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Fighting Global Warming: Is Trade Policy in Latin America and the Caribbean a Help or a Hindrance? - Technical Appendix

Marcelo Dolabella
Mauricio Mesquita Moreira

Inter-American Development Bank
Integration and Trade Sector

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TECHNICAL APPENDIX

Marcelo Dolabella
Mauricio Mesquita Moreira

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Fighting Global Warming: Is Trade Policy in Latin America and the Caribbean a Help or a Hindrance? - Technical Appendix

Marcelo Dolabella Mauricio Mesquita Moreira

Abstract

Online Technical Appendix to "Fighting Global Warming: Is Trade Policy in Latin America and the Caribbean a Help or a Hindrance?" It describes in more detail the data sources, the empirical strategy; and presents a series of robustness checks.

Keywords: Trade Policy, International Trade, Climate Change, Latin America and the Caribbean.
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Appendix A: Data Sources and Empirical Methods

A.1 Data sources

We rely on several databases. The data source for our main results is the GTAP-MRIO for 2014, the latest available year in the GTAP 10 release (Aguiar et al., 2019). The GTAP data covers 147 countries/regions across 65 industries, 45 of which are nonservice sectors. The following datasets were used to assemble the MRIO: Intermediates—Firms' Domestic Purchases at Market Prices (VDFM); Intermediates—Firms' Import Purchases at World Prices (VIFW); Household Domestic Purchases at Market Prices (VDPM); Government Domestic Purchases at Market Prices (VDGM); Household Import Purchases at World Prices (VIPW); Government Import Purchases at World Prices (VIGW); Margins on International Trade (VTWR); Protection—Ordinary Export Subsidy (XTRV); and Value of Output at Market Prices (VOM).

Miller and Blair (2009: 146) argue that most input–output studies value the entries in input–output accounts (and subsequently in the transactions matrix) in producers' prices, that is, the prices at which the seller completes the transaction (sometimes called free-on-board or FOB prices). However, the GTAP's valuation of imports (VIFW, VIPW, and VIGW) is at CIF prices and thus includes international transportation margins and export taxes/subsidies. The convention in most input–output studies is to assign the margins on all interindustry transactions in a column to the industry responsible for the margin (Miller and Blair, 2009). Therefore, we first remove international transportation margins and export taxes/subsidies from imports by using a proportionality assumption. Secondly, we follow Peters et al. (2011a) and assign them to countries supplying international transportation services based on their share of the global international transportation supply.[1]

The emission intensities for greenhouse gases (GHGs) were mainly calculated using the IO tables from the GTAP 10 database. The satellite accounts for non-CO_2 emissions are described by Chepeliev (2020). The data on GHG emissions was retrieved from the following datasets: emissions from intermediate usage of domestic product, Mt CO_2 (MDF); emissions from intermediate usage of imports, Mt CO_2 (MIF); emissions associated with output in 2014, mil tCO_2e. (NCQO); emissions associated with endowment in 2014, mil tCO_2e (NCQE); emissions associated with intermediate use of fossil fuels in 2014, mil t CO_2e (NQFF); and emissions associated with intermediate use of non-fossil fuels in 2014, mil tCO_2e (NQFX).

To assess the robustness of our results, we also calculated emission intensities using Exiobase3, version 3.8.1, industry-by-industry, fixed product sales assumption (Stadler et al., 2018, 2021). Exiobase3 covers 44 countries plus 5 aggregated regions across 163 industries, 78 of which are nonservice sectors with links to tariff data. The only LAC countries available are Brazil, Mexico, and an aggregated "Rest of America" region, which basically comprises the remaining LAC countries. Values are reported in current (2014) Euros. We transform these values to current US

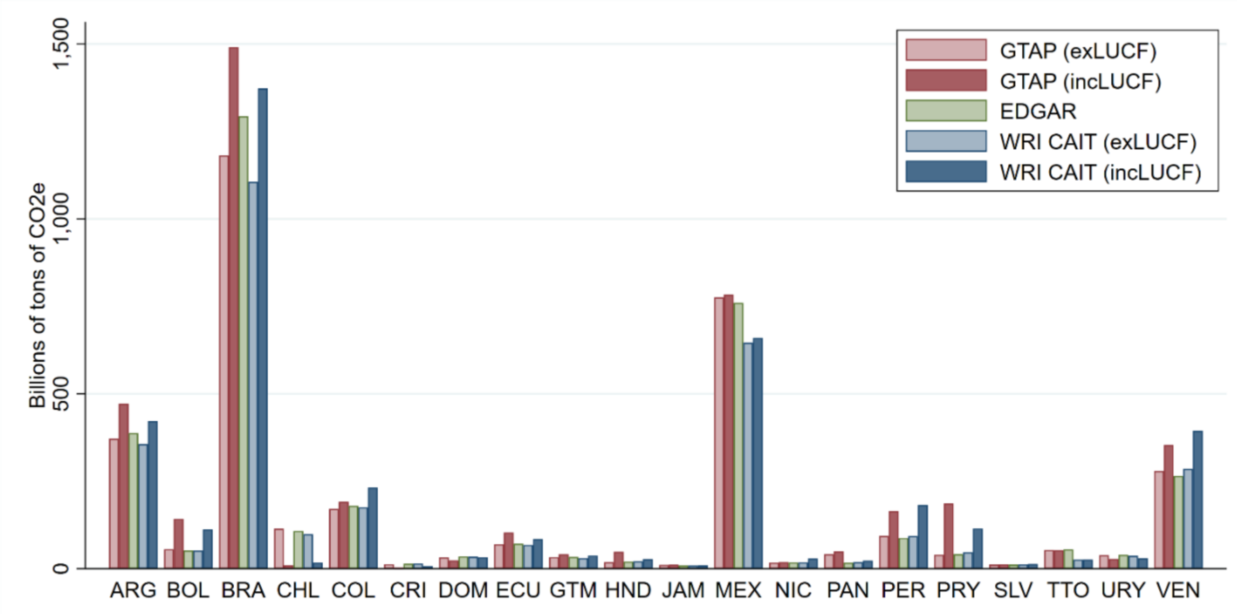
[1] For more details on how this assignment was performed, see Peters et al. (2011a), section 3.2: "MRIOT with an Endogenous International Transportation Pool."

dollars using the average nominal exchange rate for 2014, retrieved from the International Monetary Fund's International Financial Statistics dataset.

Applied and most-favored-nation (MFN) tariffs at the Harmonized System (HS) 6-digit level are from CESIFO-World Bank (Teti, 2020). The tariffs associated with LAC preferential trade agreements (preferential rates) were complemented and revised by drawing on the IDB INTrade database. International trade data for 2014 and 2019, also at the HS 6-digit level, is from the 2021 BACI (Gaulier and Zignago, 2010). Emission intensities from international freight transportation were retrieved from Li (2021). GDP in current US dollars for 2019 was retrieved from the World Bank.

A comparison of total global GHG emissions from different databases is displayed for descriptive purposes below. To compare aggregate emissions, we used EDGAR v6.0 (Crippa et al., 2021) and the Climate Analysis Indicators Tool (CAIT) from the World Resource Institute.

Figure A1. Comparison of Global Emission by Greenhouse Gas Type. Selected LAC Countries, 2014.



Source: Authors' calculations with data from 2014 GTAP-10 MRIO, CAIT, and EDGAR v6.0. Emissions from international shipping and aviation were removed from EDGAR data. Fluorinated gas and land use change and forestry (LUCF) emissions were not available for EDGAR.

A.2 Emission intensities from production—input-output methodology

In this section, we briefly present the IO framework developed by Leontief (1936) and show how it can be extended for environmental analysis. For a more detailed explanation, see Miller and Blair (2009, chapter 10), Peters et al. (2011b), Wood (2017), and/or Leontief (1970). We start by describing the model for a single economy and then extend this to multiple countries.

