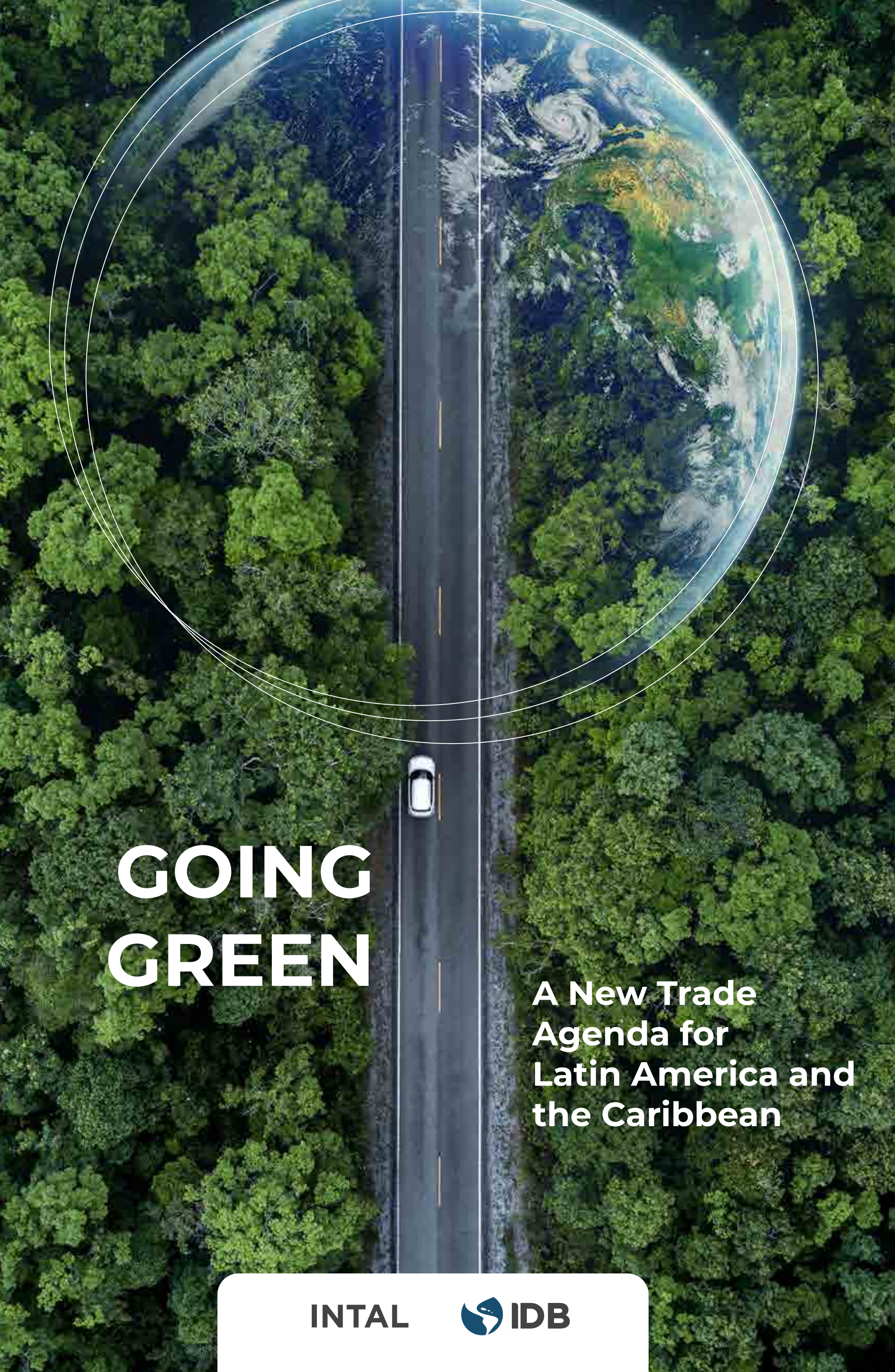

GOING GREEN

A New Trade Agenda for Latin America and the Caribbean

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GOING GREEN

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CHAPTER 5

SUSTAINABILITY AND INTERNATIONAL TRADE

THE IMPACT OF TRACEABILITY SYSTEMS IN CAMPECHE, MEXICO

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We are grateful to the beekeepers who took the time to answer the surveys analyzed in this chapter. Any errors are the responsibility of the authors.

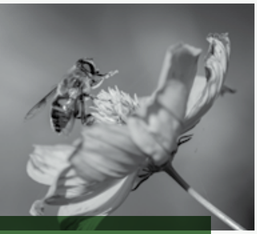
ACRONYMS AND ABBREVIATIONS

- **BCAM**
border carbon adjustment mechanism
- **DCE**
discrete choice experiment
- **EU**
European Union
- **SDGs**
Sustainable Development Goals
- **SENASICA**
National Service of Health, Food Safety, and Food Quality, Mexico

ABSTRACT

This study analyzes beekeepers' preferences regarding traceability systems in honey production in the state of Campeche, Mexico. We conducted a discrete choice experiment (DCE) in which the beekeepers surveyed were given a choice between three honey production scenarios. The production practices included in the DCE directly impact the health of the bees and their ecosystem services. Some 90% of the honey produced in Campeche is exported. The sale abroad of honey produced in line with the practices considered in this chapter is a channel through which international trade could trigger local growth and environmental conservation. Honey produced according to the practices studied would have a better chance of complying with sanitary regulations in importing countries. Implementing such measures, along with a traceability system, would allow Campeche and Mexico as a whole to position themselves as reliable suppliers. Our findings show that beekeepers would be willing to switch to production practices that conserve biodiversity and participate in a traceability system. In return, they would expect a bonus of just under US$2 per kilogram of honey. This figure is at the lower end of the range reported in previous willingness-to-pay studies for food traceability, suggesting that there appears to be potential to incentivize the production of traceable honey that conserves biodiversity in Campeche. These findings are an opportunity for the state government to act as an intermediary with various stakeholders in the honey value chain and as a driver of change at all stages in the honey supply chain.

1. INTRODUCTION



According to the 2030 Agenda for Sustainable Development, international trade could potentially become a driver for inclusive economic growth and poverty reduction, thus contributing to sustainable development (United Nations, 2015). As a direct consequence of this expectation, trade policymakers in developed and developing countries have initiated measures to seek a global green transition supported by international trade.

On the one hand, several regional trade agreements have been renegotiated to promote the spread of environmentally friendly goods and technologies by reducing or removing trade barriers (Gisselman and Merkus, 2023). On the other hand, trade rules have been amended to discourage imports of goods that contribute to deforestation. Indeed, the European Union (EU) has implemented a regulation on supply chains that seeks to stop member countries from contributing to deforestation in countries outside the bloc (López Bejarano, 2022).

At the same time, trade officials in each country have been forced to rethink conventional tariff schemes—the traditional objective of which is to protect domestic goods and services, balance the current trade account, and/or increase government revenues—to meet the dual objective of promoting domestic economic growth while "saving the planet" (Moreira and Dolabella, 2023). In this sense, several measures that form part of the European Green Deal are examples of new designs for tariff schemes to promote cleaner industries in countries outside the EU (European Commission, 2022). One such measure is the Border Carbon Adjustment Mechanism (BCAM), which seeks to set prices that reflect the carbon emitted during the entire production process of goods imported by EU member countries.

Traceability systems can help international trade go green. These systems systematically document the production, sale, and distribution of a given product (Beltrán and Coronado, 2021). They allow value chains to be monitored and checked, enabling consumers to trace the steps taken to manufacture the good or service they are about to purchase right back to the point of origin. Traceability systems can thus provide support for the monitoring of producers' environmental and biodiversity conservation initiatives. This is particularly important for goods that are traded internationally and therefore cannot be closely monitored by potential end consumers. At the same time, traceability systems can enhance the role of international trade in promoting inclusive economic development and poverty reduction. This role is important when producers are part of poor or vulnerable groups whom consumers may potentially be willing to compensate for using environmentally friendly practices.

Traceability mechanisms reduce information asymmetries throughout the production process, meaning that they can potentially promote differential payments to producers for adopting sustainable practices. As a consequence, more environmentally friendly goods can be placed on the international market. This study focuses on honey produced in the state of Campeche, Mexico, whose position on the international market could potentially be improved. Between 2009 and 2019, Mexico consolidated its position as one of the world's top 10 honey exporters. Luis-Rojas et al. (2022) interpret this as evidence that the European and US markets have revealed their preferences for honey perceived as being less likely to contain chemical components that are not approved by importing countries' regulations, as opposed to honey from China (the leading international producer), much of which is deemed to be of substandard quality (Jones Ritten et al., 2019; Luis-Rojas et al., 2022; Moore et al., 2012). Mexican honey is analyzed in laboratories in importing countries and is not allowed to enter their markets when the concentration of chemicals in it exceeds regulation ceilings, as happened in August 2012, when honey from Campeche was found to contain sulfates (Vázquez Martínez, 2022). According to European standards (FAO/WHO Codex Alimentarius Commission, 2023), Mexican honey is analyzed for pesticide residues and heavy metals, which are common components of fertilizers, pesticides, and paints.

Even though honey from Mexico is perceived as less likely to contain high concentrations of regulated chemicals, beekeepers engage in practices that expose bees to chemicals that can affect pollination services and biodiversity conservation. For example, to use hive boxes for longer, beekeepers paint them with products containing chemicals that affect pollination because they decrease the bees' ability to fly (Balbuena et al., 2015) and modify their sleep/rest patterns (Vázquez et al., 2020). Another practice that may affect pollination is the distance between apiaries and farmland. The greater the distance between these, the less likely it is that bees will come into contact with pesticides and fertilizers. While Mexico's National Service of Health, Food Safety, and Food Quality, Mexico (SENASICA) recommends there should be at least 3 km between the apiary and crops or farmland (SENASICA, 2022, p. 5), beekeepers in the country do not take measures to ensure this distance is maintained.

