878036]	8.55e-06	Yes
log(1+value)	M5	Product	log(1+value)	0.002109	0.003031	[-0.003833; 0.008051]	0.48650	Yes
log(1+value)	M5	Country	log(1+value)	0.002109	0.009287	[-0.016258; 0.020477]	0.82067	Yes
log(1+value)	M5	Two-way	log(1+value)	0.002109	0.009426	[-0.016534; 0.020753]	0.82327	Yes
log(1+value)	B5	Product	log(1+value)	0.002095	0.003031	[-0.003846; 0.008037]	0.48938	Yes
log(1+value)	B5	Country	log(1+value)	0.002095	0.009287	[-0.016273; 0.020463]	0.82184	Yes
log(1+value)	B5	Two-way	log(1+value)	0.002095	0.009428	[-0.016553; 0.020743]	0.82447	Yes
Presence (linear model)	M5	Product	probability	-0.000750	0.000671	[-0.002065; 0.000565]	0.26338	Yes
Presence (linear model)	M5	Country	probability	-0.000750	0.001851	[-0.004411; 0.002911]	0.68587	Yes
Presence (linear model)	M5	Two-way	probability	-0.000750	0.001876	[-0.004460; 0.002960]	0.68978	Yes
Presence (linear model)	B5	Product	probability	-0.000752	0.000671	[-0.002067; 0.000563]	0.26236	Yes
Presence (linear model)	B5	Country	probability	-0.000752	0.001851	[-0.004413; 0.002909]	0.68525	Yes
Presence (linear model)	B5	Two-way	probability	-0.000752	0.001875	[-0.004461; 0.002957]	0.68911	Yes
Product-country integration	M4	Product	log mean	0.209249	0.119474	[-0.024970; 0.443468]	0.07993	Yes
Product-country integration	M4	Country	log mean	0.209249	0.259427	[-0.303783; 0.722281]	0.42132	Yes
Product-country integration	M4	Two-way	log mean	0.209249	0.246090	[-0.277409; 0.695907]	0.39666	Yes

Robustness check	Model	Clustering	Scale	Estimated comparison	SE	95% CI	p	Valid
Product-country integration	B4	Product	log mean	0.334657	0.180521	[-0.019240; 0.688554]	0.06382	Yes
Product-country integration	B4	Country	log mean	0.334657	0.256288	[-0.172169; 0.841483]	0.19383	Yes
Product-country integration	B4	Two-way	log mean	0.334657	0.227248	[-0.114740; 0.784054]	0.14316	Yes

Note: SE denotes standard error; 95% CI is the 95% confidence interval; p is the p-value. P75–P25 difference in regional integration, with other characteristics at their reference values. PPML is on the log scale; Table 5 converts it to percent. log(1+value) retains its own unit; LPM here is in probability units, whereas Table 5 reports percentage points. Estimands are not interchangeable. Invalid intervals are not repaired.

Source: Author's calculations.

Table E3. Samples and numerical convergence of the integration comparisons

Robustness check	Model	Fixed effects	Estimator	Observations	Countries	Products	Converged
Baseline	M5	C	PPML	2479753	134	5182	Yes
Baseline	B5	B	PPML	2467173	134	5182	Yes
Clean mapping	M5	C	PPML	2252607	134	4802	Yes
Clean mapping	B5	B	PPML	2242060	134	4802	Yes
Excluding 2018	M5	C	PPML	2241508	134	5182	Yes
Excluding 2018	B5	B	PPML	2230245	134	5182	Yes
Excluding 2020-2021	M5	C	PPML	2001416	134	5179	Yes
Excluding 2020-2021	B5	B	PPML	1991610	134	5179	Yes
Universe of 206 countries	M5	C	PPML	4718041	198	5199	Yes
Universe of 206 countries	B5	B	PPML	4711019	198	5199	Yes
Lower bound	M5	C	PPML	2479753	134	5182	Yes
Lower bound	B5	B	PPML	2467173	134	5182	Yes
Upper bound	M5	C	PPML	2479753	134	5182	Yes
Upper bound	B5	B	PPML	2467173	134	5182	Yes
Existing relationships	M5	C	PPML	1540894	134	5124	Yes
Excluding the top five	M5	C	PPML	2190542	129	5142	Yes
Excluding the top five	B5	B	PPML	2167995	129	5142	Yes
log(1+value)	M5	C	log(1+value)	9124245	135	5199	Yes

Robustness check	Model	Fixed effects	Estimator	Observations	Countries	Products	Converged
log(1+value)	B5	B	log(1+value)	9124245	135	5199	Yes
Presence (linear model)	M5	C	LPM	9124245	135	5199	Yes
Presence (linear model)	B5	B	LPM	9124245	135	5199	Yes
Product-country integration	M4	C	PPML	2370379	137	5172	Yes
Product-country integration	B4	B	PPML	2358957	137	5172	Yes

Note: Observations used in each check, not the conceptual universe. C includes country-product and country-year fixed effects; B includes country-product and product-year effects. LPM is the linear probability model. Windows: 2012–2024 unless explicitly excluded. Existing relationships select positive activity in 2015–2017 and retain subsequent zeros. Convergence indicates a numerical solution, not causality. No unreported R^2 is added.

Source: Author's calculations; see also Table 5.