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Environmental Regulation and foreign trade: an analysis for the CAN and MERCOSUR trade blocs in the period 2001-2019

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ABSTRACT

This study examines the impact of trade and environmental agreements on trade in the Andean Community (CAN) and the Southern Common Market (MERCOSUR) during the period 2001–2019. Using a panel data methodology, the study analyses the effects of ratifying a number of agreements (the Paris Agreement, the Kyoto Protocol, the Nagoya Protocol, and Free Trade Agreements with the European Union) on total exports and imports. The results reveal that environmental regulations have a differentiated impact on the exports and imports of both trade blocs. These findings underscore the importance of trade and environmental agreements in promoting sustainable trade and emphasize the need for ongoing monitoring of their implementation to foster equitable and sustainable growth in the region.

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1. Introduction

The increase in pollution and the environmental impact of the economic model requires countries to implement various measures and mechanisms to address their negative effects. In recent years, there has been a significant rise in the contribution of trade to pollution. According to the WTO (2021), around 20% to 30% of total greenhouse gas (GHG) emissions are linked to international trade due to the production and transportation of exported and imported goods and services. However, the WTO also recognizes that higher levels of trade have the potential to drive technological advancements and enhance efficiency, ultimately fostering sustainable development.

Pollution creates a trade-off between trade and environmental concerns. Unregulated trade may contribute to increased environmental pollution (WWF et al., 2020) while also being recognized as a driver of development that can reduce pollution (Brenton & Chemutai, 2021).

In this regard, implementing environmental regulations plays a crucial role by incorporating clauses or provisions aimed at ensuring environmental quality. However, the

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ongoing debate surrounding the role of these environmental provisions in trade has not yet reached a consensus.

Additionally, it is important to emphasize that pollutant emissions are not distributed equitably among countries. While environmental regulation affects all countries equally, it is the industrialized nations that have recorded the highest pollution levels in recent years. On the other hand, developing countries – although not polluting to the same extent – depend on trade relations with industrialized nations. Particularly in Latin American and Caribbean (LAC) countries, environmental pollution encompasses much more than carbon emissions from specific industries, including issues such as deforestation, extraction of natural resources, and soil depletion (Lo Vuolo, 2014).

The production models adopted by CAN and MERCOSUR countries pose a threat to the environment, compounded by limited institutional capacity to address these challenges. Furthermore, income heavily relies on trade in these countries due to low industrialization. As climate change intensifies, producers will need to increase the value-added in trade to sustain their income levels (Deere Birkbeck, 2021; UNCTAD, 2021).

While developed countries are the main GHG emitters, LAC countries represent around 7% of global GHG emissions (World Bank, 2020).¹ Additionally, the region's biodiversity is already severely affected by international trade. LAC records the highest regional decline: a 94% decrease in monitored populations (out of a total of 32,000 populations of 5,230 species worldwide) (WWF et al., 2020).

This article aims to assess how multilateral regulations and commitments in trade and environmental agreements affect LAC countries' trade with their main trading partners, specifically in the Andean Community (CAN) and Southern Common Market (MERCOSUR) in the period 2000–2019. We emphasize three contributions of this article from economic, political, and multilateral perspectives.

The economic significance of this analysis lies in comprehending how trade and environmental regulations can influence regional and global trade dynamics, impacting the competitiveness of local industries and their ability to access international markets. Furthermore, it seeks to underscore how these regulations can either stimulate or impede foreign investment, thereby directly affecting the economic development of the countries in the region.

From a political standpoint, this study aims to shed light on how decisions in trade and environmental matters can serve as key instruments in national and international political strategies. Trade and environmental regulations, by affecting trade, become pivotal elements in the formulation of policies that strive for both environmental sustainability and the strengthening of diplomatic relations.

The multilateral focus stands out by acknowledging that trade and environmental regulations are not solely tools for enhancing sustainability but also means to build bridges and foster cooperation among nations. In an interconnected world, understanding how these regulations impact multilateral trade relations contributes to the establishment of a more equitable and sustainable global environment.

This article seeks to build empirical evidence on these issues in LAC countries, for which there are few studies. The structure of the article is as follows: the second section

¹According to the World Bank (2020) database, in 2020 the world emitted 46,120,921 kt of CO₂ equivalent, while the LAC region emitted only 3,064,546.

provides a literature review summarizing the main works on the topic; the third section describes the databases used; the fourth section presents the methodology employed and explains the model; the fifth section presents the results; and finally, the last section presents the research conclusions.

2. Literature review

The unsustainability of current patterns in the production and consumption model necessitates an urgent shift towards strategies that promote economic “dematerialization.” This entails reducing pressures on the environment and mitigating the impacts of climate change. It involves the generation and dissemination of green technologies and the adoption of more sustainable production models, which may stimulate technological change and innovation cycles, with human capital and scientific/technological development as key factors (CEPAL, 2018, 2020).

The Marrakech Agreement establishes environmental protection as a key objective of the multilateral trading system. In 1995, less than 1 in every 12 trade notifications included an environmental component, whereas the current ratio stands at 1 in every 6. Between 2009 and 2018, WTO Members reported over 11,000 environmental measures (WTO, 2020).

2.1. Environmental clauses in international trade agreements and their effects

Trade agreements go beyond the realm of commerce by incorporating chapters or titles on sustainable development. These are known as “Deep Trade Agreements” i.e., reciprocal agreements between countries that cover not only trade, but also additional policies aimed at deepening economic integration among trading partners. These agreements address aspects such as the protection of intellectual property rights, innovation, technology transfer, investment, decent work, and the environment (Mattoo et al., 2020).

Numerous research studies have aimed to elucidate the impact of environmental measures on trade Najarzadeha et al. (2021) found that the participation of committed countries in global value chains decreased in terms of exports but increased in terms of imports. Additionally, De Santis (2011) analysed the impact of preferential trade agreements (PTAs) on exports in the European Union countries. The main result of this study is that bilateral export flows were positively influenced by the presence of both trade and environmental agreements (UNFCCC, Montreal and Kyoto) in the period 1988–2008.

Further insights into this dynamic were provided by Morin et al. (2019), who highlighted the dissemination patterns of environmental provisions within preferential trade agreements (PTAs). Their findings suggested that environmental clauses initially introduced in intercontinental PTAs were more likely to proliferate compared to those embedded in PTAs encompassing only specific parts of a region. Moreover, they noted a heightened dissemination rate for environmental provisions within PTAs featuring a multitude of participating parties. Furthermore, Blümer et al. (2019) suggest that the likelihood of adopting environmental provisions increases with PTAs safeguarding policy space but decreases with greater variation in members’ regulations and economic power, indicating a shift towards offensive provisions by countries with stringent

regulations and strong economic bargaining power to level the playing field with trading partners.

Studies such as that of Brandi et al. (2020) have considered the analysis of environmental provisions on trade, distinguishing between dirty and green exports. In this instance, they find that this type of regulation generates positive effects on green exports for developing countries. Additionally, Kolcava et al. (2019) suggests that trade liberalization via PTAs correlates with an expansion in the ecological footprint of exports from developing nations. Intriguingly, the presence of environmental provisions within PTAs appears to exacerbate this effect, according to their finding.