Leontief's model states that gross output, *x*, produced by industry *k* can be divided into what is sold as intermediate inputs to all industries, *Z*, and what is sold for consumption by final demand, *y*. In matrix notation:

$$\mathrm{x}_{(k.1)} = Z_{(k.1)} + \mathrm{y}_{(k.1)} \tag{A.1}$$

where $\mathrm{x}_{(k.1)}$ represents a column vector with the gross output from each industry *k*; $Z_{(k.1)}$, is a column vector of size *k x 1*; and $\mathrm{y}_{(k.1)}$is a column vector representing final demand. Consumption of intermediate inputs by industries can be further decomposed into:

$$Z_{(k.1)} = \mathrm{A}_{(k.k)}\,\mathrm{x}_{(k.1)} \tag{A.2}$$

where $\mathrm{A}_{k.k}$ is the technical coefficient matrix of size *k x k*. For each column, we have the percentage of this sector's output that is spent on inputs from all sectors in the economy. For example, element a_{12} represents the percentage of inputs from industry 1 required by industry 2 as a share of industry 2's gross output, formally: $a_{12} = z_{12}/x_2$. Substituting A.2 in A.1, we arrive at:

$$\mathrm{x}_{(k.1)} = \mathrm{A}_{(k.k)}\,\mathrm{x}_{(k.1)} + \mathrm{y}_{(k.1)} \tag{A.3}$$

$$\mathrm{x}_{(k.1)} - \mathrm{A}_{(k.k)}\,\mathrm{x}_{(k.1)} = \mathrm{y}_{(k.1)} \tag{A.4}$$

$$\mathrm{x}_{(k.1)} = \left(I_{(k.k)} - \mathrm{A}_{(k.k)}\right)^{-1}\mathrm{y}_{(k.1)} \tag{A.5}$$

$$\mathrm{x}_{(k.1)} = L_{(k.k)}\,\mathrm{y}_{(k.1)} \tag{A.6}$$

where $I_{(k.k)}$ is an identity matrix of size *k x k*, and $L_{(k.k)} = \left(I_{(k.k)} - \mathrm{A}_{(k.k)}\right)^{-1}$ is called the Leontief inverse. Each element in this matrix shows the direct and indirect input requirements for producing US$1 of output. For example, element l_{12} is the coefficient of direct and indirect inputs required by sector 1 need to produce US$1 of output by sector 2. This matrix, $L_{(k.k)}$, is central to our analysis, as we want to understand how much GHG is embodied across the whole supply chain.

Data on GHG emissions is found in the satellite accounts for IO tables. Direct emission intensities, $EI_{(1.k)}^{direct}$, are retrieved by dividing the amount of GHGs emitted by sector *k* by this sector's gross output, formally:

$$EI_{(1.k)}^{direct} = F_{(1.k)}\,\hat{\mathrm{x}}_{(k.k)}{}^{-1} \tag{A.7}$$

where $F_{(1.k)}$ is also a row vector with the direct GHG emissions in metric tons of CO_2e by sector *k* and $\hat{\mathrm{x}}_{(k.k)}{}^{-1}$ is a diagonalized matrix with elements representing the inverse of this sector's gross output. Simply put, we are dividing the direct emissions from each sector by its gross output. With this vector in hand, we can premultiply it by the Leontief inverse to get a row vector of the total (direct plus indirect) GHG emissions rate:

$$EI_{(1.k)}^{total} = EI_{(1.k)}^{direct} \, L_{(k.k)} \tag{A.8}$$

This single economy analysis can be extended to a global analysis with *n* countries. Equations A1 to A8 can be replicated, replacing subscript *k* with *nk*. This means that matrices are extended from *k* columns/rows to *n* times *k* columns/rows. In an MRIO setting, equation A.8 can be rewritten as:

$$EI_{(1.nk)}^{total} = EI_{(1.nk)}^{direct} \, L_{(nk.nk)} \tag{A.9}$$

where $L_{(nk.nk)}$ is the global Leontief inverse. The GTAP-10 MRIO comprises 147 countries and over 65 sectors, resulting in a Leontief inverse of almost ten thousand rows and columns (147x65=9,555). Exiobase 3, on the other hand, is slightly smaller, with 49 countries and 163 industries and an $L_{(nk.nk)}$ of 7,987 rows and columns (49x163=7,987). By premultiplying the row vector of direct emission intensities, we obtain the vector of total emission intensities for all countries and industries ($EI_{(1.nk)}^{total}$). This emission intensities vector is employed in the econometric exercise in section 5.

Calculations of emissions associated with international trade and net exports/imports require the vector with direct emission intensities to be diagonalized and then multiplied by the global Leontief inverse and the vector of final demand consumption by country:

$$E_{(nk.n)} = \widehat{EI}_{(nk.nk)}^{direct} \, L_{(nk.nk)} \, \mathrm{y}_{(nk.n)} \tag{A.10}$$

Each element in $E_{(nk.n)}$ represents the amount of GHGs emitted by sector *k* in country *n* (row) in order to meet the final demand requirements of country *n* (column). To obtain a squared matrix of size *n* x *n*, we need to sum the rows of each column for each country, collapsing the sectoral dimension. Formally, this is done by premultiplying the equation above by an aggregation matrix $v_{(n.nk)}$. This matrix can be thought of as an identity matrix of row vectors of size *k*, containing elements of 1.[2] To ensure most emissions are taken into account, we add emissions associated with final demand consumption and obtain the matrix of emissions associated with final demand by country:

$$\mathrm{E}_{(n.n)} = v_{(n.nk)} \, \widehat{EI}_{(nk.nk)}^{direct} \, L_{(nk.nk)} \, \mathrm{y}_{(nk.n)} + \widehat{HC}_{(n.n)} \tag{A.11}$$

As in Peters (2008) and Yamano and Guilhoto (2020), we can calculate emissions in two ways: production-based accounting (PBA), by performing a row sum of this matrix, or consumption-based accounting (CBA), by performing a column sum. Formally, this can be expressed as the

[2] In a MRIO with 3 countries and 2 sectors, the aggregation vector would be: $v_{(3.6)} = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{bmatrix}$

postmultiplication of the emissions matrix by a column vector of unity elements, $c_{(n.1)}$, (PBA emissions) and the premultiplication of unity elements r by row vector (CBA emissions):

$$E^{PBA}_{(n.1)} = E_{(n.n)}c_{(n.1)} \tag{A.12}$$

$$E^{CBA}_{(1.n)} = r_{(1.n)}E_{(n.n)} \tag{A.13}$$

Net exports are then obtained as the difference between PBA and CBA emissions:

$$Net\ exports_{(1.n)} = E^{PBA\,\prime}_{(n.1)} - E^{CBA}_{(1.n)} \tag{A.14}$$

A partial picture of the role played by international trade can be calculated by adding up the off-diagonal elements of matrix $E_{(n.n)}$ and dividing it by the sum of all elements of this matrix, that is, total global emissions. Furthermore, by manipulating matrix $E_{(n.n)}$, it is possible to calculate the share of imported emissions (emissions produced abroad and consumed domestically) out of total CBA for each country, as well as the share of export emissions (emissions produced domestically and consumed abroad) out of total PBA.

A.3 Emission intensities from international freight transportation

This study makes an additional effort to include emissions associated with the international transportation of goods in the analysis. To do so, the emissions associated with the transportation of goods are attributed to the countries involved in exporting and importing these goods. For this purpose, we use data from Li (2021), which is calculated using the methodology proposed by Cristea et al. (2013). These authors apply a bottom-up approach and calculate emissions associated with each origin-destination-product-mode of transportation. We use data for 2014 at current US$. For detailed information on the calculation of these emission intensities, see Li (2021) and Cristea et al. (2013).

A few assumptions had to be made to adapt the data to our analysis. First, Li (2021) displays emission intensities from air transportation using a lower and an upper bound based on fuel efficiency. We take an average of these values. Second, the sectoral and country-pair aggregation used in Li (2021) is different from ours, as she does not exploit the complete sector-country dimension available in the GTAP data. She reports emission intensities for 47 countries/regions (for both the exporter and importer dimensions) across 26 traded goods. The country dimension includes most LAC economies. The sector dimension is mainly aggregated into agricultural goods and food processing industries. For these cases, a uniform emissions rate was assumed in order to match the data to our dimension. For example, according to Li's estimates, transporting Brazil's agricultural exports to Argentina emitted 0.5 tons per US$1,000 in exports. We assumed this emission intensity from transportation to be the same for all Brazilian agricultural exports to Argentina in our database, from rice and wheat to cattle and fishing.

We multiplied the emission intensities for all bilateral relationships in our data by trade flows to obtain the total global emissions associated with international transportation. Based on Li's (2021) data, the estimates for 2014 ranged from 1,415 to 1,701 million tons of CO_2.

A.4 Tariff data management, concordances, and estimation sample

This section describes the procedure performed to aggregate bilateral tariffs from the HS 6-digit level to the country-pair-sector level of GTAP and Exiobase 3. Around 160 million tariffs from 175 origins, 175 destinations, and over 5,000 products were processed to calculate four types of tariffs. MFN and applied tariffs were calculated using the simple and trade-weighted averages. BACI data was used as trade weights to aggregate trade-weighted average tariffs from HS-6 to GTAP and Exiobase sectors.