Given these findings, adopting a honey traceability system in Mexico could make beekeepers' practices transparent, notably by implementing changes that would improve bees' pollinating capacity, which would then have an impact on biodiversity. This would allow Mexican honey to strengthen its position in international trade. Indeed, there is already evidence of consumer segments that are interested in paying a premium for foods that can be tracked through traceability systems, including for honey (e.g., Mora and Menozzi, 2008; Cosmina, 2016; Jonas Ritten, 2019) and other foods like meats and grains. **By establishing a honey traceability system, Mexico has the chance to achieve two things at once: first, to consolidate itself as a reliable honey exporter by helping its beekeepers to produce honey that would earn a premium price; and second, to contribute to international trade through sustainable economic development by combating the sale of fraudulent honey, and thus countering the environmental impacts of this.**

The initial obstacle to implementing a traceability system in Mexico is the unwillingness of beekeepers in the country to do so. There is currently a traceability system for Mexican honey (SENASICA, 2022) but it depends on beekeepers keeping logbooks in which they report on their production practices. Mexican honey is thus not traceable in practice because only a tiny percentage of beekeepers keep logs—for example, according to figures reported in section 4, only 19% of beekeepers in Campeche do so. However, producers are likely unaware of the potential premium that consumers are willing to pay for traceable honey.

In this study, we begin to explore the feasibility of implementing a honey traceability system in Mexico. Specifically, we estimate the price beekeepers in the state of Campeche could expect to receive on the international market if their honey were produced using environmentally sustainable practices and a system that guarantees product traceability. To do so, we use a discrete choice experiment (DCE) to estimate the price premium that beekeepers would consider sufficient to compensate for changes in production practices. To address the possibility of beekeepers not being aware of the potential premium associated with traceability, the DCE is combined with a split-sample approach. This methodology works as follows: half of the respondents are explicitly told that the government is exploring the implementation of a traceability system that would allow them to receive higher prices for their honey on the international market, while the other half are told that the government is exploring a scheme that would allow them to receive higher prices but without providing any specifics.

On the international demand side, we present a range of prices that consumers would be willing to pay for traceable honey from Campeche, based on a review of estimates made in previous studies. We also discuss the potential for Mexican honey to access a higher-value segment of the international market. The DCE was presented to a representative sample of beekeepers in Campeche. These beekeepers were chosen because (i) Campeche is the second-largest honey-producing state in Mexico (SIAP, 2022) and (ii) the state authorities responsible for agricultural and beekeeping policies expressed interest in using the recommendations of this study to inform beekeeping policies that would enhance beekeepers' welfare. This interest translated into the authorities providing direct input into the design of the DCE implemented in this study.

The rest of this document is divided into five sections. Section 2 describes the beekeeping sector, focusing on (i) the international structure of the honey market; (ii) beekeeping production in Mexico; and (iii) the production, harvesting, and sale of honey in Campeche, with an emphasis on the components of this process that represent a challenge for the implementation of a traceability system. Section 3 describes food traceability. Section 4 provides a detailed description of the DCE that is implemented and analyzed in this study. Section 5 reports the results of the study. Finally, section 6 discusses the implications of these results and makes some recommendations.

2. THE HONEY MARKET

I) International structure

In 2022, global exports of natural honey[1] increased by an average of 17% compared to 2018, reaching US$2.27 billion. China was the world's leading honey exporter, accounting for US$277.7 million (10.5% of the total market). The figures also reveal that New Zealand, Argentina, India, and Ukraine contributed significantly to this market: together, they accounted for 43.1% of international sales of natural honey in 2022 (Workman, 2023).

Recent research has documented that China makes fraudulent claims regarding the quality and origin of its honey. This includes shipping honey to other Asian nations where the packaging is changed and the product is falsely labeled, such that it appears to originate in a country other than China (Ahmad and Khairatun, 2021; Ritten et al., 2019). These tactics allow Chinese producers to avoid (temporary) import restrictions in the United States and Europe. Production practices in China also include the use of unauthorized antibiotics (Trotta, 2013). One practice that is particularly detrimental to the environment and human health is the dilution of honey to conceal the presence of pesticide, herbicide, fertilizer, and paint residues (Bottemiller, 2013; Johnson, 2014). In terms of economic value, research conducted in 2011 revealed that the value of honey imported fraudulently into the United States from China is equivalent to US$80 million annually (Leeder, 2011).

China is not the only exporter that engages in fraudulent practices: these have been identified in other countries and have become a shared concern in terms of honey quality and environmental impacts, including on biodiversity. For example, García and Phipps (2018) note that the increase in global honey exports in 2015–2017 does not square with the relatively constant numbers of hives and the decrease in productivity per hive. This inconsistency suggests that fraudulent honey flooded the market during this period. The authors suggest that

1 · The honey market also includes by-products such as pollen, propolis, beeswax, and apitoxin or bee venom. Details on these by-products can be found in Dussart (2007).

India potentially also traded fraudulent honey as both China and India appear to experience a decline in hive numbers and productivity per hive, but a substantial increase in exports. They further emphasize that drops in productivity are an indicator of environmental degradation in the ecosystems where honey is produced.

Broadly speaking, fraudulent food represents an obstacle to achieving the Sustainable Development Goals (SDGs) (Chandan et al., 2023). It is particularly problematic when measuring progress in responsible consumption and production (SDG 12). Trade in fraudulent food implies that the international food supply chain still lacks transparency, which is an indispensable part of moving toward the SDGs. Transparent supply chains allow monitoring and verification mechanisms to be established, which are essential for implementing policies in the event of emergencies relating to foodborne diseases or contamination. Transparency is also a vital part of assigning responsibility through a monitoring system that both consumers and producers can trust. Such systems are also needed to verify the environmental outcomes of agreements reached under the EU Green Deal.

II) Production, harvesting, and sale of honey products in Campeche

Mexico ranks ninth globally in terms of its honey exports, which are mainly purchased by Germany and the United States (SIAP, 2022). The country's hive productivity (measured in kilograms of honey per hive) is high, outstripped only by Argentina and China[2] (Magaña Magaña et al., 2016).

The states of Yucatán, Campeche, and Quintana Roo produce a third of the country's total supply (SIAP, 2022). This region, known as the Yucatán Peninsula, has a long tradition of beekeeping that is important to its economy but is also socially and culturally significant (Güemes-Ricalde et al., 2003).

2 · The estimated productivity for China includes fraudulent honey because the calculations made by Magaña Magaña et al. (2016) are based on aggregated country-level data available from FAOSTAT.

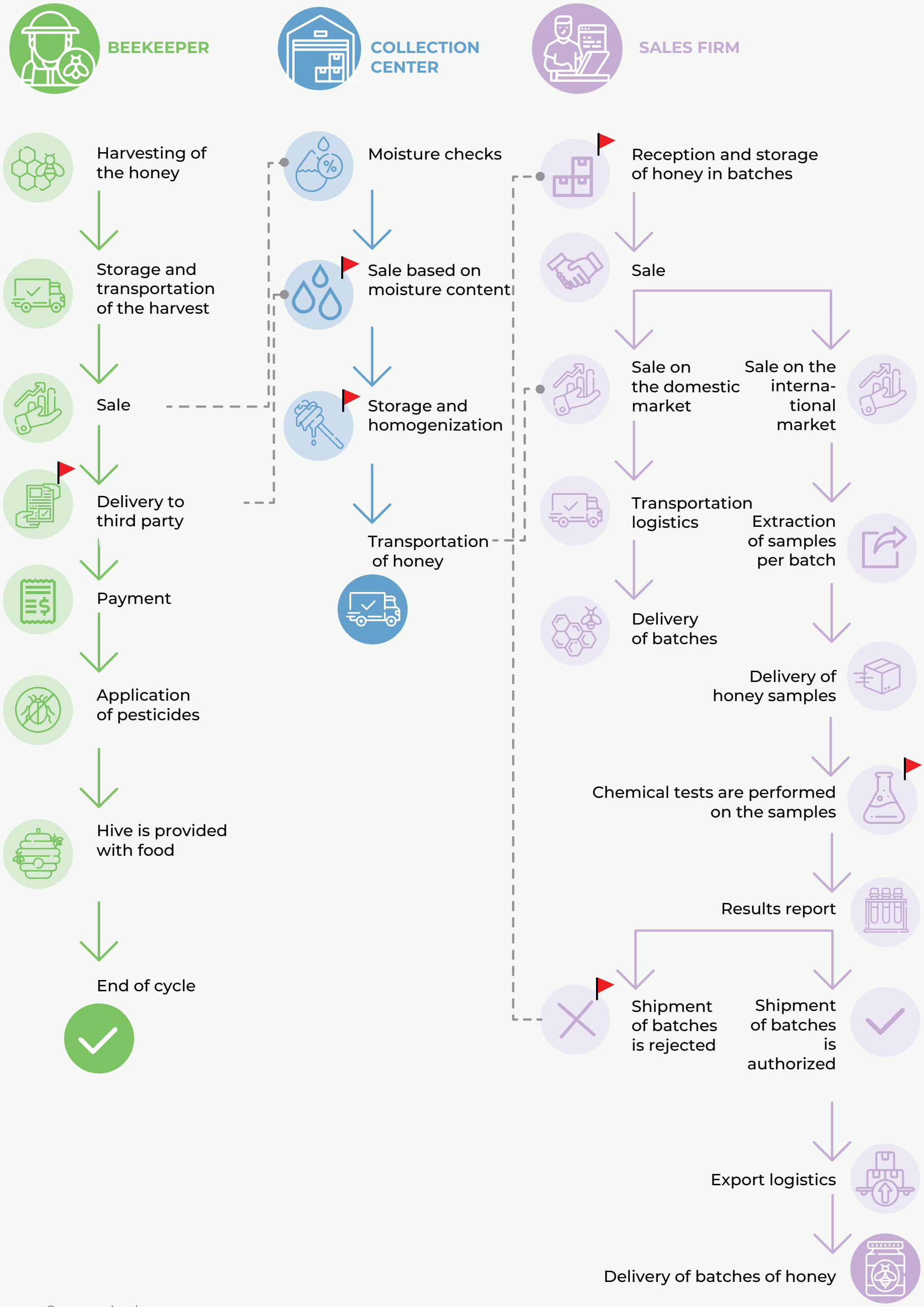
In Campeche, the second-largest honey-producing state in Mexico, there are around 7,500 honey producers. In 2021, honey production and sales in Campeche reached 8,951 tons, with an average price per ton of US$2,600. Around 90% of Campeche's honey reaches export markets, most notably Germany and Saudi Arabia (SIAP, 2022; Vázquez Martínez, 2022).