In the LAC region, Fairlie et al. (2023) examine how environmental clauses within regional trade agreements affects the exports of CAN and MERCOSUR countries in the period from 2001 to 2019. Their findings indicate that the inclusion of environmental clauses does not significantly affect trade, the PTA alongside compliance leads to a notable negative impact on total exports. Moreover, this effect is particularly pronounced in trade arrangements following a South-North structure. These results contribute to existing research and enhance our understanding of the influence of environmental clauses on international trade within the region's countries.

2.2. Environmental regulations, international trade and emissions reduction

Moreover, recent research has significantly expanded the scope of inquiry into the impact of trade on pollution. This expansion includes investigations into various pollutants and analyses conducted within the context of diverse economies. For example, Ma and Wang (2021) analysed the effects of international trade participation on the intensity of carbon dioxide and sulphur dioxide emissions. They examined variations in the impact of emission intensity reduction across different forms of trade and explored mechanisms to enhance production efficiency and implement stricter end-of-pipe regulations. Also, Yang (2023) evaluate the effect of carbon emission trading policy on firm's environmental investment and found that the establishment of a carbon emission trading system imposes a negative effect on corporate environmental investment and that the reduction in environmental investment arising from carbon emission trading policy is particularly pronounced in non-state-owned enterprises and mature enterprises with large-size.

Duan et al. (2021) developed a general equilibrium trade model and quantitatively assessed the Pollution Haven Effect and the Pollution Haven Hypothesis.² Their analysis suggests that environmental regulations can provide a comparative advantage. However, they did not find evidence that the reduction of trade barriers leads to a concentration of pollution-intensive industries in countries with less stringent environmental regulations.

Research studies such as Ghosh and Yamarik (2006) have found that the implementation of Free Trade Agreements (FTAs) leads to a reduction in pollution. However, this effect derives from the positive impact of increased trade on per capita income, which in turn influences environmental quality. Baghdadi et al. (2013) argue that there is a direct effect on the reduction of CO₂ emissions in countries that have FTAs with environmental provisions.

²Pollution Haven Hypothesis: Countries open to international trade may adopt less stringent environmental regulations due to concerns about losing international competitiveness (De Santis, 2011, p. 2).

Furthermore, Martínez-Zarzoso (2017) maintains that FTAs with environmental clauses have a direct positive effect on reducing environmental degradation. They also generate incentives for member countries to ensure compliance with supranational environmental regulations implied by international treaties that affect all ratifying countries equally. Additionally, FTAs with environmental provisions are estimated to contribute to reducing emissions of polluting gases. Complementary, Wang et al. (2016) examine the effect of FTAs on the reduction of environmental pollution and find that only the chemical industry could afford significant losses in international trade under strict environmental regulation.

In the LAC region, efforts are underway to develop and implement policies and instruments that target climate change mitigation and adaptation. The commitment to the Paris Agreement is a pivotal milestone towards achieving a sustainable future. Many FTAs signed by LAC countries incorporate environmental clauses or chapters specifically addressing the mitigation of environmental impacts stemming from economic activities conducted under these agreements.

Studies conducted by Fairlie et al. (2021) reveal that in the LAC region, for each additional bilateral agreement with an environmental clause, the average population-weighted concentrations of carbon dioxide, nitrogen oxides, and particulate matter with a diameter of 2.5 microns increase by 1.8%, 4.7%, and 2.5%, respectively. However, the average population-weighted concentration of sulphur dioxide decreases by 7.7%.

Considering the comprehensive review of literature, it is evident that there is no unanimous consensus regarding the impacts of integrating environmental clauses (within PTAs or FTAs) on trade or pollution mitigation. The repercussions of such clauses may vary depending on the specific variables considered, the developmental status of the countries involved, and the sector of the economy affected.

3. Data and methodology

In this section, we describe and explain the data sources, agreements included in the analysis, and variables in subsection 3.1. Additionally, the econometric methodology employed in the empirical application is presented in sub-section 3.2.

3.1. Data sources

3.1.1. Trade map

This study utilizes data from the Trade Map database for the period 2001–2019. Trade Map provides information on trade performance indicators, international demand, alternative markets, and competitive markets, among others. The data used in this study focuses on exports and imports of CAN (Bolivia, Colombia, Ecuador, and Peru) and MERCOSUR (Argentina, Brazil, Paraguay, and Uruguay) countries with 44 trading partners on an annual basis that is measured in millions of dollars.

The sample is constrained to the examination of trade (exports and imports) between the Andean Community (CAN) and the Southern Common Market (MERCOSUR) and 44 other countries. As these 44 destination countries include the economies of CAN and MERCOSUR, each of the eight origin nations engages

in trade with the remaining 43 destination countries (every country on the list except itself). The Table 1 shows the classification of the countries by origin and destination.

The trade data is displayed in logarithmic form, streamlining the examination of percentage changes from 2001 to 2019. In total, the database comprises 6,536 observations, averaging 344 observations annually over the 19-year period.

3.1.2. *Cepii*

We utilized the GeoDist database, which is part of the CEPii (Centre d'Etudes Prospectives et d'Informations Internationales) database set. GeoDist provides valuable data for empirical economic research, encompassing geographical elements and variables, particularly for country pairs. For this study, we used the data on common language, shared borders, and land area of the exporting and importing countries within CAN and MERCOSUR, along with their 44 trading partners³ on the period of study that is available in the data set of Gravity variables. The treatment of this variable will be explained in the next section.

3.1.3. *Trade and environmental agreements*

The study evaluates three environmental agreements currently in effect, as well as one trade agreement, the FTA with the European Union. The FTA stands out for incorporating rigorous environmental standards in bilateral trade. In the next subsections, we present the definition of each agreement and the source of information. It is crucial to underscore that, owing to the temporal analysis conducted in this study, the incorporation of each agreement has been temporally delineated. Specifically, distinctions have been made based on the periods during which these agreements came into effect for the countries within the sample and those periods in which they were absent, treated as a categorical variable.

Paris Agreement:

Table 1. Country groups differentiated by origin and Destination.

Origin Countries	Destination Countries
Andean Community (CAN): Bolivia, Colombia, Ecuador, and Peru	Argentina, Australia, Austria, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, El Salvador, France, Germany, Guatemala, Honduras, Hong Kong (China), India, Indonesia, Israel, Italy, Japan, South Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Paraguay, Peru, Poland, Portugal, Russia, Singapore, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America, Uruguay
Southern Common Market (MERCOSUR): Argentina, Brazil, Paraguay, and Uruguay	

Source: TradeMap. Authors' elaboration.

The Destination Countries box incorporates the economies of the CAN and MERCOSUR members.

³The partners countries are Argentina, Australia, Austria, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, El Salvador, France, Germany, Guatemala, Honduras, Hong Kong (China), India, Indonesia, Israel, Italy, Japan, South Korea, Malaysia, Mexico, Netherlands, New Zealand, Norway, Panama, Paraguay, Peru, Poland, Portugal, Russia, Singapore, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States of America and Uruguay.