Tariffs reported in different versions of the HS were matched to the 2012 version. Unmatched codes were matched with correlation tables linking older versions of the HS (H3, H2, H1, and H0) to the 2012 (H4).[3] Tariffs were then averaged into codes of the 2012 HS. This dataset was matched with trade weights at the HS 6-digit level from BACI. Around 2.75% of global trade in 2014 was left out of the analysis due to missing tariffs for a few countries (e.g., Iraq, Iran, Ethiopia, and Serbia). Finally, tariffs were averaged into the GTAP sector-origin-destination combinations using both simple and trade-weighted averages. Trade-weighted average tariffs (MFN and applied tariffs) were used to assess the robustness of the results. For brevity, these results have been omitted here.

For the econometric exercise in section 5, we do not consider the full sector and country dimensions of the GTAP dataset. In addition to the service sectors, we dropped one of the tradable sectors, raw milk, as there was no direct link for this sector to the HS classification. As mentioned above, we excluded a few regions for which tariffs were missing and all the aggregated GTAP regions (Rest of Oceania, Rest of Caribbean, Rest of North America, and so on). This reduced the country dimension from 147 countries to 120, such that the resulting estimation sample contained 44 sectors and 120 countries. The results are similar when the aggregated GTAP regions are included in the estimation sample. For brevity, they are not displayed here.

The procedure was slightly different for the Exiobase exercise. Given that the conversion table from HS to Exiobase sectors was given for the 1996 HS (H1), the tariff structure was harmonized at this level. A single converter linking recent versions of the HS (H4, H3, H2) to H1 was constructed using the conversion tables from the UN Statistics Division. The correspondence table (linking one new code to one or more old codes) was used as the primary connection across versions. Other codes from the HS 1996 version that were not present in the correspondence tables were retrieved from the correlation table to minimize data loss. This converter was used to bring tariffs to a single HS version (i.e., the 1996 version). This was performed by computing a simple average of duplicated HS 1996 lines for each country pair. Trade weights at the HS 6-digit

[3] Correlation tables retrieved from the UN Statistics Division, https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp

level were retrieved from BACI. Again, missing tariff data left approximately 3% of global trade in 2014 unmatched.

A.4 Upstreamness index

Upstreamness measures how a sector from a specific country is positioned in the global value chain. This index was first proposed by Fally (2012) and Antràs et al. (2012) and measures the average distance from final use. An upstream sector sells most of its output to intermediate industries and therefore is more "distant" from final demand. More formally, the upstreamness index in matrix notation, $U_{(nk.1)}$, was calculated for each country *n* and sector *k* accordingly:

$$U_{(nk.1)} = \left(I_{(nk.nk)} - \Delta_{(nk.nk)}\right)^{-1} c_{(nk.1)} \tag{A.15}$$

where $I_{(nk.nk)}$ is the identity matrix and $c_{(nk.1)}$ a column vector of one, size *nk*. $\Delta_{(nk.nk)}$ is a square matrix, each element of which is calculated as follows: $a_{ij}x_j/x_i$. Here, a_{ij} is the technical coefficient from producing (row) sector *i* to consuming (column) sector *j* retrieved from matrix $\mathrm{A}_{(nk.nk)}$; and x_j and x_i are the gross output of consuming sector *j* and sector *i*, respectively. See Fally (2012) and Antràs et al. (2012) for a more detailed discussion.

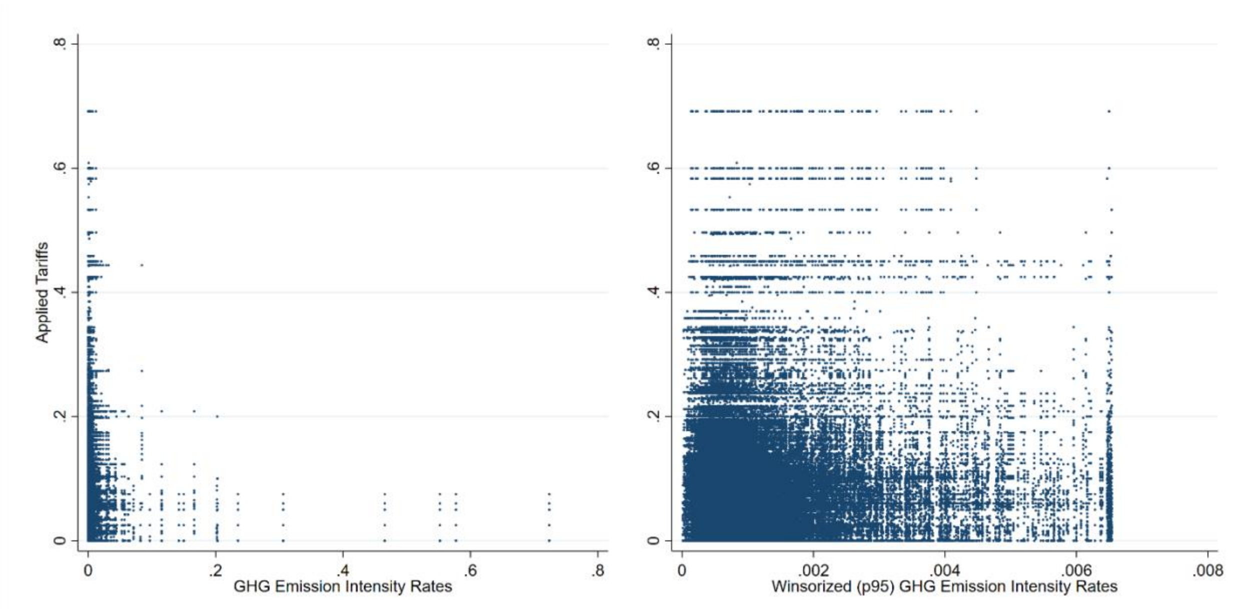
Appendix B: Descriptive Statistics

Table A1. Distribution of Emission Intensities, Applied Tariffs, and Relative Carbon Efficiency in LAC, 2014.

	N	MEAN	SD	SKEWNESS	MIN	P25	P50	P75	P95	MAX
APPLIED TARIFFS (SIMPLE AVERAGE)	104,720	8.34	8.65	2.23	0.00	2.06	6.15	11.24	24.42	69.17
RELATIVE CARBON EFFICIENCY	104,720	0.17	1.07	0.38	-5.72	-0.46	0.14	0.76	1.88	6.95
EI (DOMESTIC)	880	1.62	3.96	8.26	0.01	0.47	0.75	1.25	4.98	55.07
EI (PARTNER)	5,280	2.71	18.73	26.32	0.01	0.51	0.86	1.60	6.49	723.72