The honey harvesting and sales process in Campeche is shown in figure 1, which is divided into three panels that correspond to the main three stakeholders: beekeepers, collection centers, and sales companies. Each panel shows the activities carried out by each actor. The arrows across the panels show the activities in which these stakeholders are involved.

Generally speaking, the process starts with the beekeeper collecting, storing, and transporting the honey harvest. This can then be sold directly to the collection center or to a third party who acts as an intermediary. Once the honey is at the collection center, it is checked for moisture content, which is a determining factor in the price beekeepers receive—optimum levels are between 17% and 18%.[3] Once purchased, the honey is stored and homogenized by the collection center and then transferred to the premises of the sales company. This firm receives and stores the honey in batches that it sells to the international or domestic market. If a batch might be sold on the foreign market, a sample is taken and sent to laboratories approved by European buyers. Sale on the international market depends on the results of laboratory tests indicating that the chemicals present in the honey are below the thresholds established in European regulations (e.g., the Codex Alimentarius).

3 · The higher the moisture content of the honey, the lower the price, because moisture accelerates the fermentation process.

Figure 1.
Description of the Honey Harvesting and Sales Process in Campeche



Source: Authors.

However, there are critical points in the harvesting and sales process that reveal the advantages of a traceability system. These points are marked with red flags in figure 1. The first relates to who beekeepers decide to sell their honey to a collection center or a third party that functions as an intermediary. These intermediaries tend to be illegal honey traders known locally as "coyotes,"[4] who offer higher prices but are not officially authorized as collection centers.

The challenge associated with sales to coyotes is that they often do not test honey sufficiently to assess its quality. Three production practices can particularly affect honey quality at this point: painting hive boxes, the distance between apiaries and crops or farmland, and hive-cleaning methods. Although the purpose of painting hive boxes is to keep them in use for longer, the paint used contains chemicals that directly affect both the bees living in them and the honey they produce. The distance between the apiary and crops or farmland is a factor in honey contamination due to agricultural pesticides and fertilizers: the greater the distance between the apiary and crops, the less likely such chemicals are to reach and affect bees and their honey. Cleaning hives is important, but beekeepers tend to do this using methods involving chemicals such as gasoline.

4 · "Coyotes" are intermediaries who buy honey from producers and resell it to collection centers or traders. The defining feature of these intermediaries is that they are not regulated, which prevents their activities from being monitored.

The second critical point is when the collection center decides to purchase the honey in question. As figure 1 shows, the collection center evaluates honey moisture levels to decide what price to offer but does not test for chemicals. The advisability of chemical testing relates to the third key moment in the process, when the collection center mixes the honey received from individual beekeepers and intermediaries (i.e., homogenization). If the chemical profile of the honey is unknown, contaminated honey and honey that passes health and safety standards may be homogenized into the same batch.

The fourth critical point is the chemical testing that the trader performs on the honey being sold by the collection center. When the trader receives the honey, before deciding whether or not it can be exported, it stores it in batches without any rigorous origin checks. This is a direct consequence of the way in which homogenization is carried out since it is impossible to trace the origin of the honey at this stage. Challenges can subsequently arise during the export process if chemicals are detected that were not identified at earlier stages. Generally speaking, honey that is not successfully exported is sold on the domestic market, which has implications for the average quality of local honey.

3. FOOD TRACEABILITY

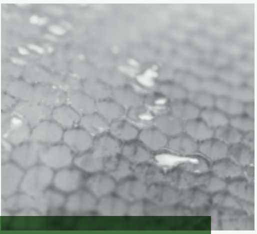
A traceability system is the systematic documentation of the production, sales, and distribution operations that enable a product to be made available to the final consumer (Beltrán and Coronado, 2021). In the food market, it is a tool for managing food hazards (Hobbs, 2004; Pouliot and Sumner, 2008). Traceability systems are extremely useful when handling contamination scares since they can be used to identify sources of risk and enable the affected products to be rapidly removed from circulation.

These systems operate reactively and preventively, as they allow potential sources of contamination to be identified early on and help countries and producers proactively adopt measures to mitigate future risks (Olsen and Borit, 2018). From the producer's point of view, a traceability system is a monitoring and oversight tool that allows data to be measured and collected to determine efficient resource allocations at each stage of production (Hualpa and Rangel, 2023).[5]

The use of a traceability system in the Mexican beekeeping sector **would allow the early detection of chemicals in honey and the identification of stakeholders engaging in questionable practices (beekeepers, collection centers, and/or sales companies),** particularly those active at the critical points described in the previous section. There is evidence that some consumer segments are interested in honey produced in ways that respect the environment and biodiversity (e.g., avoiding the use of pesticides and chemical fertilizers). A traceability system would thus allow Mexican beekeepers to reach those market segments. The sale of environmentally friendly honey would have positive effects on the environment and biodiversity in producing regions (as described in the next section), which would help international trade play its part in the transition to sustainable development. The next section explains how our DCE addresses the relationship between a traceability system and environmentally friendly practices within Mexican beekeeping.

5 · Technology plays a vital role in the effective implementation of traceability systems. Barcodes, radio frequency identification (RFID) tags, and blockchain are some examples of such innovations (Qian et al., 2020).

4. DISCRETE CHOICE EXPERIMENT



I) Earlier studies

This study focuses on documenting the preferences of honey producers in a Latin American country in relation to adopting a traceability system and practices that would reduce environmental impacts. However, most previous research addressing these issues focuses on the preferences of consumers in European countries and the United States for organic and/or locally produced honey.[6]

Cosmina et al. (2016) and Vapa-Tankosić et al. (2020) assess willingness to pay for organic, local honey in Italy and Serbia, respectively. Using a DCE, Cosmina et al. (2016) find that Italian consumers are more willing to pay for honey produced in Italy than organic honey—that is, local production is more important to them than organic production. Vapa-Tankosić et al. (2020) find the reverse preference among consumers in Serbia, who are willing to pay more for organic honey than locally produced honey.
Meanwhile, Arvanitoyannis and Krystallis (2006) and Ureña et al. (2008) explore market segments in Romania and Spain, respectively.

Arvanitoyannis and Krystallis (2006) use cluster analysis to identify three groups of honey consumers in Romania, which they label traditional consumers, enthusiastic consumers, and indifferent consumers.
Enthusiastic consumers would pay a premium for organically produced honey; indifferent consumers are not particularly interested in honey (regardless of whether it is conventional or organic); and traditional consumers are mainly interested in price changes (i.e., they buy cheaper conventional honey and most likely would not buy organic honey because of the premium it entails). The authors emphasize that consumers in Romania do not tend to be interested in labeling systems denoting country of origin or certifications. Ureña et al. (2008) divide their segments into regular consumers, occasional consumers, and potential consumers, reaching fairly similar conclusions to Arvanitoyannis and

6 · A group of studies that are related to ours but not included in this review explore how interested Latin American farmers or ranchers are in productive practices that have positive environmental impacts. For example, Colin Castillo et al. (2022) report on the interest of farmers in central Mexico in organic fertilizers and pesticides. Likewise, Ortiz et al. (2023) look at whether cattle farmers in Ecuador are interested in production practices that conserve water.

Krystallis (2006) regarding willingness to consume organic honey. They also observe that men are more willing than women to pay for organic honey in all three groups.

Two exceptions to the focus on organic honey are the studies by Ritten et al. (2019) and Wu et al. (2015). Both of these publications are more closely related to this study in that their starting point is the presence and increase in fraudulent honey and the resulting increase in risks to human health.
Ritten et al. (2019) have conducted laboratory experiments to explore the implications of informing Australian consumers about the negative effects of fraudulent honey on human health. Specifically, they find that providing this information leads to a 27% increase in the premium that consumers report being willing to pay for honey that is produced locally and using approved practices. Wu et al. (2015) document US consumers' interest in locally produced honey but leave out the organic focus that other studies have included. By conducting laboratory experiments, they report that consumers are more willing to pay a premium for locally produced honey, particularly when information is provided about the negative effects that fraudulent (internationally produced) honey can have on human health.

We have only identified two previous studies focusing on honey producers, both in Ethiopia: Girma and Gardebroek (2015) and Tarekegn et al. (2017). Focusing on southwestern Ethiopia, Girma and Gardebroek document an organic honey success story. Small producers in the region experienced an increase in their sales income after signing contracts with a company that sells organic honey internationally. Tarekegn et al. (2017) also find that producers in Chena district mainly sell their honey to cooperatives, which is a successful strategy for maximizing and stabilizing their sales income in the long term. In other words, even though they could sell to unregulated intermediaries offering higher prices (much like the Mexican "coyotes" described in section 2), honey producers in Chena decide to go through cooperatives, even though they offer lower average prices. They do so because cooperatives represent an alternative way of stabilizing incomes by providing access to international markets and offering both formal and informal benefits as part of membership (e.g., training, building social networks, etc.).

II) Atrributes

The DCE described in this chapter consisted of asking the beekeepers surveyed to choose one of three alternatives regarding different honey production practices. These options were presented via choice cards. Figure 2 shows the format of the DCE choice cards, which presented respondents with three alternatives. Each was described in terms of five attributes relating to production practices and one attribute relating to compensation, namely the price that the international market should pay, from the beekeeper's point of view, to compensate them for adopting the beekeeping practices presented in the DCE.