The Paris Agreement was adopted at the end of 2015 during the twenty-first session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). Its objective is to strengthen the global response to climate change, enhance countries' ability to deal with the impacts of climate change, and mobilize financial resources for low-carbon and climate-resilient development. It requires all Parties to submit their Nationally Determined Contributions (NDCs) and to regularly report on their emissions and implementation efforts (UNFCCC, 2021).⁴

This study utilized information from the United Nations Treaty Collection,⁵ which specifies that the Agreement will come into effect on the thirtieth day after at least 55 Parties to the Convention (representing an estimated 55% of global GHG emissions) have deposited their instruments of ratification, acceptance, approval, or accession (see Annex 2 for further details).

3.1.4. Nagoya Protocol

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity was adopted in 2010 during the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP-10). The Protocol emphasizes the third COP-10 objective, which aims to ensure a solid foundation for legal certainty and transparency for both providers and users of genetic resources. Each party is obligated to fulfil specific obligations to ensure compliance with the legislation or regulatory requirements of the providing party regarding genetic resources and to adhere to mutually agreed conditions of cooperation (CEPAL, 2011).⁶

By promoting the use of genetic resources and associated traditional knowledge and by enhancing opportunities for the fair and equitable sharing of benefits derived from their use, the Protocol creates incentives for conserving biological diversity and utilizing its components sustainably. It further enhances the contribution of biological diversity to sustainable development and human well-being (CEPAL, 2011, p. 3).

This study utilizes information from the United Nations Treaty Collection, which confirms that the Protocol entered into force on 12 October 2014, in accordance with Article 33⁷ (see Annex 2 for further details).

3.1.5. Kyoto Protocol

The Kyoto Protocol was adopted in 1992 at the third session of the UNFCCC. One of its objectives was to reduce emissions from 36 industrialized countries and the European Union by an average of 5% compared to 1990 levels over 2008–2012. It also called on industrialized countries to adopt mitigation policies and to report periodically (UNFCCC).⁸

⁴UNFCCC (2021). Key aspects of the Paris Agreement. https://cop23.unfccc.int/most-requested/key-aspects-of-the-paris-agreement?_gl%3D1*_jlre7*_ga*MTI5NjA5MzQwNC4xNjg2MDE1MzA4*_ga_7ZZWT14N79*MTY4NjAxNTMxMC4xLjEuMTY4NjAxNTQwOC4wLjAuMA&sa=D&source=docs&ust=1688262712147434&usg=AOvVaw1M-IKt0shkZrWQcTQPdaan.

⁵UNTC. See Annex 2 for further information.

⁶CEPAL (2011). The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. https://observatoriop10.cepal.org/sites/default/files/documents/treaties/nagoya_protocol_sp.pdf.

⁷UNTC. Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity.

⁸UNFCC. What is the Kyoto Protocol? URL: https://unfccc.int/kyoto_protocol.

This study utilizes information from the United Nations Treaty Collection, specifically for the Kyoto Protocol to the UNFCCC and the Amendment to Annex 2 of the Kyoto Protocol to the UNFCCC. The Amendment was adopted in 2006 at the second session of the COP to the Kyoto Protocol. According to the United Nations, the Protocol enters into force on the ninetieth day after at least 55 Parties to the Convention, including Annex I Parties representing at least 55% of the total CO₂ emissions for 1990 of Annex I Parties, have deposited their instruments of ratification, acceptance, approval, or accession. The Amendment enters into force for Parties that have accepted it on the ninetieth day following the date on which the Depository receives instruments of acceptance from at least three-fourths of the Parties to this Protocol. The Amendment enters into force for any other Party on the ninetieth day following the date on which that Party deposits its instrument of acceptance of the Amendment with the Depository.⁹ (see [Annex 2](#) for further details).

3.1.6. FTAs with the European Union

FTAs with the European Union include environmental clauses for promoting and contributing to sustainable development. These agreements take a comprehensive approach towards trade and sustainable development, where the Parties recognize the value of governance and international environmental agreements, reaffirming their commitment to comply with their rules and practices.¹⁰ Information on these agreements is drawn from relevant government sources and official documentation.

Within the realm of study, the aim is to underscore the influence of environmental clauses on trade. In this context, and based on the review of literature, it is anticipated that the primary environmental clauses, duly approved and implemented in countries belonging to the CAN and the MERCOSUR will exert a significant positive impact on trade development in the region.

The consulted literature suggests that the inclusion of environmental clauses in trade agreements can not only foster more sustainable practices but also facilitate market access by promoting shared environmental standards. This approach has the potential to strengthen trade relationships while addressing common environmental concerns among participating countries.

Furthermore, it is relevant to highlight that environmental clauses not only influence the perception and behaviour of trade actors but can also have implications in terms of access to international markets and the competitiveness of local industries. The alignment of environmental policies through these clauses can create a more conducive environment for trade, incentivizing foreign investment and promoting active participation in global value chains.

⁹UNTC – UNCTC. Amendment to [Annex 2](#) of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

¹⁰Multilateral environmental agreements: Montreal Protocol on Substances that Deplete the Ozone Layer, adopted on September 16, 1987; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, adopted on March 22, 1989; Stockholm Convention on Persistent Organic Pollutants, adopted on May 22, 2001; Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), adopted on March 3, 1973; Convention on Biological Diversity (CBD) and its associated Cartagena Protocol on Biosafety, adopted on January 29, 2000; Kyoto Protocol of the UNFCCC, adopted on December 11, 1997; and Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, adopted on September 10, 1998. These multilateral environmental agreements encompass various protocols, amendments, annexes, and adjustments ratified by the Parties. From (p. 80): http://www.sice.oas.org/Trade/COL_PER_EU_FTA/COL_EU_Accord_s.pdf.

Table 2. CAN-European union FTA – Effective date.

FTA with the EU	Effective Date
Colombia	2013
Ecuador	01/01/2017
Peru	03/01/2013

¹¹Source: SICE-OEA.¹¹

¹²See Marques & Spies (2006), Melitz (2005), Subramanian & Wei (2003), and Rose (2002).

¹¹OEA. Trade agreements by country. http://www.sice.oas.org/ctyindex/ARG/ARGagreements_s.asp.

Authors' elaboration. OEA. Trade agreements by country. http://www.sice.oas.org/ctyindex/ARG/ARGagreements_s.asp.

¹¹OEA. Trade agreements by country. http://www.sice.oas.org/ctyindex/ARG/ARGagreements_s.asp.

Table 3 shows the variables used in this study and their sources.

Finally, Table 4 presents descriptive statistics for the variables used in the study. Table 2 reports the descriptive statistics of the primary variables. The average participation in the Paris Agreement was 18%, indicating a certain engagement in global efforts to address climate change among the blocs of countries. Meanwhile, the low averages for the Kyoto Agreement (2%), the Nagoya Agreement (9%), and the European Union Agreement (3%) suggest more limited adherence to specific agreements between pairs of countries in the analysis.