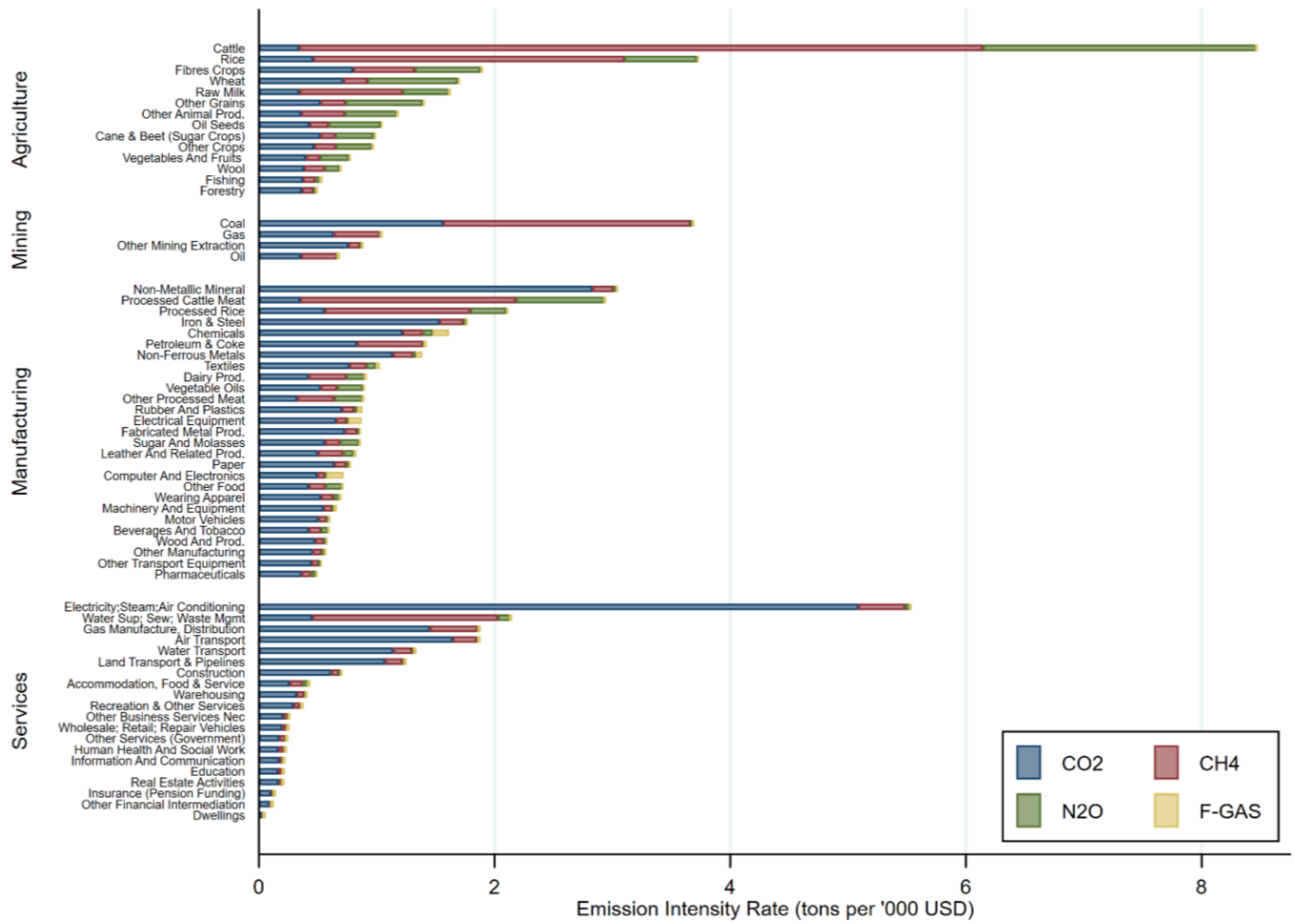
Source: Authors' calculations based on 2014 GTAP-MRIO data. Tariffs are a simple average of duties imposed by the 20 LAC countries on the other 119 partner countries for 44 sectors (20*119*44=104,720). Relative carbon efficiency represents how much more GHG efficient the production of goods in LAC is, compared to each partner. This is also computed for 20 LAC countries vis-a-vis the other 119 partner countries for 44 sectors (20*119*44=104,720). Emission intensities (EI) are measured in metric tons of CO_2e per US$1,000 of output and include direct and indirect emissions. Domestic EIs statistics are calculated for the 20 LAC countries in the 44 sectors (20*44=880). Foreign EIs, which include LAC EIs, are calculated for 120 partner countries for 44 sectors (120*44=5,280). Service sectors and aggregated GTAP regions are not included.

Figure A2. Scattergrams of LAC's Applied Tariffs and Foreign Emission Intensities, 2014.



Source: Authors' calculations based on 2014 GTAP-MRIO data. Observations are LAC importers-partners-sectors. Emission intensities (EI) are measured in metric tons of CO_2e per dollar of output and include direct and indirect emissions. Applied tariffs are measured in cents per dollar of imports. The right panel shows GHG EIs winsorized at the percentile 95^{th} for each of LAC importers.

Figure A3. Global Emission Intensities by Sector and Gas Type, 2014.



Source: Authors' calculations based on 2014 GTAP-MRIO data.

Note: Emission intensities (EI) are measured in metric tons of CO_2e per US$1,000 of output and include direct and indirect emissions. Total GHG EI are broken down by gas type.

Appendix C: Estimation Details and Robustness Checks

This section starts by reporting the full estimation details of the specifications presented in the main article (see C.1).

Next, we report how our results change when variations of the baseline specifications are considered. More specifically, section C.2 analyzes how sensitive our results are to different treatments of outliers. First, we report the estimations using the original dataset and both variables in levels. Second, we estimate the parameters using trade weights and thus allowing more relevant trade sectors to influence estimates. Third, we log transform emission intensities to reduce their dispersion and use these as the independent variable. We then proceed by estimating the coefficients for different levels of sample winsorizing (at the 99th, 95th, and 90th percentiles). Lastly, we estimate equation 4 using different outlier-robust estimation methods (see Verardi and Croux, 2009, and Jann, 2021). We first estimate an M-estimator (*rreg* command in Stata). However, this estimator displays weaknesses in treating some types of outliers.[4] For this reason, we also estimate an MM-estimator or an S-estimator (depending on the Hausman test statistic).[5] However, even these estimators resist contamination of up to 50% of outliers (Verardi and Croux, 2009).

In section C.3, we first explore the existence and magnitude of tariff escalation in LAC countries and selected world economies. After that, we introduce our upstreamness index as another explanatory variable in equation 4 and assess how our baseline results are affected.

Lastly, in section C.4, we replicate our identification strategy using another MRIO dataset, Exiobase 3, with greater sectoral disaggregation. However, these results are only available for Brazil and Mexico.

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[4] Verardi and Croux (2009) argue that the M-estimator (rreg command) does not have the expected robustness properties for two main reasons. First, Cook distances only manage to identify isolated outliers and are inappropriate when clusters of outliers exist, as one outlier can mask the presence of another. It can therefore not be guaranteed to have identification of all leverage points. Second, the initial values for the iteratively reweighted OLS algorithm are monotone M-estimators that are not robust to bad leverage points and that may lead the algorithm to converge to a local instead of a global minimum.

[5] We test the null hypothesis that an MM-estimator is not statistically different from an S-estimator and hence should be preferred due to its higher efficiency (Dehon et al., 2012).

C.1 Detailed baseline estimation results

Table A2. Applied Tariffs and Their Relationship with Sector and Partner CO_2e Intensities. Selected LAC Countries.

Countries	(1) Sector-Partner	(2) Sector	(3) Partner
Argentina	-10.12***	-12.74***	1.43***
	(0.50)	(0.51)	(0.22)
Bolivia	-5.42***	-7.32***	1.52***
	(0.38)	(0.36)	(0.23)
Brazil	-10.29***	-12.85***	1.26***
	(0.50)	(0.52)	(0.22)
Chile	3.41***	-0.07**	5.66***
	(0.24)	(0.04)	(0.30)
Colombia	9.00***	9.54***	0.10
	(1.41)	(1.47)	(0.52)
Costa Rica	1.01	-0.20	2.08***
	(0.75)	(0.75)	(0.24)
Dominican Republic	-0.50	-1.54*	1.09***
	(0.76)	(0.80)	(0.23)
Ecuador	-3.92***	-5.35***	0.62*
	(0.90)	(0.90)	(0.33)
El Salvador	2.69***	1.79**	1.5***
	(0.78)	(0.80)	(0.28)
Guatemala	2.66***	1.91***	1.64***
	(0.58)	(0.61)	(0.21)
Honduras	2.87***	2.12***	1.39***
	(0.72)	(0.73)	(0.29)
Jamaica	-0.16	-0.61	0.45***
	(0.79)	(0.85)	(0.15)
Mexico	-1.01	-5.99***	4.92***
	(0.77)	(0.77)	(0.42)
Nicaragua	3.62***	2.91***	1.89***
	(0.89)	(0.91)	(0.29)
Panama	5.85***	6.47***	0.41***
	(1.11)	(1.18)	(0.10)
Paraguay	-6.76***	-8.56***	0.91***
	(0.42)	(0.43)	(0.19)
Peru	-2.68***	-3.26***	0.21***
	(0.18)	(0.19)	(0.07)
Trinidad and Tobago	-5.60***	-6.48***	0.02
	(0.60)	(0.65)	(0.11)
Uruguay	-7.1***	-9.06***	1.16***
	(0.43)	(0.44)	(0.19)
Venezuela	-7.25***	-9.43***	1.21***
	(0.56)	(0.55)	(0.31)
Sector fixed effects	No	No	Yes
Partner fixed effects	No	Yes	No

Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: Regressions run by country. The dependent variable in all regressions is the applied tariff rate faced by the partner of each country in specific sector *g*. The right-hand-side variables are total emission intensities (CO_2e per US$1 of output). Observations are at the sector-partner level. Emission intensities larger than the 95th percentile were replaced by the 95th-percentile value. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