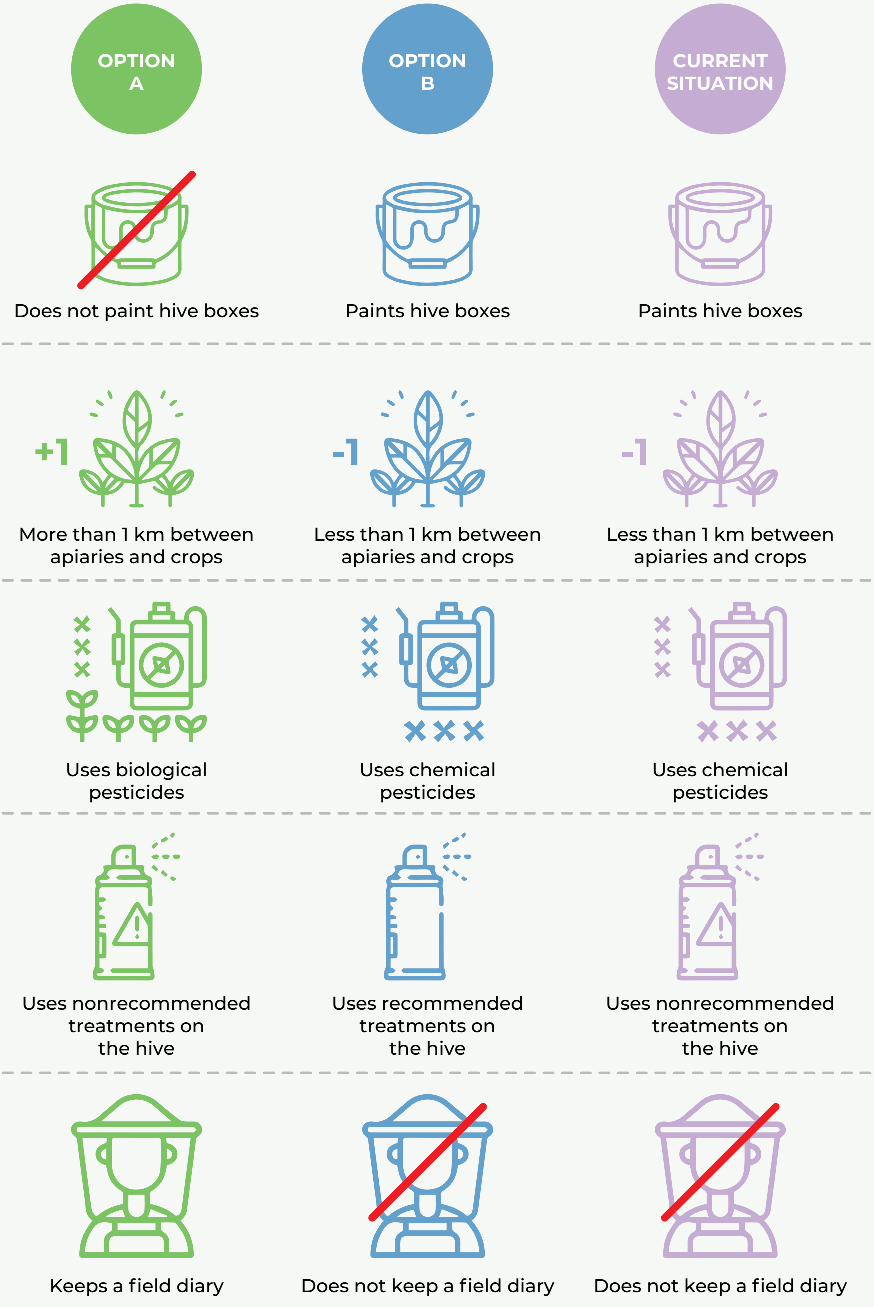
The circumstances shown in the last column of figure 2 represent the status quo—in other words, the conditions that currently prevail for beekeeping in Campeche. At present, beekeepers paint hive boxes, keep apiaries less than 1 km from crops or farmland, apply chemical pesticides to these crops, use nonrecommended chemical treatments in the hive, and do not keep field diaries.[7]

The honey production practices included in this DCE have a direct impact on the health of the bees and the ecosystem services they provide. The recent report by Vides Borrell et al. (2023) describes the effect of these practices. The authors document bee poisoning in Hopelchén, Campeche, which was reported on March 22, 2023. Their findings illustrate that bee poisoning occurs not only due to direct contact with chemicals—via paint or hive-cleaning strategies—but also through the use of pesticides in crop fields. Vides Borrell et al. (2023) document that the wind carried an insecticide used in a field at least 1.6 km away, affecting apiaries located in an area covering 11,304 ha. The authors calculate that the insecticide affected 110 apiaries belonging to 80 beekeepers and containing 3,365 hives. In economic terms, they estimate that 13,200 days of rural employment and US$741,000 were lost, including losses in honey production, swarm replacement, and pollination services.

7 · Other production practices are also part of the current modus operandi. These include how often queen bees are replaced or whether beekeeping is the respondent's main activity. However, our DCE does not include these or other practices for two reasons. The first reason is that we have prioritized practices that may have an impact on reducing the presence of chemicals in honey. The second is that the cognitive demand of the exercise increases with the number of attributes included. The number of attributes included in this study is consistent with the state of the art—less than 20% of the studies reviewed by Martínez-Cruz (2015) use seven or more attributes.

Pollination services are the most significant in terms of the impacts of current beekeeping practices on the environment and biodiversity. Globally, it is estimated that bees account for 80% of pollination (Gill et al., 2012). Bees' pollination capacity is not only jeopardized by exposure to chemicals that cause their death, as in the case documented by Vides Borrell et al. (2023). Gill et al. (2012) also argue that chronic exposure to chemicals affects bees' performance and feeding patterns even if it does not cause mortality—for example, bees that are chronically exposed to chemicals collect pollen less efficiently. This decrease in pollination efficiency is due to effects on both their flight ability (Balbuena et al., 2015) and sleep/rest patterns (Vázquez et al., 2020).

Figure 2.
Choice Card Presented to Respondents.



Source: Authors.

Regarding the positive externalities of bees in productive activities, Garibaldi et al. (2016) document the potential for what they call ecological intensification—that is, increasing crop yields by enhancing biodiversity. Specifically, they observe a pattern that holds in several regions of the world and for a variety of crops: in agricultural fields of 2 ha or less, pollinator density and variety are positively associated with crop yields.

Production practices that help to reduce bees' exposure to chemicals thus have a positive impact on their pollination capacity, with corresponding effects on biodiversity, without jeopardizing the positive externalities for agricultural production. **Given these findings, the DCE seeks to explore whether beekeepers are interested in moving toward more environmentally friendly practices and, if so, how much they would require as compensation for doing so.** One additional advantage of modifying the practices examined in this study is that honey produced by beekeepers in Campeche would stand a better chance of meeting importing country regulations. This, when combined with a traceability system, would help the state position itself as a reliable global honey supplier.

Table 1 shows the six attributes of the DCE and the options for each, which are known as levels. These levels reflect potential changes in production practices compared to the current situation. The first attribute in table 1 is the practice of painting hive boxes to keep them in use for longer. Since paint contains chemicals that contaminate the honey, it is recommended that hive boxes be left unpainted. There are thus two levels to this attribute: painting the hive box (current situation) and not painting the hive box. Abandoning this practice would align with the recommendations listed in the official Mexican organic beekeeping manual, which states that hive boxes should "be made of natural materials that do not present contamination risks for bees" (SENASICA, 2022, p. 5).

The second attribute is the distance between apiaries and agricultural crops. The greater this distance, the less likely it is that the honey produced in apiaries will be contaminated by agricultural pesticides and fertilizers. The organic beekeeping manual suggests that this distance should be at least 3 km (SENASICA, 2022, p. 5), which is beyond the possibilities of most beekeepers in Campeche.[8] As a result, we have proposed a more achievable distance in this DCE of at least 1 km.

8 · Pérez Canepa and Pérez Akaki (2017) report that most beekeepers in Campeche are small-scale in terms of both the number of hives they manage (less than 25, on average) and the area of land under their control (usually less than 2 ha). Given these circumstances, they cannot comply with the recommendation to keep their apiaries at least 3 km from crops.

The third attribute is the type of pesticide used on crops. Because the recommended distance between apiaries and crops is not realistic for most beekeepers, using biological pesticides is a complementary measure that will help reduce the probability of honey contamination due to proximity to crops. The transition to biological pesticides aligns with the recommendations of Mexico's official organic beekeeping manual (SENASICA, 2022, p. 5).

The fourth attribute concerns measures used to clean hives, which have a direct impact on hive health. Beekeepers in Campeche generally clean their hives using liquids containing chemicals that contaminate honey (e.g., gasoline). There are thus two levels for this attribute: nonrecommended treatments (current situation) and recommended treatments, which focus on avoiding the use of chemicals. The aim of the recommended treatments is for "workers who have direct or indirect contact with hives not to represent a risk of contamination" (SENASICA, 2022, p. 15).

The fifth attribute is the keeping of a field logbook, which would be the first step in establishing a traceability system that would allow consumers to trace honey to its origin. Keeping a logbook is necessary regardless of the technology used to implement traceability schemes. Logbooks are currently being promoted by SENASICA through the "certification program for producers interested in reducing the risks of honey contamination" (SENASICA, 2022, p. 12). To obtain certification, beekeepers must document the stages of production in their logbook.

The sixth attribute is financial, which was described to the respondent as the price they would receive on the international market per kilogram of honey produced using the practices mentioned in each alternative on the choice cards. There are five levels for this attribute. The current situation is MOP36, which is the average price received per kilogram of honey in 2022. The other four levels are MOP40, MOP43, MOP47, and MOP50.