The consistency in participation over time varies, underscoring the importance of considering these dynamics to understand the differential impact of environmental clauses on trade within the CAN and MERCOSUR. Finally, Annex 1 presents the Free Trade Agreements (FTA) for the countries of origin during the period 2001-2019.

Table 3. Sources of variables used in the study.

Endogenous variables		Source
<i>Exports from the country of origin</i>	Expressed in logarithms	Trade Map
<i>Imports from the country of origin</i>	Expressed in logarithms	Trade Map
<i>GDP of the country of origin</i>	Expressed in logarithms	World Bank
<i>GDP of the country of destination</i>	Expressed in logarithms	World Bank
<i>Population of the country of origin</i>	Expressed in logarithms	World Bank
<i>Population of the country of destination</i>	Expressed in logarithms	World Bank
<i>Bilateral distance</i>	Coordinates of longitude and latitude	CEPII
<i>Similarity (GDP similarity index)</i>	Expressed in logarithms	CEPII
<i>Factor (Absolute difference in factor endowments between countries)</i>	Expressed in logarithms	World Bank
<i>Dummy variables for bilateral characteristics</i>	Vector of variables including common language (dummy), shared borders (dummy), and the land area of the exporter and importer.	CEPII
<i>Kyoto</i>	1: The countries have signed the Kyoto Agreement. 0: The countries have not signed the Kyoto Agreement.	Climate Policy Database
<i>Paris</i>	1: The countries have signed the Paris Agreement. 0: The countries have not signed the Paris Agreement.	Climate Policy Database
<i>Nagoya</i>	1: The countries have signed the Nagoya Agreement. 0: The countries have not signed the Nagoya Agreement.	Climate Policy Database
<i>Free Trade Agreements with the European Union (UE)</i>	1: The countries have an FTA with the EU. 0: The countries do not have an FTA with the EU.	Organization of American States (OAS)

Source: Authors' elaboration.

Table 4. Descriptive statistics.

Variable	N	Mean	Std.Dev.	Min	Max
	(1)	(2)	(3)	(4)	(5)
Ln(Exports)	6,536	12.25	2.48	1.1	18.0
Ln(Imports)	6,536	16.73	1.21	14.3	19.3
Ln(Mass)	6,536	51.90	2.39	45.4	59.0
Bilateral distance	6,536	8.93	0.83	5.4	9.9
Similarity	6,536	-1.81	1.13	-6.6	-0.7
Factor	6,536	1.39	0.92	0.0	4.2
Contiguity	6,536	0.09	0.29	0	1
Common language	6,536	0.31	0.46	0	1
Ln(Area)	6,536	13.89	1.23	12.1	16.0
Ln(Area Partner)	6,536	12.50	2.26	6.5	16.7
Paris Agreement	6,536	0.18	0.38	0	1
Kyoto Agreement	6,536	0.02	0.15	0	1
Nagoya Agreement	6,536	0.09	0.29	0	1
Union European Agreement	6,536	0.03	0.17	0	1

Source: Authors' elaboration. The descriptive statistics presented in the table reflect the overall data.

3.2. Methodology

This research draws on the study conducted by De Santis (2011) to analyse the impact of multilateral environmental regulations on CAN and MERCOSUR trade. Utilising a panel data approach, the author examines how these environmental regulations influenced trade in 15 European Union countries over the period 1988–2008.

The adoption of a panel data approach, as in De Santis (2011), is relevant for addressing the research question in this study, given the nature of the dataset utilised. Panel data analysis offers a distinct advantage, as it enables the examination of the effects of variables over time using the available information.

To implement this methodology, first, a Breusch-Pagan test was conducted to compare the use of a panel data methodology against a pooled dataset. Second, a Hausman test was performed to compare panel data models with random effects versus fixed effects in case there is an issue of correlation between the unobservable heterogeneity term and the regressors included in the model.

Moreover, considering the potential challenge of endogeneity resulting from the correlation between the model's exogenous variables and the error term varying at individual and time levels, the study employs the Hausman-Taylor analysis. This approach accounts for the plausible correlation of the explanatory variables with individual effects (Baltagi, 2008). To address this concern effectively, the method employs an instrumental variables approach using a Two-Stage Least Squares (2SLS) methodology.

The instruments must meet two crucial conditions for their suitability: 1) exogeneity, meaning they should not be correlated with the error term that varies over time and at the country level in the equation being estimated, and 2) relevance, indicating that they should be correlated with the explanatory variable being instrumentalised or experiencing endogeneity. These conditions ensure the quality and relevance of the instruments used in the analysis.

Subsequently, an endogeneity test is performed to assess its significance in the analysis – essentially, to determine whether addressing endogeneity is necessary in this analysis or not.

Like the referenced research, the equation we estimate includes three sets of variables in the gravity equation: i) standard gravity variables, ii) variables as substitutes for the multilateral trade resistance index, and iii) dummy variables for trade and environmental agreements:

- (1) Standard gravity variables: Bilateral distance as a proxy for transportation costs, and the product of the importer's and exporter's GDP as an indicator of "mass".
- (2) Multilateral trade resistance index: Following the approach of De Santis (2011) and Feenstra (2004), specific dummy variables are included for each pair of countries, such as common language, shared borders, currency, and land area of the exporter and importer.¹²
- (3) Trade and environmental agreements.

The regression equations take the following forms:

$$\begin{aligned} \ln EXP_{ijt} = & b_0 + b_1 \ln Mass_{ijt} + b_2 \ln Distance_{ij} + b_3 \text{Similarity}_{ijt} + b_4 \text{Factor}_{ijt} + b_5 Z_{ij} \\ & + b_6 \text{Kyoto}_{ijt} + b_7 \text{Paris}_{ijt} + b_8 \text{Nagoya}_{ijt} + b_9 \text{EU}_{ijt} + \mu_i + \varphi_j + \sigma_{ij} + \omega_t + e_{ijt} \end{aligned} \quad (1)$$

Where $\ln EXP_{ijt}$ is the natural logarithm of country i's exports to country j in year t; $\ln Mass_{ijt}$ is the natural logarithm of the product of the GDP of the exporting and importing countries, used as an indicator of the "mass" of trading countries i and j in year t; $\ln Distance_{ij}$ represents the distance between countries i and j, which was estimated using each country's longitude and latitude coordinates; and Similarity_{ijt} is the similarity index for the GDP of the two trading partners, which serves as a measure of country size, and it is constructed as follows:

$$\text{Similarity}_{ijt} = \ln \left[1 - \left(\frac{PBI_{it}}{PBI_{it} + PBI_{jt}} \right)^2 - \left(\frac{PBI_{jt}}{PBI_{it} + PBI_{jt}} \right)^2 \right] \quad (2)$$

Next, Factor_{ijt} represents the absolute difference in factor endowments and is constructed as follows:

$$\text{Factor}_{ijt} = \left| \left(\frac{PBI_{it}}{POP_{it}} \right) - \left(\frac{PBI_{jt}}{POP_{jt}} \right) \right| \quad (3)$$

Where POP represents the population of countries i and j in year t.