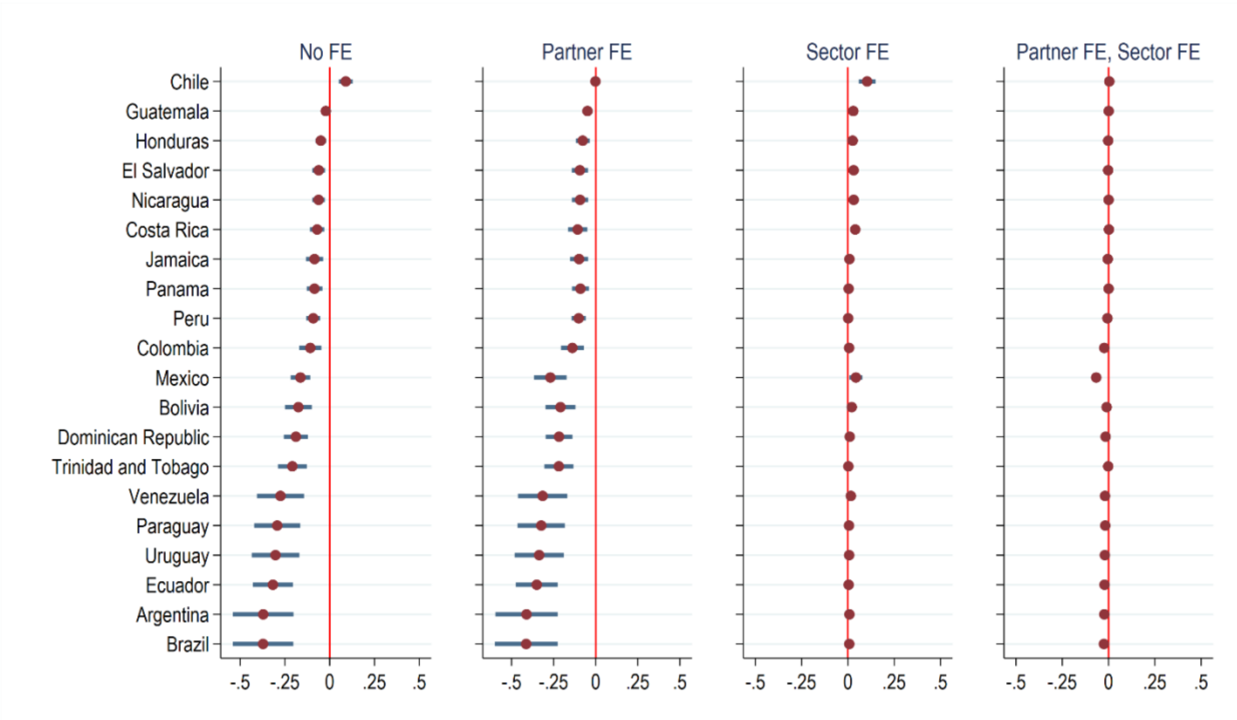
Table A3. Applied Tariffs and Their Relationship with CO2e Goods Emission Intensity Conditional on Carbon Efficiency. Selected LAC Countries.

	(1)	(2)	(3)	
Countries	Goods intensity (eir_k^g)	Carbon efficiency (eff_{jk})	Interaction ($eir_k^g * eff_{jk}$)	Adjusted R-squared
Argentina	-16.69***	0.000826	-2.609***	0.094
	(0.503)	(0.00140)	(0.413)	
Bolivia	-11.69***	-0.00140	-1.406***	0.060
	(0.520)	(0.000924)	(0.258)	
Brazil	-14.20***	0.00229	1.013**	0.091
	(0.405)	(0.00150)	(0.447)	
Chile	0.605**	0.00780***	-0.735***	0.049
	(0.292)	(0.000615)	(0.244)	
Colombia	13.48***	-0.0349***	1.416	0.083
	(1.577)	(0.00259)	(1.221)	
Costa Rica	-3.462***	-0.0279***	6.227***	0.039
	(0.706)	(0.00217)	(0.600)	
Dom. Republic	-4.377***	0.00639***	-2.723***	0.007
	(0.761)	(0.00144)	(0.561)	
Ecuador	-2.246**	0.00522***	-6.572***	0.018
	(0.936)	(0.00196)	(0.823)	
El Salvador	5.522***	0.00285**	2.716***	0.014
	(0.866)	(0.00121)	(0.567)	
Guatemala	4.915***	0.00356***	0.519	0.017
	(0.714)	(0.00104)	(0.508)	
Honduras	7.955***	-0.0127***	4.206***	0.019
	(0.931)	(0.00158)	(0.492)	
Jamaica	4.285***	0.00105	-3.642***	0.008
	(0.804)	(0.00181)	(0.653)	
Mexico	-5.795***	0.0197***	-5.312***	0.023
	(0.721)	(0.00227)	(0.751)	
Nicaragua	10.44***	-0.0164***	6.803***	0.021
	(1.156)	(0.00167)	(0.709)	
Panama	9.639***	0.0102***	5.025***	0.057
	(1.312)	(0.00174)	(1.191)	
Paraguay	-11.29***	0.0116***	-3.362***	0.090
	(0.407)	(0.00108)	(0.359)	
Peru	-4.073***	0.00205***	-0.829***	0.052
	(0.190)	(0.000463)	(0.139)	
Trinidad andTobago	-8.252***	0.0105***	-7.908***	0.045
	(0.722)	(0.00138)	(0.720)	
Uruguay	-11.18***	0.00256***	-2.013***	0.076
	(0.332)	(0.000972)	(0.320)	
Venezuela	-11.33***	0.00580***	-2.301***	0.053
	(0.374)	(0.00128)	(0.401)	

Source: Authors' calculations, with GTAP 10-2014 data.
Note: Regressions run by country. The dependent variable in all regressions is the applied tariff rate faced by the partner of each country in specific sector *g*. The right-hand-side variables are the total world emission intensities (CO_2e per US$1 of output) of sectors, the relative carbon efficiency variable, and an interaction term between them. The number of observations in all regressions is 5,236. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

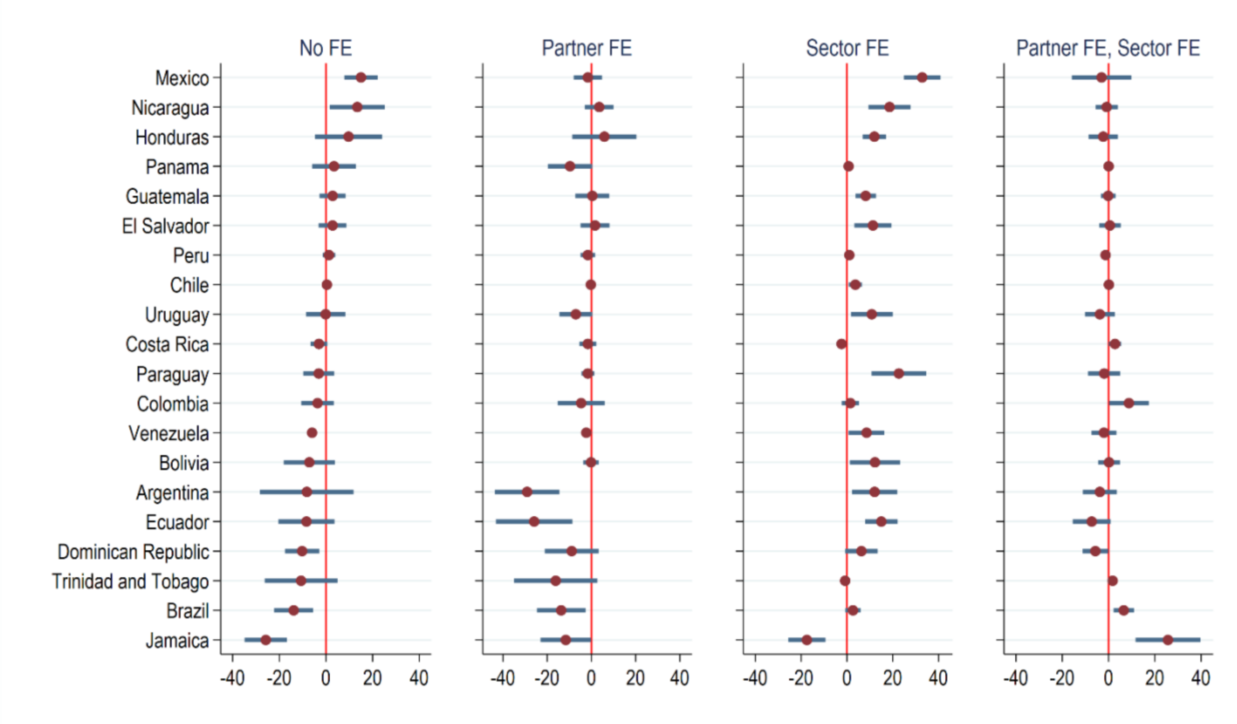
C.2 Robustness estimations

Figure A4. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Original Data (No Winsorizing).



Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. No winsorizing was performed. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

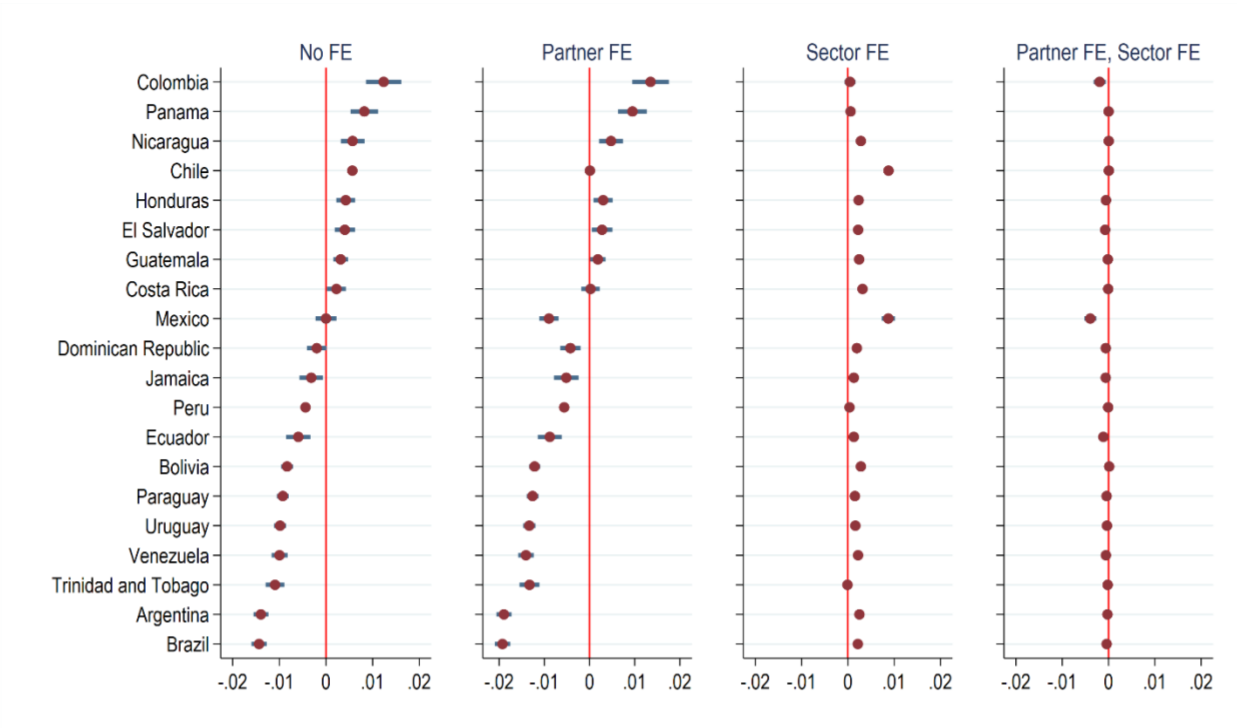
Figure A5. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Original Data. Trade-Weighted Regressions.



Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.

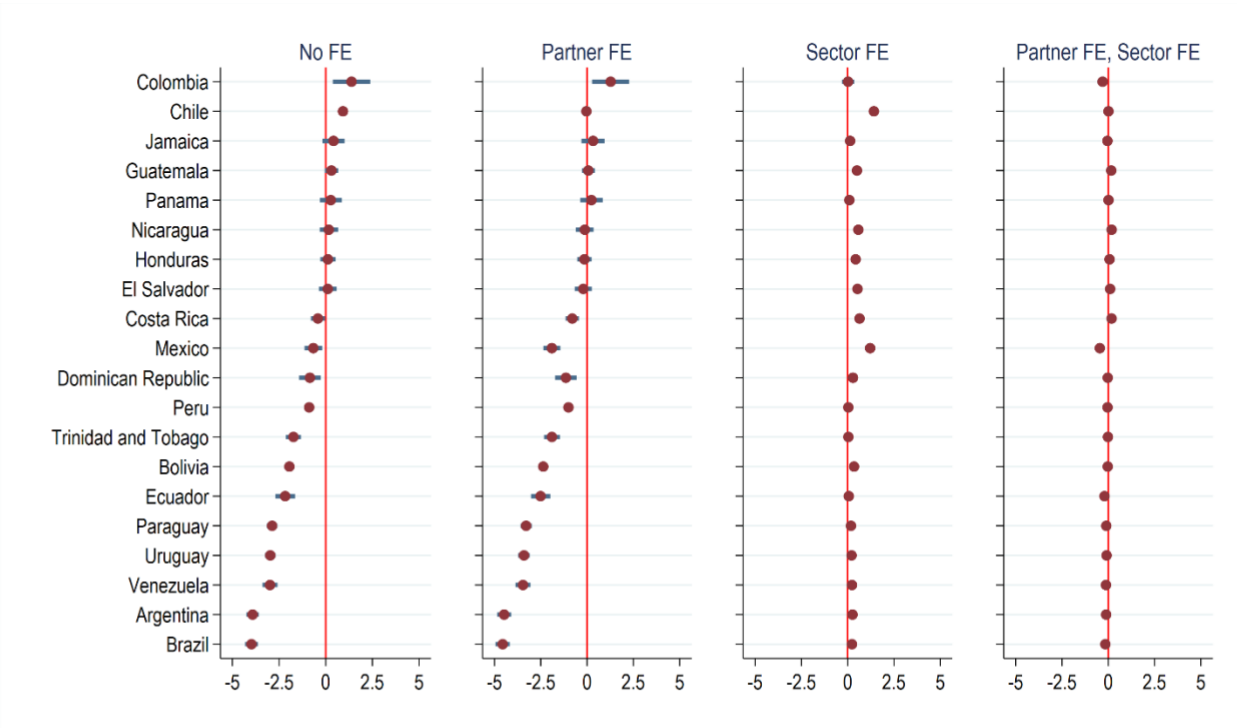
Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. No winsorizing was performed. Observations were weighted by the value of imports. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

Figure A6. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Linear-Log Specification.



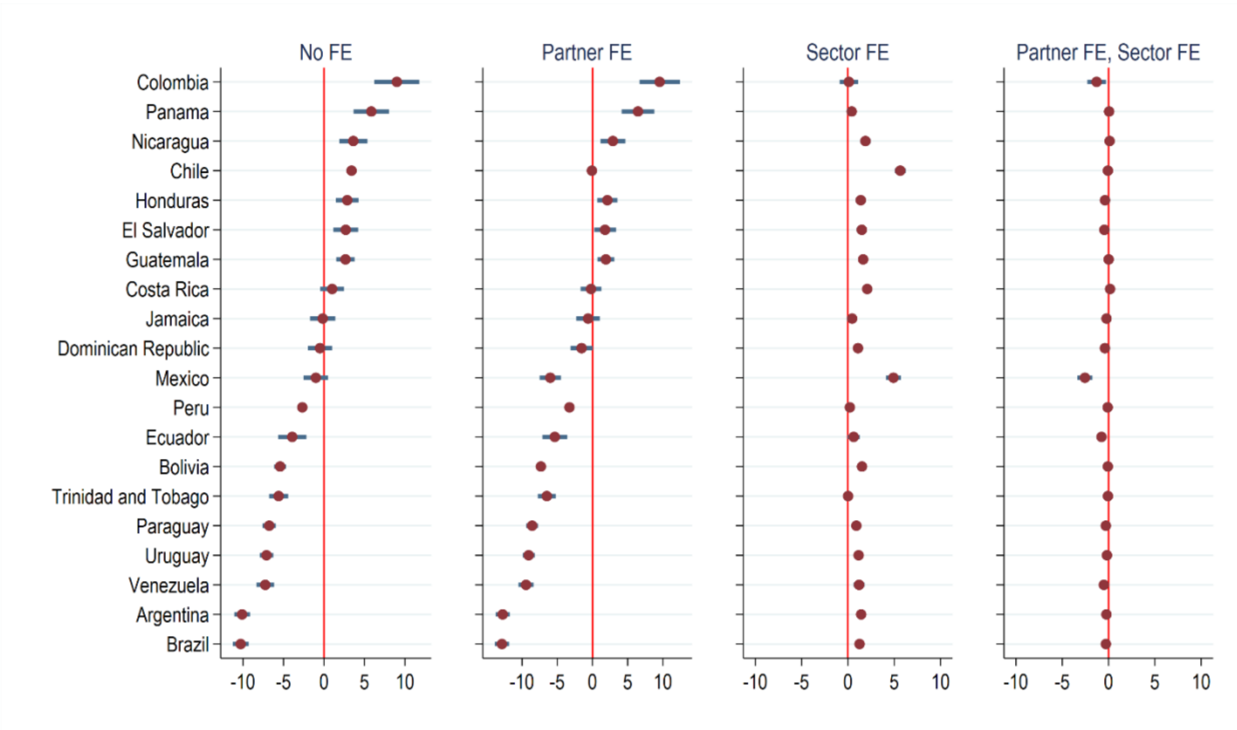
Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are the logarithm of total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. No winsorizing was performed. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

Figure A7. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Winsorized Regressions at the 99th Percentile.