Table 1.
Attributes and Levels Used in the Discrete Choice Experiment

ATTRIBUTE	DESCRIPTION	LEVELS
Painting hive boxes	Beekeepers paint hive boxes to keep them in use for longer, but the paint contains chemicals that contaminate the honey. It is therefore recommended that hive boxes should not be painted.	Yes (current situation); No.
Distance between apiaries and crops	The greater this distance, the less likely it is that the honey will be contaminated by agricultural pesticides and fertilizers.	Less than 1 km (current situation); more than 1 km.
Type of pesticide used on crops	The probability of honey contamination is higher for chemical pesticides compared to biological ones.	Chemical pesticides (current situation); biological pesticides.
Hive cleaning	Beekeepers usually maintain and clean their hives using treatments that contain chemicals that can contaminate the honey.	Nonrecommended treatment (current status); recommended treatments.
Keeping a field logbook (diary)	Field logbooks are the first step toward establishing a traceability system. They allow producers to make their production process more efficient.	No (current situation); Yes.
Price per kilogram of honey (in MOP)	Price that the beekeeper would receive per kilogram of honey produced using the practices described in each alternative scenario.	MOP36 (current situation); MOP40; MOP43; MOP47; MOP50.

Source: Authors

This DCE allows us to infer the willingness of beekeepers to accept monetary compensation for implementing the production practices described above. These practices—whether implemented together or separately—reduce the probability of honey being contaminated with chemicals, which has positive implications for Mexico's environment and biodiversity, and increase the probability of it complying with importing country standards.

Specifically, the DCE allows us to infer how much beekeepers would need to be compensated for using logbooks, the first step in establishing a traceability system. This would also entail several other steps, such as coordination between beekeepers and honey collection and sales companies. If this sort of coordination were simple, it would already be happening. The government has a part to play in this process, namely by designing and promoting a traceability system and facilitating and coordinating communication between beekeepers and collection and sales companies. However, beekeepers do not necessarily associate the traceability system with an opportunity to access better international prices.

We thus used a split-sample strategy to explore whether beekeepers are interested in a traceability system that would be designed and implemented by the state government and would allow them to access better international prices. The split-sample strategy consisted of introducing half of the respondents to the DCE by broadly describing the government's efforts without explicitly mentioning the traceability system. This is referred to in the following section as the "standard scenario":

> *The state government is considering implementing a program to enable honey producers in Campeche to obtain higher prices on the international market. In exchange, honey producers would be required to adapt their beekeeping practices.*
>
> *The Ministry of Agricultural Development has commissioned researchers from the University of Campeche and colleagues of theirs from the Swedish University of Agricultural Sciences to explore what changes you are willing to make to your beekeeping practices. The results of this study will be presented to authorities at the ministry, who will decide whether to implement the program based on this information.*

The remaining respondents were introduced to the DCE by being told about the government's efforts, making explicit mention of the traceability system. This is described in the following section as the "traceability scenario":

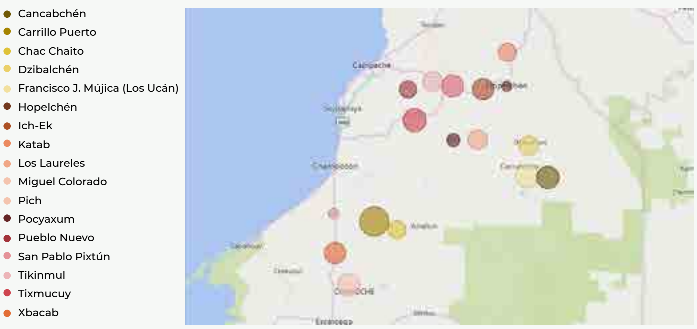
> *EThe state government is considering implementing a traceability program to enable honey producers in Campeche to obtain higher prices on the international market. Traceability would allow honey producers to document the health conditions of the honey they sell. This would imply honey producers adapting their beekeeping practices.*
>
> *The Ministry of Agricultural Development has commissioned researchers from the University of Campeche and colleagues of theirs from the Swedish University of Agricultural Sciences to explore what changes you are willing to make to your beekeeping practices. The results of this study will be presented to authorities at the ministry, who will decide whether to implement the program based on this information.*

This split-sample design enables us to infer whether beekeepers express more interest (measured in willingness to accept compensation) in changing their production practices when the possibility of implementing a traceability system is explicitly mentioned compared to when no such possibility is mentioned.

III) Application and descriptive statistics

In June and July 2023, we visited 17 areas in the three honey-producing municipalities of the state of Campeche (Hopelchén, Champotón, and Campeche) and surveyed 196 beekeepers: 66 in Hopelchén municipality, 66 in Champotón municipality, and 64 in Campeche municipality. Figure 3 shows the locations visited. To select the areas to be surveyed, we used simple random sampling on the list of beekeepers for 2018 provided by the Ministry of Agriculture and Rural Development.

Figure 3.
Locations Where the Discrete Choice Experiment Was Conducted



Source: Authors.

Table 2 provides socioeconomic information of the beekeepers who responded to the DCE: 84% are men, with an average age of 47; 11% are women, with an average age of 40; and the 5% who preferred not to state their gender have an average age of 56.

Table 2.
Socioeconomic Information for Beekeepers Surveyed (n=196)

SEX	#	AVERAGE AGE	AVERAGE # OF APIARIES	AVERAGE PRODUCTION (KG/HIVE)	PEOPLE WHO ARE ECONOMICALLY DEPENDENT ON PRODUCTION	PERCENTAGE SPEAKING AN INDIGENOUS LANGUAGE
Men	165	47	3	1,207	2	46%
Women	22	40	3	941	2	36%
Not specified	9	56	2	405	2	44%

Source: Authors.

Table 2 reveals that beekeepers in the state of Campeche are small-scale producers. Regardless of their gender, they each work three apiaries, on average. The average production reported by female beekeepers represents just 78% of the level reported by male beekeepers (941 kg/hive versus 1,207 kg/hive). Regardless of the gender of the beekeeper, an average of two other people are financially dependent on them. With regard to the significance of beekeeping in the region's culture, 46% of the male beekeepers and 36% of the female beekeepers state that they speak an indigenous language.[9]

9 · See annex tables A1, A2, and A3 for a more detailed description of respondents by municipality of residence.

5. INTEREST OF BEEKEEPERS IN CAMPECHE IN A TRACEABILITY SYSTEM

Table 3 shows the results of the conditional logit specifications carried out on the beekeepers' responses in each split sample and in the total sample. Participants in the sample presented with the standard scenario answered exactly the same choice cards as those in the group presented with the traceability scenario. As explained in the previous section, the difference between these two groups is that the latter were explicitly told that the state government is considering implementing a traceability system to enable beekeepers to access better international prices. **The logic behind this split-sample design is to explore whether beekeepers are more interested in changing their production practices when they are explicitly informed that the instrument being considered is a traceability system, as opposed to simply providing a very general description of the government's intention to implement a program to enable beekeepers to access better international prices (the generic scenario).**

Although we collected information from 196 participants (98 in each split sample), the econometric specifications reported in table 3 are based on 5,292 observations (2,646 in each split sample). The number of observations is the result of each respondent answering nine choice cards,[10] which each present three alternatives. That is, each observation reported in table 3 describes whether or not the participant selected each of the alternatives that were presented to them.

Keeping in mind that the coefficients reported in table 3 cannot yet be interpreted as measures of willingness to accept compensation—which are presented in table 4—these coefficients suggest the overall direction of preferences for the corresponding attributes or levels. That is, a positive coefficient indicates that respondents are interested in the attribute or level in question.

10 · Using this number of choice cards is consistent with the state of the art. For example, 53% of the studies reviewed by Martínez-Cruz (2015) use six to eight cards. The lowest number of cards used is four, and the highest number is 16.

The first coefficient in table 3 reflects the participants' preferences for the current situation, which refers jointly to the practices that are in practice at present (the third alternative for each choice card, as illustrated in figure 2): painting hive boxes, keeping their apiaries at less than 1 km from crops, using chemical pesticides on the crop, applying nonrecommended chemical treatments to the hive, and not keeping a field logbook.[11] The positive sign of the coefficient implies that, from the outset, beekeepers prefer the current situation. In other words, they would rather not change their production practices. This preference is observed in both of the split samples and thus in the whole sample.

The following five coefficients in table 3 denote each production practice as it currently stands: painting the hive box, a distance of less than 1 km between apiaries and crops, the use of chemical pesticides, not following hive-cleaning recommendations, and not keeping a field logbook. The aim of including these factors in the econometric specification is to assess whether there are specific preferences for one or more practices, on top of the inclination for these practices as a whole, as revealed by the coefficient associated with the current situation. There are two practices that respondents report having a particular preference for: chemical pesticide use and the current approach to hive cleaning. To forgo these activities, beekeepers in Campeche would require higher compensation (i.e., more than they earn in the current situation). These preferences are observed in both of the split samples and thus in the whole sample.

The last coefficient in table 3 reveals a highly significant preference for higher payment, which is consistent with both human intuition and classical economic theory: beekeepers prefer to be paid more rather than less. The coefficients reported in table 3 could be used to estimate beekeepers' willingness to accept monetary compensation to implement changes in their production practices via price increases on the international market.[12] Table 4 shows estimates of beekeepers' willingness to accept compensation that were obtained on the basis of both the full sample and each split sample. Given the 95% confidence

11 · To capture preferences for the current situation, the econometric specification includes a binary variable that takes value of 1 if the alternative under consideration describes the current situation, and 0 if the alternative is one of the two options that represent changes to production practices.
12 · Willingness to accept compensation for changing production practices is the result of dividing the corresponding coefficient by the coefficient associated with the monetary factor. In practice, this calculation yields a marginal rate of substitution between money and practice, which is equivalent to marginal willingness to accept compensation. See Ortiz et. al (2023) for a brief description of the theoretical and economic underpinnings of these calculations.

intervals, average values do not differ between the split samples, indicating that the explicit mention of the traceability system does not change beekeepers' average preferences. In the remainder of this paper, we refer to the estimates obtained from the full sample. These estimates are expressed in MOP/kg.