Additionally, Z_{ij} is a vector of dummy variables that capture bilateral characteristics between countries i and j (i.e., dummies for common language, shared borders, currency, and exporter's and importer's land area). Finally, the trade and environmental treaty variables, such as the Paris Agreement, the Kyoto and Nagoya Protocols, and FTA with the European Union, are specified as dummies that take a value of 1 if countries i and j have the agreement in force in period t, and 0 otherwise.

The model also incorporates a constant term (b_0), fixed effects at the country (μ_i, φ_j), pair of countries (σ_{ij}), and time (ω_t) levels, with the aim of controlling for other factors that could be related to their trade relationships. Please notice that when distance is

¹²See Marques & Spies (2006), Melitz (2005), Subramanian & Wei (2003), and Rose (2002).

included in the regression the term (σ_{ij}) , is not included. This term will be added in the within specifications of the model, in which distance will be absorbed by the pair fixed effects. It should be noted that according to Kandogan (2007) it is important to make the proper specification of the model in order to evaluated assertively the trade effects because there is often considerable sensitiviyy to the specification of the gravity model used.

The second equation to be estimated is:

$$\begin{aligned} LnIMP_{ijt} = & b_0 + b_1 LnMass_{ijt} + b_2 LnDistance_{ij} + b_3 Similarity_{ijt} + b_4 Factor_{ijt} + b_5 Z_{ij} \\ & + b_6 Kyoto_{ijt} + b_7 Paris_{ijt} + b_8 Nagoya_{ijt} + b_9 EU_{ijt} + \mu_i + \varphi_j + (\sigma_{ij}) + \omega_t \\ & + e_{ijt} \end{aligned} \quad (4)$$

Where $LnIMP_{ijt}$ is the natural logarithm of the variable representing the imports from country i to country j in year t. The specifications of the variables included in this equation are the same as those detailed for the natural logarithm of the export equation.

The Hausman-Taylor model in a bilateral form is presented in equations (5) and (6), for the outcome variables of interest:

$$LnEXP_{ijt} = \alpha_0 + \beta_1 X_{1ijt} + \beta_2 X_{2ijt} + \delta_1 Z_{1ij} + \delta_2 Z_{2ij} + \mu_i + \varphi_j + (\sigma_{ij}) + \omega_t + e_{ijt} \quad (5)$$

$$LnIMP_{ijt} = \alpha_0 + \beta_1 X_{1ijt} + \beta_2 X_{2ijt} + \delta_1 Z_{1ij} + \delta_2 Z_{2ij} + \mu_i + \varphi_j + (\sigma_{ij}) + \omega_t + e_{ijt} \quad (6)$$

where α_0 is the constant term, the model includes fixed effects at the country (μ_i, φ_j) , pair of countries (σ_{ij}) , and time (ω_t) levels, with the aim of controlling for other factors that could be related to their trade relationships. Additionally, X_1 are the time-varying variables uncorrelated with σ_{ij} , X_2 are the time-varying variables correlated with σ_{ij} ; Z_1 are time-invariant variables, uncorrelated with σ_{ij} and Z_2 are time invariant variables correlated with σ_{ij} .

As in De Santis (2011) is specify, the σ_{ij} term also includes bilateral characteristics not specifically modelled in X_1 , X_2 , Z_1 and Z_2 . It includes also unobservable trade resistance variables.

The presence of X_2 and Z_2 . Causes correlation with unobserved individual effects. For that reason, Hausman-Taylor model uses variables already included in the model to instrument X_2 and Z_2 by the deviations from the group of mean of X_2 and Z_2 respectively. The election of the instruments could be base of the economic intuition (Hausman & Taylor, 1981) or following different procedures (De Santis, 2011).

It is worth mentioning that, unlike De Santis (2011), this study aims to identify the effect of environmental regulations on CAN and MERCOSUR trade during a more recent period. Moreover, De Santis (2011) specifically examines the European Union, which has distinct characteristics differing from LAC countries. Furthermore, this article seeks to complement previous studies conducted by Fairlie et al. (2021) on the relationship between trade and the environment in Pacific Alliance countries.

4. Results

We present the two main results of this research, regarding the impact of trade and environmental regulations on CAN and MERCOSUR trade, along with a joint regression for both trade blocs. Firstly, we assess the effect of these regulations on exports (Table 5). Secondly, we examine their effect on imports (Table 6). Both results involve the three most relevant estimation methodologies as we defined in the section before: random-effects (GLS) and fixed-effects (Within) panel analysis, as well as the Hausman-Taylor (HT) estimation.

To determine the most suitable methodology for explaining the proposed model, the Hausman (1978) test was used to compare the results of the random-effects model (GLS) and the fixed-effects (Within). The null hypothesis that the conditional mean of the disturbances given the regressors is zero was not rejected. For that reason, the Hausman test identifies that the random-effects model (GLS) is the most appropriate method for explaining the analysed data.

Furthermore, in line with Baltagi et al. (2003) and Baltagi (2023), a second Hausman test is conducted to examine fixed-effects (Within) and Hausman-Taylor (HT). This additional test affirms the absence of endogeneity despite the potential correlation that

Table 5. Export analysis estimation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total			CAN			MERCOSUR		
Variables	GLS	Within	HT	GLS	Within	HT	GLS	Within	HT
Ln(Mass)	0.202 (0.145)	0.232* (0.136)	0.357*** (0.0366)	0.162 (0.260)	0.188 (0.247)	0.407*** (0.0505)	0.185 (0.186)	0.211 (0.176)	0.286*** (0.0347)
Ln(Distance)	-2.526 (1.759)		-0.560*** (0.143)	-2.678 (1.688)		-0.722*** (0.270)	0.601 (0.684)		-0.374*** (0.110)
Similarity	0.521*** (0.187)	0.517*** (0.180)	0.426*** (0.143)	0.189 (0.366)	0.198 (0.359)	0.161 (0.197)	0.648*** (0.219)	0.635*** (0.211)	0.161** (0.0714)
Factors	0.296* (0.156)	0.291* (0.150)	0.170 (0.125)	0.205 (0.275)	0.211 (0.274)	-0.00543 (0.175)	0.292 (0.189)	0.279 (0.181)	-0.162 (0.103)
Paris (=1)	0.288* (0.162)	0.303* (0.155)	-0.0105 (0.0885)	0.128 (0.225)	0.145 (0.215)	-0.143 (0.118)	0.475* (0.272)	0.483* (0.263)	0.118 (0.124)
Kyoto (=1)	0.532* (0.297)	0.527* (0.290)	0.540* (0.291)	0.474 (0.299)	0.467 (0.292)	0.500* (0.295)			
Nagoya (=1)	-0.291** (0.140)	-0.280** (0.131)	-0.300** (0.133)	-0.0708 (0.215)	-0.0441 (0.199)	-0.123 (0.207)	-0.483*** (0.171)	-0.486*** (0.160)	-0.457*** (0.159)
European Union (EU) (=1)	-0.558** (0.242)	-0.568** (0.236)	-0.573** (0.239)	-0.513** (0.248)	-0.539** (0.241)	-0.554** (0.249)			
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,536	6,536	6,536	3,268	3,268	3,268	3,268	3,268	3,268
R-2		0.033			0.039			0.035	
Number of groups	344	344	344	172	172	172	172	172	172