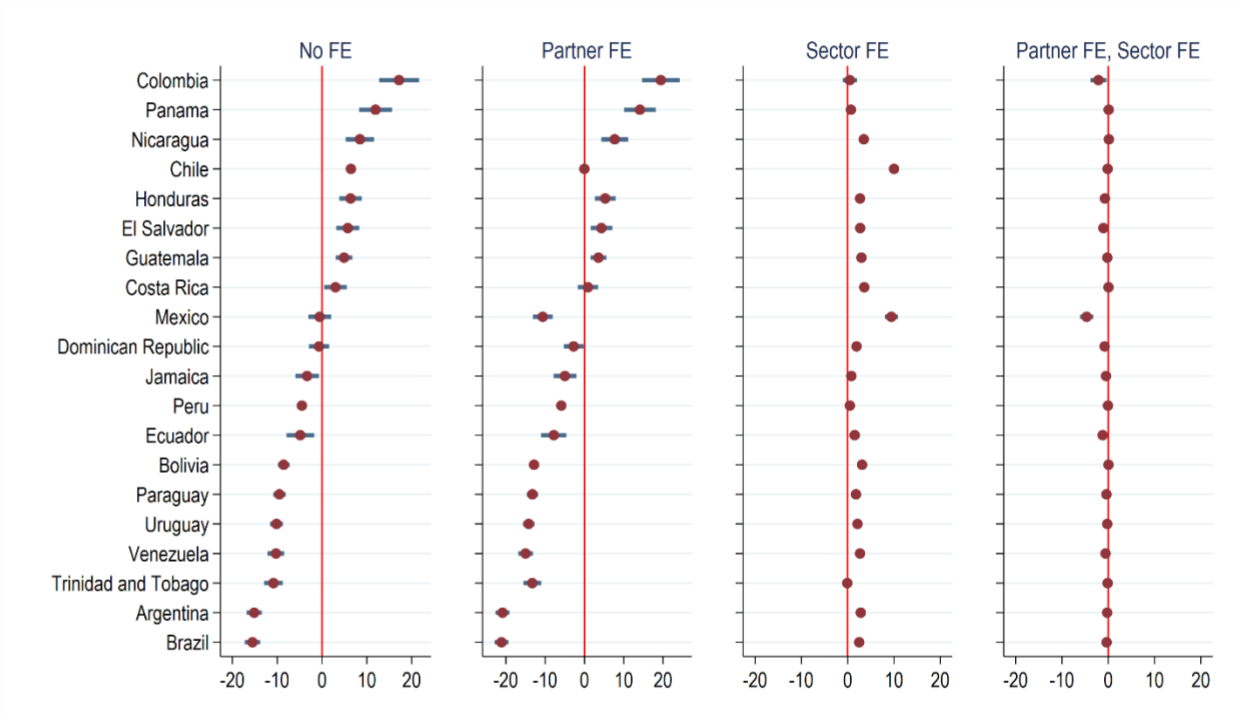
Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. Emission intensities larger than the 99th percentile were replaced by this 99th percentile value. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

Figure A8. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Winsorized Regressions at the 95th Percentile.



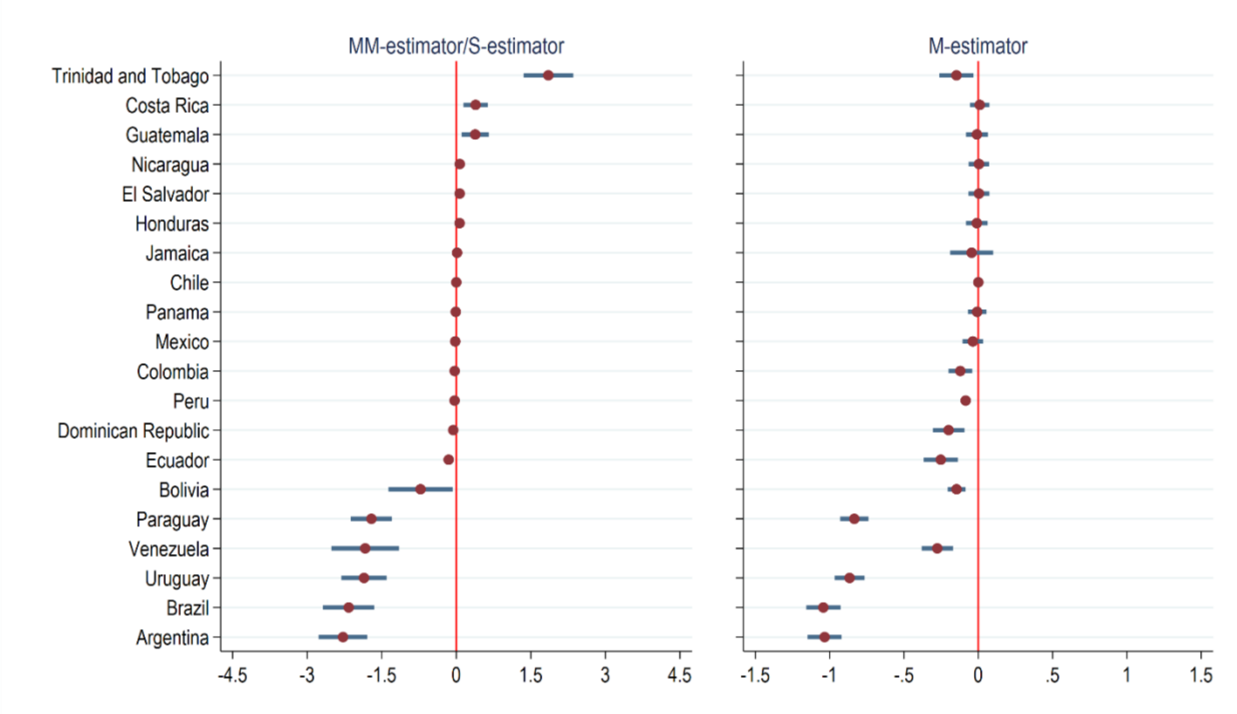
Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: This figure is similar to figure 9 and is displayed here to ease comparison. The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. Emission intensities larger than the 95th percentile were replaced by this 95th percentile value. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

Figure A9. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Winsorized Regressions at the 90th Percentile.



Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country. Emission intensities larger than the 90th percentile were replaced by this 90th percentile value. The left panel assesses the sector-partner dimension with estimates from equation 4. The second panel assesses the sectoral dimension by estimating equation 4 with partner fixed effects. The third panel captures the effect over the partner dimension by estimating equation 4 with sector fixed effects. The fourth panel simultaneously includes partner and sector fixed effects. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

Figure A10. Covariances of Applied Tariffs and Emission Intensities. Selected LAC Countries. Outlier-Robust Regression Methods.