The first row in table 4 shows the amounts required for beekeepers in Campeche to consider changing their practices. On average, they would require MOP25.4/kg to do so. However, beekeepers are not willing to change all the practices considered in the DCE unless they are compensated for specific changes—namely refraining from using chemical pesticides and changing their hive-cleaning practices. They are willing to accept compensation of MOP3.6/kg for using biological pesticides and MOP3.9 for following hive-cleaning recommendations. In other words, beekeepers require a minimum of MOP33/kg in compensation (the sum of MOP25.4, MOP3.6, and MOP3.9). This is equivalent to approximately US$1.89 and represents 92% of the average price they received in 2022. **In other words, they would require their sale price to increase from $36 to $69.**

These results are estimates made from the full sample. Annex tables A4 through A9 report coefficients from the econometric estimates and estimates of willingness to accept compensation for the samples obtained within each of the three municipalities that produce honey in Campeche (Holpechén, Champotón, and Campeche). The results by municipality yield similar estimates, although there are some differences between them.[13]

How do the compensation-related aspirations of Campeche's beekeepers compare with foreign consumers' willingness to pay a premium for certain products? This comparison will allow us to ascertain whether traceability systems could potentially become the starting point for international trade to contribute to sustainable economic development in Campeche, allowing access to market segments that would pay a premium for production practices that conserve the environment and biodiversity in Campeche.

13 · Although discussing differences in preferences between municipalities would be instructive, we do not enter into such a discussion because we used simple random sampling, in line with our objective of obtaining a representative sample of beekeepers at the state level in Campeche. That is, our samples by municipality do not necessarily reflect the preferences of beekeepers in the corresponding municipality.

Table 3.
Conditional Logit Specifications (respondents=196, choice cards=9, alternatives on each card=3)

	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
Current situation	1.961*** (0.402)	2.210*** (0.574)	1.735** (0.565)
1 if hive boxes are painted	0.0281 (0.0546)	0.00324 (0.0777)	0.0537 (0.0770)
1 if the distance between apiaries and crops is greater than 1 km	0.0298 (0.0528)	0.0638 (0.0753)	-0.00391 (0.0744)
1 if using chemical pesticide	0.282*** (0.0549)	0.207** (0.0780)	0.357*** (0.0778)
1 if hive-cleaning recommendations are not followed	0.308*** (0.0529)	0.374*** (0.0752)	0.244** (0.0748)
1 if no field logbook is maintained	0.00982 (0.0540)	0.0787 (0.0767)	-0.0595 (0.0763)
Price per kilogram of honey (Mexican pesos)	0.0773*** (0.00826)	0.0817*** (0.0118)	0.0733*** (0.0116)
Observations	5,292	2,646	2,646
Respondents	196	98	98
Pseudo-R2	0.235	0.239	0.235
Log-likelihood	-1481.6	-737.4	-741.6
AIC	2,977.3	1,488.7	1,497.1
BIC	3,023.3	1,529.9	1,538.3

Source: Authors.

Table 4.
Willingness of Beekeepers to Accept Compensation for Changing Their Practices (estimates from specifications reported in table 2, CI=95%)

WILLINGNESS TO ACCEPT (MEXICAN PESOS/KILOGRAM)	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
For changing current situation Lower limit Upper limit	**25.4** 19.1 29.7	**27.0** 18.5 32.3	**23.7** 12.8 29.9
For not painting hive boxes Lower limit Upper limit	0.4 -1.1 1.78	0.0 -1.9 1.9	0.7 -1.4 2.9
For increasing the distance between apiaries and crops Lower limit Upper limit	0.,4 -0.9 1.7	**0.8** 0.9 2.6	0.0 -2.12 1.85
For using biological pesticides Lower limit Upper limit	**3.6** 2.2 5.3	**2.5** 0.7 4.7	**4.8** 2.69 7.7
For following hive-cleaning recommendations Lower limit Upper limit	**3.9** 2.5 5.9	**4.6** 2.6 7.5	**3.3** 1.3 6.4
For keeping a field logbook Lower limit Upper limit	0.1 -1.2 -1.5	0.9 -0.8 2.9	0.8 -2.89 1.31

Source: Authors.

Since this study does not focus on consumers, and in the absence of studies estimating consumers' willingness to pay more for traceable honey, we drew on the estimates reported by previous studies that looked at consumers' willingness to pay a premium for traceability in other foods. Table 5 lists the studies we drew on.

Table 5.
Studies Reporting Willingness to Pay for Food Traceability

COUNTRY	YEAR	BONUS	BONUS (US$ 2023)	QUANTITY	PRODUCT	STUDY
Norway	2003	NOK12	6	kg	Beef	(Alfnes and Rickertsen, 2003)
France	2003	US$9.26	7.5	kg	Beef	(Lusk, Roosen, and Fox, 2003)
Germany	2003	US$7.31	6.1	kg	Beef	(Lusk, Roosen, and Fox, 2003)
United Kingdom	2003	US$8.1	6.5	kg	Beef	(Lusk, Roosen, and Fox, 2003)
Germany	2004	€0.47	1.04	kg	Pork	(Enneking, 2004)
Netherlands	2007	€4.18	9.09	kg	Pork	(Meuwissen, Van Der Lans, and Huirne, 2007)

Source: Authors.

The estimates reported by each study have been converted into 2023 US$. **The compensation-related aspirations of Campeche beekeepers for changing their production practices and taking part in a traceability program is equivalent to just under US$2.** In terms of the average price per kilogram of honey, this figure represents an increase in value of almost double relative to the amount they are currently being paid. **However, in terms of willingness to pay for a traceability system, table 5 reveals that European consumers have reported values ranging from US$1 (in Germany) to US$9 (in the Netherlands).** In other words, the aspirations of Campeche beekeepers seem to be within a reasonable range.

6. CONCLUSIONS AND RECOMMENDATIONS

This study has focused on the supply of honey subject to a traceability system and has explored the preferences of beekeepers in Campeche, Mexico, in relation to this. Two tasks remain in analyzing the feasibility of a honey traceability system in the country. The first would be to study the preferences of a representative sample of beekeepers in Mexico. Although the state of Campeche ranks second in total production, it represents only 13% of the national total. It is therefore appropriate to view this study as a pilot that provides an initial understanding of beekeepers' preferences, on the understanding that **further research needs to be carried out to reach conclusions regarding beekeepers at the national level. The second pending task would be to explore demand for honey subject to a traceability system.** There are indications that consumers of honey and other food products are willing to pay a premium for the existence of a traceability system. However, to provide useful recommendations, we would need to know whether the willingness to accept compensation estimated in this study is matched by a willingness to pay among potential consumers. This demand study should focus on consumers in Europe and the United States (the two main markets for Mexican honey).

With these limitations in mind, the message of this study is clear: beekeepers in Campeche would be willing to move toward production practices that preserve the environment and biodiversity of their state and to participate in a traceability system that allows international consumers to verify production practices. In return, beekeepers would expect to receive additional payment of just under US$2/kg of honey. This aspiration seems reasonable because it is at the lower end of the range reported in studies of willingness to pay for food traceability—US$1 to US$9. As noted in section 2, honey **collection centers and sales companies are key players in the success of a**

traceability system Government initiatives should thus include these stakeholders in any discussions.

Developing a mechanism that allows collection centers to measure the presence of chemicals in honey would reduce contamination during the homogenization process. This will make it possible to establish financing schemes that benefit all stakeholders in the chain and thus to implement the traceability scheme.

In other words, since there are economic benefits for all stakeholders in the supply chain, the cost of investing in infrastructure and training to implement a traceability system throughout the supply chain do not have to be covered entirely by public funds.

However, subnational agricultural authorities have two immediate opportunities for action to promote traceability: (i) by facilitating discussions among the various stakeholders in the chain and (ii) through their beekeeping extension program to promote best practices, such as providing information on alternative techniques and materials for painting boxes (vegetable oils and ecological paints) and appropriate oversight of hive health. In the medium term, work needs to be done in partnership with the economic development and foreign trade departments and the academic and private sectors to calculate and determine the premium that the international market is willing to pay for traceable honey. This will make it possible to set up financing schemes that will benefit all stakeholders in the chain and allow the traceability system to be implemented.

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ANNEX

Tables documenting descriptive statistics and econometric results by municipality.

Table A1
Socioeconomic Information for Beekeepers Surveyed in Hopelchén Municipality (respondents=66.

SEX	#	AVERAGE AGE	AVERAGE # OF APIARIES	AVERAGE PRODUCTION (KG/HIVE)	PEOPLE WHO ARE ECONOMICALLY DEPENDENT ON PRODUCTION	PERCENTAGE SPEAKING AN INDIGENOUS LANGUAGE
Men	56	44	3	1,390	3	61%
Women	7	42	2	850	2	43%
Not specified	3	71	2	283	1	33%

Source: Authors.

Table A2
Socioeconomic Information for Beekeepers Surveyed in Champotón Municipality (respondents=66)

SEX	#	AVERAGE AGE	AVERAGE # OF APIARIES	AVERAGE PRODUCTION (KG/HIVE)	PEOPLE WHO ARE ECONOMICALLY DEPENDENT ON PRODUCTION	PERCENTAGE SPEAKING AN INDIGENOUS LANGUAGE
Men	63	47	3	1,078	2	44%
Women	3	43	7	2,770	1	67%

Source: Authors.

Table A3
Socioeconomic Information for Beekeepers Surveyed in Campeche Municipality (respondents=64)

SEX	#	AVERAGE AGE	AVERAGE # OF APIARIES	AVERAGE PRODUCTION (KG/HIVE)	PEOPLE WHO ARE ECONOMICALLY DEPENDENT ON PRODUCTION	PERCENTAGE SPEAKING AN INDIGENOUS LANGUAGE
Men	46	51	4	1,160	2	30%
Women	12	38	2	456	2	25%
Not specified	6	54	2	467	2	50%

Source: Authors.