The column (1), (4) and (7) corresponds to the estimation of a panel with random effects. The column (2), (5) and (8) corresponds to the estimation of a panel with fixed effects (within groups). Finally, the column (3), (6) and (6) corresponds to the estimation of a panel with the Hausman-Taylor method. The estimation methodology was conducted using panel data and includes control variables such as a common language, contiguity between countries, country size, and partner country size (both expressed in logarithms). Additionally, the estimation includes categorical variables such as country fixed effects and year fixed effects. The standard errors in parentheses are robust, and the significance level corresponds to the following classification: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6. Import analysis estimations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Total				CAN			MERCOSUR	
Variables	GLS	Within	HT	GLS	Within	HT	GLS	Within	HT
Ln(Mass)	0.272*** (0.0170)	0.271*** (0.0162)	0.609*** (0.00591)	0.246*** (0.0302)	0.248*** (0.0287)	0.615*** (0.00800)	0.192*** (0.0185)	0.190*** (0.0175)	0.604*** (0.00834)
Ln(distance)	-0.00934 (0.0409)		-0.353*** (0.112)	-0.0303 (0.0199)		-0.408*** (0.110)	-0.283*** (0.0666)		-0.204 (0.170)
Similarity	0.196*** (0.0237)	0.199*** (0.0230)	0.258*** (0.0347)	0.210*** (0.0413)	0.215*** (0.0398)	0.346*** (0.0609)	0.149*** (0.0216)	0.150*** (0.0208)	0.188*** (0.0427)
Factor	-0.0831*** (0.0200)	-0.0803*** (0.0192)	-0.178*** (0.0273)	-0.101*** (0.0369)	-0.0990*** (0.0357)	-0.213*** (0.0556)	-0.0328* (0.0174)	-0.0299* (0.0166)	-0.156*** (0.0303)
Paris (=1)	0.0453*** (0.0158)	0.0465*** (0.0151)	-0.203*** (0.00861)	0.138*** (0.0165)	0.139*** (0.0158)	-0.169*** (0.00903)	0.00637 (0.0311)	0.00665 (0.0301)	-0.224*** (0.0132)
Kyoto (=1)	0.0575* (0.0295)	0.0578** (0.0286)	0.0721* (0.0416)	0.0714** (0.0287)	0.0714** (0.0279)	0.0832* (0.0431)			
Nagoya (=1)	-0.0367** (0.0180)	-0.0390** (0.0171)	-0.0912*** (0.0193)	0.00758 (0.0232)	0.00606 (0.0218)	-0.0667*** (0.0235)	-0.0971*** (0.0156)	-0.1000*** (0.0149)	-0.129*** (0.0263)
European Union (EU) (=1)	0.00741 (0.0345)	0.00732 (0.0335)	0.00452 (0.0457)	-0.0802** (0.0318)	-0.0800** (0.0308)	-0.0641 (0.0448)			
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,536	6,536	6,536	3,268	3,268	3,268	3,268	3,268	3,268
R-2		0.968			0.981			0.973	
Number of groups	344	344	344	172	172	172	172	172	172

The column (1), (4) and (7) corresponds to the estimation of a panel with random effects. The column (2), (5) and (8) corresponds to the estimation of a panel with fixed effects (within groups). Finally, the column (3), (6) and (9) corresponds to the estimation of a panel with the Hausman-Taylor method. The estimation methodology was conducted using panel data and includes control variables such as a common language, contiguity between countries, country size, and partner country size (both expressed in logarithms). Additionally, the estimation includes categorical variables such as country fixed effects and year fixed effects. The standard errors in parentheses are robust, and the significance level corresponds to the following classification: * $p < 0.1$, ** $p < 0.5$, *** $p < 0.01$.

may arise from the relationship between time-varying and time-invariant factors with the disturbance terms. The rejection of the null hypothesis in the overidentification test serves as another indicator that the model does not exhibit endogeneity issues and does not require the use of instrumental variables for its estimation.

This outcome provides evidence that it is feasible to control for unobservable differences in bilateral trade within both time-varying and time-invariant contexts. Moreover, the discernible variations observed within this pair of countries offer additional support, suggesting that the model effectively captures and accounts for the unique characteristics and dynamics inherent to each nation.

To initiate the discussion about the GLS results, we explore the impact of trade and environmental agreements on the exports of the trade blocs. Our findings, presented in column (1) of [Table 5](#), reveal a positive and significant effect of 28.8% on CAN and MERCOSUR exports during the period 2001–2019, following the implementation of the Paris Agreement. This result underscores the significant influence of incorporating an agreement on export growth in these trade blocs. Similarly, adoption of the Kyoto Protocol has a positive and significant effect of 53.2% on CAN and MERCOSUR exports from 2001 to 2019.

In contrast, the inclusion of the Nagoya Protocol and the FTA with the European Union yielded negative and significant effects of 29.1% and 55.8%, respectively, on CAN and MERCOSUR exports during the period 2001–2019. These results allow for a comparison between CAN countries with a “deep integration” agreement with the European Union and MERCOSUR, which has not yet concluded such an agreement.

Focusing on CAN exports, the results presented in column (4) of [Table 5](#) reveal a 51.3% decrease in exports due to the FTA with the European Union. This could be attributed to the inclusion of more restrictive environmental clauses affecting Ecuador, Colombia, and Peru. As for the regional agreements (Paris Agreement, Kyoto Protocol, and Nagoya Protocol), which are not limited to CAN countries, there is no significant overall effect. This could be because these regulatory frameworks aim to restrict pollution effects from developed countries, as stipulated in the Paris Agreement. Additionally, the objectives outlined in the Kyoto and Nagoya Protocols, such as environmental conservation and access to traditional knowledge associated with genetic resources, may not be generating an impact on the target regions.

The negative effect of the FTA with the European Union may be attributed to competition barriers between European and local products, primarily in terms of technological sophistication and environmental standards. A recent publication by CEPAL ([2023](#)) on the outlook for international trade in the LAC region confirms the persistent high share of raw materials in the region’s total exports, as well as the challenges faced by the region’s industrial exports due to policies aimed at enhancing environmental sustainability. This is particularly relevant within the context of the regulatory requirements of the European Union (p. 25).

In the case of MERCOSUR, the results in column (7) primarily focus on the impact of the Paris Agreement and the Nagoya Protocol on trade. For this trade bloc, the Kyoto Treaty was omitted from the estimate due to its lack of temporal representation, and the agreement with the European Union was excluded due to the absence of a ratified deal. The findings indicate a contrasting effect, where the Paris Agreement positively

influences total exports by a significant 47.5%, while the Nagoya Protocol negatively impacts them by 48.3%.