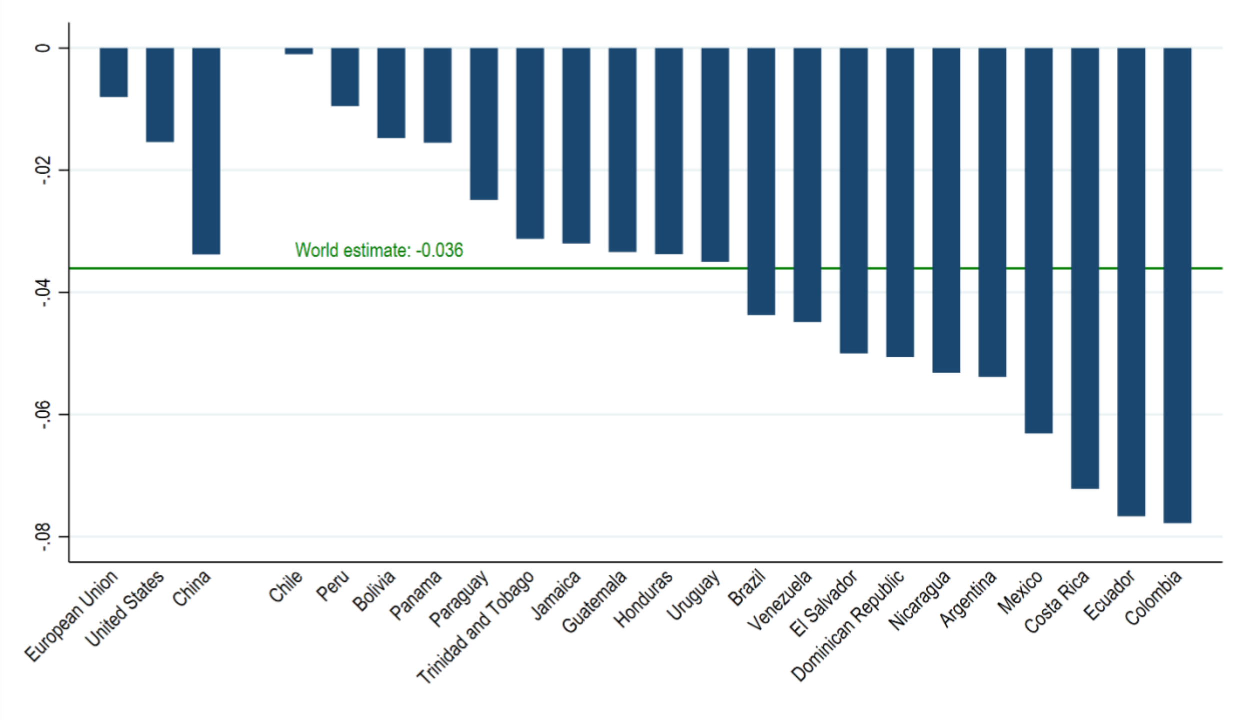


Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.

Note: The left-hand-side variables are applied tariffs, and the right-hand-side variables are total emission intensities (CO_2e per US$1 of output) of the partner country. Observations are at the sector-partner level. Estimates were performed for each LAC country, and no fixed effects were included. The left panel estimates an MM-estimator for cases in which we do not reject the Hausman test null hypothesis (both estimates are not statistically different, and hence the MM-estimator should be preferred due to its higher efficiency). Otherwise, we estimate an S-estimator model. The right panel estimates an M-estimator model. The blue bars represent the 95% confidence interval, calculated with robust standard errors.

C.3 Tariffs, emission intensities, and upstreamness

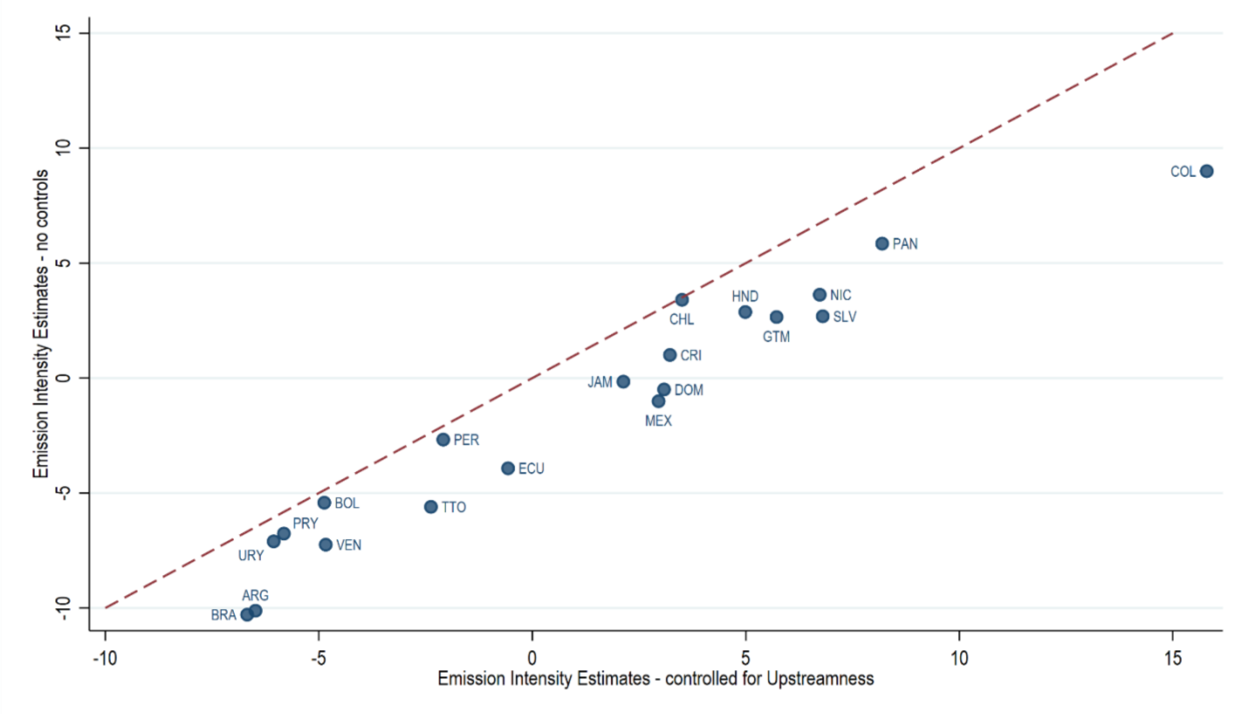
Figure A11. Relationship between Applied Tariffs and Upstreamness.



Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.

Note: The left-hand-side variable is applied tariffs, and the right-hand-side variable is the upstreamness index of domestic industries and is a constant. Observations are at the sector-partner level. Estimates were performed for each LAC country and a few extraregional economies. No fixed effects were included. The green line represents the parameter estimated using the global sample: one additional unit in the upstreamness index is related to a 3.6% smaller tariff. All estimates are statistically significant at the 95% confidence level.

Figure A12. Covariances of Applied Tariffs and Emission Intensities and the Role of Upstreamness. Selected LAC Countries.



Source: Authors' estimates based on data from 2014 GTAP 10-MRIO.
Note: This figure plots our baseline estimates for emission intensities—column (1) in table A2—against the same specification but adding upstreamness as a control variable. Observations are at the sector-partner level. Estimates were performed for each LAC country, and no fixed effects were included. Emission intensities larger than the 95th percentile were replaced by this 95th percentile value.

C.4 Exiobase 3 estimation results

Table A2. Exiobase 3 Results: Applied Tariffs and Their Relationship with Sector and Partner CO2e Intensities. Selected LAC Countries.

Independent Variable	(1) Sector-Partner	(2) Sector	(3) Partner
Panel A—Brazil			
EI	-8.8e-07***	-9.6e-07***	4.6e-09*
	(.0000)	(.0000)	(.0000)
EI—Winsorized 90th percentile	-16.104***	-17.0801***	.0364
	(.5212)	(.5269)	(.0402)
EI—Winsorized 95th percentile	-5.1119***	-5.3142***	.024**
	(.1547)	(.1607)	(.0106)
EI— Winsorized 99th percentile	-.0521***	-.0552***	.0005***
	(.0023)	(.0024)	(.0001)
EI—trade-weighted	-9.5767**	-8.6539**	.1591
	(4.0368)	(4.1137)	(.1974)
Log (EI)	-.0093***	-.0099***	0.00004*
	(.0012)	(.0013)	(.0000)
Panel B—Mexico			
EI	-5.7e-07***	-4.4e-07**	4.4e-12
	(.0000)	(.0000)	(.0000)
EI—Winsorized 90th percentile	-5.695***	-7.2128***	1.9489***
	(.9273)	(.9338)	(.7147)
EI—Winsorized 95th percentile	-2.5346***	-2.5056***	.2996*
	(.2466)	(.2629)	(.1805)
EI— Winsorized 99th percentile	-.0425***	-.033***	-.0037
	(.0029)	(.0034)	(.0026)
EI—trade-weighted	9.5368***	-1.7096	18.5941***
	(3.1413)	(1.1789)	(5.5304)
Log (EI)	-.0029***	-.0047***	.0017***
	(.0008)	(.0009)	(.0004)
Sector fixed effects	No	No	Yes
Partner fixed effects	No	Yes	No

Source: Authors' estimates based on 2014 Exiobase 3.

Note: Regressions were run for Brazil and Mexico. Each cell represents an estimate from a different regression. Below each estimate, robust standard errors are displayed in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable in all regressions is the applied tariff rate faced by the partner of each country in specific sector *g*. The right-hand-side variables are the total emission intensities of the partner country (CO_2e per US$1 of output) in different forms. The first row in both panels shows emission intensities without transformations. For the three following rows, this variable is winsorized at three different levels: the 90th, 95th, and 99th percentiles. The fourth row in both panels shows import-weighted estimates. Observations are at the sector-partner level. For the last row in each panel, we log transform EI to reduce the influence of outliers.

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