Table A4

Conditional Logit Specifications for Beekeepers' Responses in Hopelchén Municipality (respondents=66, choice cards=9, alternatives on each card=3)

	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
Current situation	2.081** (0.689)	1.880** (0.958)	2.375* (1.003)
1 if hive boxes are painted	-0.341*** (0.0977)	-0.256* (0.134)	-0.446** (0.145)
1 the distance between apiaries and crops is less than 1 km	0.109 (0.0942)	0.203 (0.131)	0.00623 (0.138)
1 if using chemical pesticide	0.315** (0.0978)	0.204 (0.136)	0.440** (0.143)
1 if hive-cleaning recommendations are not followed	0.298** (0.0941)	0.360** (0.131)	0.244* (0.137)
1 if no field logbook is maintained	0.109 (0.0962)	-0.0374 (0.133)	0.274* (0,142)
Price per kilogram of honey	0.0675*** (0.0144)	0.0635** (0.0200)	0.0732*** (0.0209)
Observations	1,782	918	864
Respondents	66	34	32
Pseudo-R2	0.163	0.159	0.175
Log-likelihood	-546.5	-282.7	-260.9
AIC	1,106.9	579.4	535.8
BIC	1,145.3	613.1	569.1

Table A5

Willingness of Beekeepers in Hopelchén to Accept Compensation for Changing Practices (estimated from specifications reported in Table A.4, 95% confidence interval)

WILLINGNESS TO ACCEPT COMPENSATION (MEXICAN PESOS)	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
For changing current situation Lower limit Upper limit	**30.8** 19.0 36.7	**29.6** 1.5 37.8	**32.5** 13.2 39.7
For refraining from painting hive boxes Lower limit Upper limit	**-5.0** -10.3 -2.2	-4.0 -12.9 0.14	**-6.1** -15.1 -2.1
For increasing the distance between apiaries and crops Límite inferior Límite superior	1.6 -0.9 4.7	3.2 -0.7 9.6	0.1 -4.1 4.2
For using biological pesticides Lower limit Upper limit	**4.6** 1.8 8.7	3,2 -0.9 9.6	**6.0** 2.1 13.1
For following hive-cleaning recommendations Lower limit Upper limit	**4.4** 1.6 9.6	**5.6** 1.4 18.1	3.3 -0.3 10.4
For keeping a field logbook Lower limit Upper limit	1.6 -1.1 5.1	-0.6 -5.7 4.4	**3.7** 0.1 10.4

Source: Authors.

Table A6

Conditional Logit Specifications for Beekeepers' Responses in Champotón Municipality (respondents=67, choice cards=9, alternatives on each card=3)

	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
Current situation	2,003** (0.708)	4,097*** (1.113)	0.517 (0.956)
1 if hive boxes are painted	0.0543 (0.0922)	-0.0866 0.140	0,191 (0,129)
1 if the distance between apiaries and crops is greater than 1 km	0.0188 (0.0893)	0.208 (0.137)	-0,143 (0,123)
1 if using chemical pesticide	0.294** (0.0934)	0,254* (0,141)	0,380** (0,132)
1 if hive-cleaning recommendations are not followed	0.158* (0.0898)	0,324** (0,134)	0,0239 (0,126)
1 if no field logbook is maintained	0.0168 (0.0911)	0.398* (0.139)	-0,322** (0,129)
Price per kilogram of honey	0.0944*** (0.0142)	0.134*** (0.0220)	0,0656*** (0,0194)
Observations	0.129	891	918
Respondents	0.0188	33	34
Pseudo-R2	(0.0893)	0.208	0.297
Log-likelihood	(0.137)	-0.143	-236.5
AIC	(0.123)	435.1	487.0
BIC	0.294**	468.6	520.7

Source: Authors.

Table A7

Willingness of Beekeepers in Champotón to Accept Compensation for Changing Their Practices (estimated from specifications reported in Table A.6, 95% confidence interval)

WILLINGNESS TO ACCEPT COMPENSATION (MEXICAN PESOS)	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
For changing current situation Lower limit Upper limit	**21.2** 9.6 28.2	**30.6** 20,7 36,5	7.9 -44.2 23.3
For refraining from painting hive boxes Lower limit Upper limit	0.6 -1.5 2.6	-0.6 -3.1 1.4	2.9 -1.2 9.1
For increasing the distance between apiaries and crops Lower limit Upper limit	0.,2 -1.6 1.9	1.5 -0.3 3.6	-2.1 -7.9 1.36
For using biological pesticides Lower limit Upper limit	**3.1** 1.1 5.4	1.9 -0.1 4.1	**5.6** 1.7 13.7
For following hive-cleaning recommendations Lower limit Upper limit	1.7 -0.1 4.1	**2.4** 0.5 5.2	0.6 -3.2 6.2
For keeping a field logbook Lower limit Upper limit	0.2 -1.6 2.2	**2.9** 1.1 5.6	**-4.9** -12.9 -0.8

Source: Authors.

Table A8

Conditional Logit Specifications in Beekeepers' Responses in Campeche Municipality (respondents=63, choice cards=9, alternatives on each card=3)

	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
Current situation	1.580** (0.737)	0.640 (1.021)	2.617** (1.079)
1 if hive boxes are painted	0,377*** (0.0991)	0.370** (0.139)	0.393** (0.142)
1 if the distance between apiaries and crops is greater than 1 km	-0.0352 (0.0943)	-0.205 (0.133)	0.141 (0.136)
1 if using chemical pesticide	0.253** (0.0985)	0.198 (0.140)	0.310** (0.140)
1 if hive-cleaning recommendations are not followed	0.505*** (0.0955)	.479*** (0.135)	0.540*** (0.137)
1 if no field logbook is maintained	-0.104 (0.0975)	-0.119 (0.139)	-0.0842 (0.138)
Price per kilogram of honey	0.0733*** (0.0149)	0.0556** (0.0208)	0.0927*** (0.0217)
Observations	1.701	837	864
Respondents	63	31	32
Pseudo-R2	0.299	0.289	0.316
Log-likelihood	-436.7	-217.9	-216.3
AIC	887.3	449.8	446.5
BIC	925.4	482.9	479.9

Source: Authors.

Table A9

Willingness of Beekeepers in Campeche to Accept Compensation for Changing Practices (estimated from specifications reported in Table A.8, 95% confidence interval)

WILLINGNESS TO ACCEPT COMPENSATION (MEXICAN PESOS)	COMPLETE SAMPLE	STANDARD SCENARIO	TRACEABILITY SCENARIO
For changing current situation Lower limit Upper limit	**21.5** 3.6 30.1	11.5 -77.4 28.,5	**2.2** 11.1 36.3
For refraining from painting hive boxes Lower limit Upper limit	**5.1** 2.5 9.3	**6.6** 1.7 24.9	**4.2** 1.1 8.8
For increasing the distance between apiaries and crops Lower limit Upper limit	-0.5 -3.2 1.9	-3.7 -16.8 0.9	1.5 -1.3 4.8
For using biological pesticides Lower limit Upper limit	**3.4** 0.7 6.9	-3.6 -16.8 0.9	3.3 0.4 7.4
For following hive-cleaning recommendations Lower limit Upper limit	**6.,9** 3.9 12.5	**8.6** 3.1 34.0	**5.8** 2.7 12.0
For keeping a field logbook Lower limit Upper limit	-1.4 -4.5 1.3	-2.,1 -11.5 3.5	-0.9 -4.4 2.3

Source: Authors.

ACRONYMS AND ABBREVIATIONS

- **CBAM**
Carbon Border Adjustment Mechanism
- **CBDR2**
Common But Differentiated Responsibilities
- **CO_2**
Carbon dioxide
- **EITE**
emissions-intensive trade-exposed
- **EPs**
environmental provisions
- **EU ETS**
EU Emissions Trading Scheme
- **EU**
European Union
- **EUDR**
EU Regulation on Deforestation-Free Products
- **FAO**
Food and Agriculture Organization of the United Nations
- **GATT**
General Agreement on Tariffs and Trade
- **GHGs**
greenhouse gases
- **MERCOSUR**
Southern Common Market (MERCOSUR)
- **HS**
Harmonized System
- IDB
Inter-American Development Bank
- **LAC**
Latin America and the Caribbean
- **MFN**
most-favored nation
- **Mha**
millions of hectares
- **NDCs**
Nationally Determined Contributions
- **SDGs**
Sustainable Development Goals
- **SMEs**
small and medium-sized enterprises
- **tn/Ha**
metric tons per hectare
- **UNCTAD**
United Nations Conference on Trade and Development
- **USMCA**
United States-Mexico-Canada Agreement
- **WTO**
World Trade Organization

ABSTRACT

Despite the global nature of environmental problems, targets to address these vary widely from country to country. This gap can lead to so-called carbon leakage—an increase in emissions in one country due to stricter environmental regulations in another. Given the difficulty of achieving coordinated global action, the strategies attempting to respond to this risk include measures relating to international trade. Among these initiatives are trade agreements and unilateral measures such as bans on imports of goods from deforested areas and border adjustment mechanisms based on carbon content. The proliferation of these measures will have a significant impact on international trade flows, particularly in certain countries and sectors in LAC. This chapter analyzes where countries in the region stand in relation to such measures and discusses the main challenges they will face in mitigating their negative impacts and adapting to the new rules of the game.

1. INTRODUCTION

The countries of Latin America and the Caribbean (LAC) are among the lowest emitters of greenhouse gases (GHGs) in the world. China accounted for about 30% of total global GHG emissions in 2022, while the European Union (EU) contributed around 7% and the United States 11%. LAC countries contribute approximately 7% of global emissions, with Brazil and Mexico being the largest emitters in the region (EDGAR, 2023). All the same, LAC's emissions have increased significantly over the past 30 years. The main sources of GHG emissions in the region are land-use change and agriculture, unlike the situation globally, which is dominated by energy production (World Bank, 2022).

Signatory countries to the 2015 Paris Agreement collectively committed to capping the average global temperature increase at below 2°C and to pursue efforts to limit global warming to 1.5°C above pre-industrial levels. To achieve this goal, GHG emissions must be reduced by 43% by 2030 compared to 2019 levels (UNFCCC, 2023). Despite the global nature of the problem, each country is free to choose specific measures and policies to meet its individual emission reduction targets, which are set out in the Nationally Determined Contributions (NDCs). To date, 195 countries have submitted NDC pledges, including all 33 LAC countries.[1]

The differences in the scope of the policies implemented in each country encourage what is known as "carbon leakage"—that is, when a sector or company moves its operations to a country with lower carbon prices or laxer regulations (Mehling et al., 2019; Al Hussein and Khan, 2023). As a result of carbon leakage, reductions in domestic emissions following the implementation of policies at the national level may not translate into reductions in global emissions and may even increase these (UNCTAD, 2022).