It should be noted that the Paris Agreement is centred on combating climate change and reducing GHG emissions, while the Nagoya Protocol addresses access to genetic resources and the fair and equitable distribution of benefits derived from their use. Although both agreements aim to conserve biodiversity and promote the sustainable use of natural resources, they focus on different issues and operate under separate international conventions.

In this context, the positive impact of the Paris Agreement on MERCOSUR's trade could be attributed to the implementation of measures aimed at combating climate change and reducing GHG emissions. These actions could enable access to wider markets, stimulate innovation, and foster competitiveness, potentially creating new trade opportunities. These findings align with those of Do Amaral and Martins (2021), who posit that there are no provisions in the FTA with the European Union that would impose trade barriers in response to any potential non-compliance or violation of the Paris Agreement, particularly in the case of Brazil (pp. 21–22).

Conversely, the negative impact stemming from the Nagoya Protocol could be linked to the stipulations it imposes. These may pose obstacles or challenges for MERCOSUR exports related to genetic resources and traditional knowledge. The main causes might include restrictions on accessing genetic resources, increased transaction costs, limitations on traditional knowledge, and an uneven playing field if other countries do not adhere to the Protocol, i.e., if MERCOSUR countries are subject to stricter regulations than others. Coutinot et al. (2013) assert that for common markets in both the LAC and Euro-Mediterranean regions, the regulations of the Convention on Biological Diversity adversely affect the agroindustry. Similarly, the Agreement on Sanitary and Phytosanitary Measures can impact international trade, either directly or indirectly (p.4).

These findings are consistent with those indicated by UNCTAD (2021), Deere Birkbeck (2021), and CEPAL (2023) regarding the present and future challenges that the region's exports will confront in adhering to the regulations and standards of more advanced markets such as the European Union. Similarly, the outcomes derived from the Paris Agreement align with the observations of Ghosh and Yamarik (2006), Baghdadi et al. (2013), Martínez-Zarzoso (2017), and Do Amaral and Martins (2021). These studies highlight the indirect and positive impact of entering FTAs, leading to increased trade, reduced GHG emissions, and diminished environmental degradation.

We include an analysis of imports to thoroughly capture the bilateral relationship between countries and their links with environmental agreements. Using the tests mentioned earlier, we identify that the random effects panel data model (GLS) is the most appropriate for interpreting the data, compared to the within Fixed Effects and HT analysis. The findings, presented in column (1) of Table 6, reveal a positive and significant impact of 4.5% on both CAN and MERCOSUR imports over 2001–2019, following the implementation of the Paris Agreement. These results highlight the impact of adopting the Agreement on import growth in these trade blocs. Conversely, the adoption of the Nagoya Agreement induces a negative and significant effect of 3.7% on import growth in both trade blocs. In contrast to the export analysis, neither the Kyoto Protocol nor the FTA with the EU yield significant effects on the variable of interest.

The results presented in column (4) reveal that the FTA with the European Union leads to an 8.0% decline in CAN imports. This effect could arise from the inclusion of more restrictive clauses within the FTA's environmental chapter, applicable to Ecuador, Colombia, and Peru. Although the FTA provides an opportunity for integration into the international market, it simultaneously presents a significant challenge for Andean countries, demanding enhanced competitiveness and a fundamental need for product diversification, as posited by Pérez Chávez (2019).

Quispe-Remón (2020) has highlighted that, in contrast to the FTAs with the United States and China, the FTA with the European Union has shown a favourable (although decreasing) trade surplus for Peru. Similar trends have been observed for Colombia, although the decline has been less pronounced. In the case of Ecuador, positive effects have been observed, particularly for products such as bananas, tuna, and shrimp. It is important to note that Bolivia is the sole member of CAN, which is not part of this agreement. However, due to its relatively low economic growth, Bolivia remains eligible for the Generalized System of Preferences (GSP) unilaterally granted by the European Union to least-developed countries.

While the results of this agreement are positive for the three countries and the European Union, it does not contribute to the integration of CAN as a regional bloc. However, there is a willingness to establish an association between both regions once all CAN members become part of the agreement, including Bolivia.

Regional agreements, such as the Paris Agreement, are found to have a positive and significant effect of 1.4% on CAN imports. The Kyoto Protocol also has a positive effect of 7.1%, whereas the Nagoya Protocol does not demonstrate a significant overall effect. It is worth noting that the analysis of imports reveals less depth compared to the previously identified effects. The positive impact of environmental regulations on imports may stem from the facilitation of international trade among partner countries concerning the transfer of traditional knowledge and environmental conservation. These findings contrast with our observations regarding CAN exports, underscoring the need to rethink the formulation of objectives in such treaties and assess who truly benefits from them.

Regarding MERCOSUR, the results presented in column (7) primarily focus on the impact of the Nagoya Protocol on trade. In the case of this trade bloc, the Kyoto Protocol was omitted from the estimation due to its lack of temporal representation, and the agreement with the European Union was excluded as mentioned earlier. A contrasting result is that the Nagoya Protocol has a negative effect of 9.7% on imports. Whereas in the case of CAN, the effect is non-significant, this finding suggests that the Nagoya Protocol can have a negative impact by promoting sustainable and biodiversity-friendly practices with trading partners.

5. Discussion

This study aims to evaluate the impact of four environmental regulations on CAN and MERCOSUR trade during the period 2001–2019 using a panel data methodology. The findings contribute to the literature on the impact of these trade and environmental agreements on trade, complementing studies such as De Santis (2011), Kolcava et al. (2019), Najarzadeha et al. (2021) and Fairlie et al. (2023).

The study reveals that trade and environmental agreements have a significant and differentiated impact on CAN and MERCOSUR exports and imports, unlike FTAs. The

results indicate that the incorporation of these multilateral arrangements, such as the Paris Agreement, generates a positive effect on these blocs' exports and imports. Conversely, the findings differ in the case of the FTA with the European Union. These results are consistent with the expected objectives of these agreements, unlike the findings for the Kyoto and Nagoya Protocols.

It is important to note that the magnitude of the impact varies between the trade blocs, reflecting the differences in their trade and economic structures. Certain countries have experienced substantial export growth, which can be attributed to their capacity to adapt to environmental standards and their level of economic development. The negative effect observed in cases such as the FTA between the EU and CAN countries may be attributed to the inclusion of environmental or labour provisions. Further research is needed to examine the impact of "deep integration" agreements on trade in developing countries.

Continuous monitoring and evaluation of the impact of trade and environmental agreements on CAN and MERCOSUR trade is crucial. This will help identify potential challenges and areas for improvement in the implementation of environmental policies and promote sustainable long-term growth. The study primarily focuses on the pre-pandemic period, so it is relevant to further investigate developments during the pandemic and post-pandemic periods. Additionally, it would be valuable to incorporate distinctions based on the type of goods traded and pollution sources, as demonstrated in Martínez-Zarzoso et al. (2017) and Brandi et al. (2020).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendices

1. Annex Free Trade Agreements for the countries of origin during the period - 1

<i>Country</i>	<i>FTA</i>	<i>Entry into force</i>
Argentina	Chile	11/02/17
	MERCOSUR -Colombia AAP.CE N° 72	07/21/17
	MERCOSUR – Egypt	08/02/10
	MERCOSUR – Israel	12/18/07
	MERCOSUR – Peru (ACE 58)	11/30/05
Bolivia	Mexico	05/17/2010
Brazil	Chile	11/21/18
	MERCOSUR -Colombia AAP.CE N° 72	07/21/17
	MERCOSUR – Egypt	08/02/10
	MERCOSUR – Israel	12/18/07
	MERCOSUR – Perú (ACE 58)	11/30/05
	MERCOSUR	2005
	North Triangle (El Salvador, Guatemala, Honduras)	2009
	EFTA	2011
	Canada	2011
	United States of America	2012
	European Union	2013
	South Korea	2016
	Costa Rica	2016
	Pacific Alliance	2016
Ecuador	European Union	1/01/2017
Paraguay	MERCOSUR -Colombia AAP.CE N° 72	07/21/17
	MERCOSUR – Egypt	08/02/10
	MERCOSUR – Israel	12/18/07
	MERCOSUR – Peru (ACE 58)	11/30/05
Peru	United States of America	1/02/2009
	Cuba	9/03/2001
	MERCOSUR	2/01/2016
	Pacific Alliance	Jun-17
	Chile	22/08/2006
	Canada	1/08/2009
	Singapore	1/08/2009
	China	1/03/2010
	Thailand	31/12/2011
	Mexico	1/02/2012
	Japan	1/05/2012
	EFTA	2010–2011
	South Korea	1/08/2011
	European Union	1/03/2013
	Panama	1/05/2012
	Costa Rica	1/06/2013
	Venezuela	7/01/2012
	Honduras	1/01/2017

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Uruguay	Mexico (ACE 60)	11/15/03
	Chile	10/04/16
	MERCOSUR -Colombia AAP.CE N° 72	07/21/17
	MERCOSUR – Egypt	08/02/10
	MERCOSUR – Israel	12/18/07
	MERCOSUR – Perú (ACE 58)	11/30/05

Source: Organization of American States (OAS). Authors' elaboration.

2. Annex Protocols and Countries

Countries and Entry into Force				
8. b Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity		KYOTO PROTOCOL – Status of ratification		7.d Paris Agreement
Countries of origin	Ratification/Accession Approval (AA), Acceptance(A), Accession(a), Ratification	RATIFICATION, ACCEPTANCE, ACCESSION, APPROVAL	ENTRY INTO FORCE	Ratification, Acceptance(A), Approval (AA), Accession(a)
Argentina	12/9/2016	09/28/2001 (R)	02/16/2005	09/21/2016
Bolivia	6/10/2016 a	11/30/1999 (R)	02/16/2005	10/05/2016
Brazil	9/3/2021	08/23/2002 (R)	02/16/2005	09/21/2016
Colombia		11/30/2001 (Ac)	02/16/2005	07/12/2018
Ecuador	09/20/2017	01/13/2000 (R)	02/16/2005	09/20/2017
Paraguay		08/27/1999 (R)	02/16/2005	10/14/2016
Peru	07/08/2014	09/12/2002 (R)	02/16/2005	07/25/2016
Uruguay	07/14/2014	02/05/2001 (R)	02/16/2005	10/19/2016
Destination Countries				
Argentina	12/9/2016	09/28/01 (R)	02/16/2005	09/21/2016
Australia		12/12/07 (R)	03/11/2008	09/11/2016
Austria	07/20/2018	05/31/02 (R)	02/16/2005	10/05/2016
Bolivia	10/06/2016 a	11/30/99 (R)	02/16/2005	10/05/2016
Brazil	03/09/2021	08/23/02 (R)	02/16/2005	09/21/2016
Canada		12/17/02 (R)	02/16/2005	10/05/2016

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Chile		08/26/02 (R)	02/16/2005	02/10/2017
China	06/08/2016 a	08/30/02 (Ap)	02/16/2005	09/03/2016
Colombia		11/30/01 (Ac)	02/16/2005	07/12/2018
Costa Rica		09/08/02 (R)	02/16/2005	10/13/2016
Denmark	05/01/2014 AA	05/31/02 (R)	02/16/2005	11/01/2016 AA
Dominican Republic	11/13/2014	02/12/02 (Ac)	02/16/2005	09/21/2017
Ecuador	09/20/2017	01/13/00 (R)	02/16/2005	09/20/2017
El Salvador		11/30/98 (R)	02/16/2005	03/27/2017
France	08/31/2016	05/31/02 (Ap)	02/16/2005	10/05/2016
Germany	04/21/2016	05/31/02 (R)	02/16/2005	10/05/2016
Guatemala	06/18/2014	10/05/99 (R)	02/16/2005	01/25/2017
Honduras	08/12/2013	07/19/00 (R)	02/16/2005	09/21/2016
Hong Kong, China				
India	10/09/2012	08/26/02 (Ac)	02/16/2005	02/10/2016
Indonesia	09/24/2013	12/03/04 (R)	03/03/2005	31/10/2016
Israel		03/15/04 (R)	02/16/2005	22/11/2016
Italy		05/31/02 (R)	02/16/2005	11/11/2016
Japan	05/22/2017 A	06/04/02 (At)	02/16/2005	11/08/2016 A
South Korea	05/19/2017	11/08/02 (R)	02/16/2005	11/03/2016
Malaysia	11/05/2018 a	09/04/02 (R)	02/16/2005	16/11/2016
Mexico	05/16/2012	09/07/00 (R)	02/16/2005	09/21/2016
Netherlands	08/19/2016 A	05/31/02 (At)	02/16/2005	07/28/2017 A
New Zealand		12/19/02 (R)	02/16/2005	10/04/2016
Norway	10/01/2013	05/30/02 (R)	02/16/2005	06/20/2016
Panama	12/12/2012	03/05/99 (R)	02/16/2005	09/21/2016
Paraguay		08/27/99 (R)	02/16/2005	10/14/2016
Peru	07/08/2014	09/12/02 (R)	02/16/2005	07/25/2016

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Poland		12/13/02 (R)	02/16/2005	10/07/2016
Portugal	04/11/2017 AA	05/31/02 (Ap)	02/16/2005	10/05/2016
Russian Federation		18/11/04 (R)	11/18/04 (R)	11/18/2004 (R)
Singapore		04/12/06 (Ac)	11/07/2006	09/21/2016
Spain	06/03/2014	05/31/02 (R)	02/16/2005	01/12/2017
Sweden	09/08/2016	05/31/02 (R)	02/16/2005	10/13/2016
Switzerland	08/11/2014	07/09/03 (R)	02/16/2005	06/10/2017
United Arab Emirates	09/12/2014 a	01/26/05 (Ac)	04/26/2005	09/21/2016 A
United Kingdom	02/22/2016	05/31/02 (R)	02/16/2005	11/18/2016
United States of America				20/01/2021 A
Uruguay	07/14/2014	02/05/01 (R)	02/16/2005	10/19/2016

Source: Climate Policy Database. Authors' elaboration.