This is because there is a difference between the environmental impacts within a country's territory (production impacts) and those caused by producing and transporting the goods and services that a

1 · Data from https://unfccc.int/NDCREG, accessed November 1, 2023.

country consumes (consumption impacts). This gap is known as the environmental impact of trade. **About 30% of global CO_2 emissions are embodied in exports of goods and services (WTO, 2022).** External trade flows account for between 19.8% and 26.5% of total emissions in LAC, depending on whether household emissions and land use are included in the calculation (Mesquita Moreira and Dolabella, 2022).

In response to this situation, mechanisms to compensate for carbon leakage are being sought. The optimal solution would be to introduce a globally coordinated carbon-pricing mechanism, but this poses a number of design-related challenges(Cramton et al., 2017). Implementing international carbon pricing and calculating the carbon content of products and services require detailed, up-to-date information that may be lacking in some countries or sectors. A global carbon-pricing mechanism also requires considerable coordination between countries. Financial and technological transfers may also be necessary, which could further complicate negotiations (WTO, 2022).

There are a growing number of environmental provisions in trade agreements and unilateral trade measures that are strictly environmental in nature, which could be an alternative solution to this problem. Against this backdrop, the purpose of this chapter is to assess some of the challenges faced by LAC economies in applying these rules and to analyze alternatives at both the national and regional levels with the aim of mitigating their negative effects and adapting to the new rules of the game.

This introduction is followed by an analysis of the channels through which trade is linked to climate change. Section 3 then analyzes the evolution and scope of provisions included in global trade agreements, with a focus on agreements involving LAC countries. Sections 4 and 5 look at two unilateral trade measures that the EU has recently implemented and that are also on the agenda for some of LAC's other major trade partners: the ban on imports of goods originating in deforested areas and border taxes based on carbon content. In these sections, we analyze the potential impact of these two mechanisms on LAC's foreign trade. Finally, we draw some conclusions regarding the trade challenges posed by implementing these environmental regulations.

2. THE CONNECTION BETWEEN TRADE AND THE ENVIRONMENT

To better understand the environmental impacts of international trade, a conceptual framework has been developed in the economic literature that **identifies the channels through which international trade may contribute to increases or decreases in GHG emissions.** Specifically, it breaks down the impact of major trade flows into three distinct effects: scale, composition, and technique (Grossman and Krüger, 1993; Antweiler et al., 2001).

The scale effect is the increase in production, transportation flows, and the consumption of goods and services as a result of trade. All other factors being equal, increases in economic activity will lead to higher energy consumption, which will bring about a corresponding increase in GHG emissions.

The composition effect relates to the impact of trade on a country's production structure by reallocating economic resources to sectors with comparative advantages. Although international trade helps to improve economic efficiency, its effect on GHG emissions will depend on which sectors have comparative advantages. The composition effect triggers an increase (decrease) in emissions if a country's comparative advantage (disadvantage) is in carbon-intensive sectors. International trade may lead countries to specialize in industries that pollute more or less, depending on the availability of their factors of production. If a country's comparative advantage is in natural resource-intensive or carbon-intensive sectors such as fossil fuel extraction, specialization may lead to an increase in production for more polluting industries. In LAC, the expansion of the agricultural frontier is the main driver of deforestation, which is strongly linked to products with high export content.

Food production is the economic activity with the largest global water footprint—the total volume of freshwater used directly or indirectly to produce a product. A country's water footprint can increase its carbon footprint and lead to environmental problems such as soil degradation and water and air pollution. Conversely, a country can develop cleaner industries if its comparative advantage is in low-emission, energy-efficient sectors such as information technology, renewable energy, or services.

Finally, international trade can help improve production processes and techniques, thereby reducing emissions per unit of product. This mechanism is often referred to as the technology effect and can occur in two ways. First, trade facilitates the availability of and access to a greater variety of clean technologies. Furthermore, the growth in income resulting from trade liberalization will shift consumer preferences toward a greater appreciation of the environment. Greater social demands for environmental standards can lead to the implementation of stricter climate policies, thus promoting the green transition. Similarly, globalization and international trade also influence societies' consumption patterns, promoting lifestyles and practices that may be more environmentally sustainable or less so. In markets where consumers are aware of the importance of protecting the environment and the environmental impacts of consumption patterns, they can put pressure on companies and governments to adopt more sustainable practices.

Governments could direct the latter two **channels of transmission between trade and the environment—the composition and technical effects**—through environmental regulations and standards, trade policies, and international agreements to specifically design the measures governing this relationship to promote sustainable environmental practices that encourage the exchange of environmentally friendly goods and services. In this chapter, we address this point in specific relation to three policy instruments that could influence the composition and technical effects: trade agreements, import bans on deforestation-intensive goods, and border adjustments.

3. ENVIRONMENTAL PROVISIONS IN TRADE AGREEMENTS

Rising levels of concern about the impact of trade on the environment have prompted a growing public interest in analyzing **the role of environmental provisions (EPs) in trade agreements.** Countries include EPs through specific articles, the "greening" of chapters on other issues (including chapters devoted entirely to environmental matters), or side agreements. The motives often associated with including EPs in agreements include sustainable development and the global environmental agenda, promoting trade in environmental goods and services, and leveling the playing field among signatories to agreements (OECD, 2023; George and Yamaguchi, 2018).

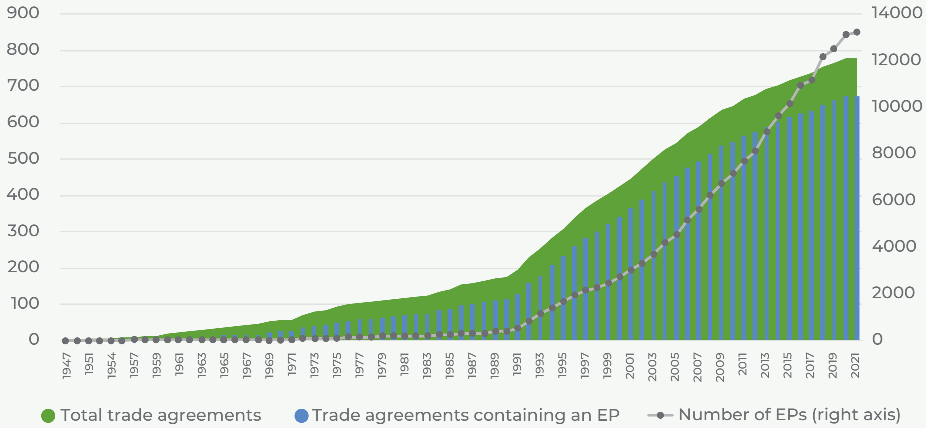
Recent studies have found that the inclusion of EPs in integration agreements contributes to environmental sustainability: countries that have ratified agreements with such provisions have lower pollution levels (Martínez-Zarzozo and Oueslati, 2016), lower GHG emissions, more limited deforestation, and less habitat destruction (Abman et al., 2021). Furthermore, there is also some evidence of ex ante and ex post effects as countries adapt during the negotiation process (Weber, 2021; Bstiaens and Postnikov, 2017). In any case, the results may mask reverse causality, possibly because countries that reduce emissions may export their domestic standards as a result of larger market size and bargaining power.

Weber (2021) underlines that the legal enforceability of environmental agreements means that these have the potential to trigger changes in domestic laws to strengthen environmental regulations; they may also provide legal mechanisms for private stakeholders and civil society organizations to seek environmental rights not covered by local regulations.

According to the Trade and Environment Database (TREND) developed by Morin, Dür, and Lechner (2018),[2] **the number of agreements with at least one EP has increased.** Before the 1990s, an average of 65% of trade agreements contained at least one EP. Since 1991, this share has risen to more than 90% (figure 1). However, Weber (2021) points out that the mere inclusion of one or a handful of EPs in an agreement does not have an impact on GHG emissions, but countries that include numerous clauses in their trade agreements tend to reduce their CO_2 emissions per capita more than those without such clauses. Although fewer agreements were signed per year between 2009 and 2021 than between 1991 and 2008, the average number of EPs per agreement has increased substantially, going from an average of 14 to an average of 47 in recent years.

Figure 1.
Evolution of Agreements Containing Environmental Provisions

Cumulative number of total trade agreements, trade agreements with at least one environmental provision, and cumulative number of provisions.



Source: Authors based on the TREND database. The right axis shows the number of EPs.

Of the 778 trade agreements signed between 1947 and 2021, only 104 do not contain EPs. The agreements that contain EPs of some sort include regional agreements, multilateral agreements such as the General Agreement on Tariffs and Trade (GATT)[3] and the 1994 World Trade Organization (WTO)[4] Agreement, and the 2014 Trade Facilitation Agreement and the Plurilateral Agreement on Government Procurement, all of which fall within the remit of the WTO.

2 · The database was updated in 2022 and includes all agreements signed up to 2021.
3 · The article on exceptions to obligations under the GATT contains just two EPs.
4 · The WTO Agreement includes 22 EPs, most of which relate to exceptions and coherence between international institutions.

The most common measures relate to trade in goods, which feature in 81% of the agreements in the TREND database (figure 2). Among the most common of these are exceptions to trade in goods that are connected to the conservation of natural resources or flora and fauna. Another is the right to develop or apply technical barriers to trade when these relate to the (promotion or protection of) the environment. The ability to overturn procedures for the adoption of technical barriers during an emergency is one more example.

Relations with other international institutions are the second-most-common type of EP, as they are included in 59% of agreements, including the Paris Agreement and the Kyoto Protocol. The most common of these EPs were mentions of other institutions or specific environmental agreements, the implementation of other agreements on environmental issues, and the preemption of other environmental agreements should these prove incompatible.

Third, cooperation clauses are included in 38% of the agreements. The enforceability of these clauses is limited, as the most common are vague obligations for countries to cooperate and exchange information on environmental matters or protective measures.

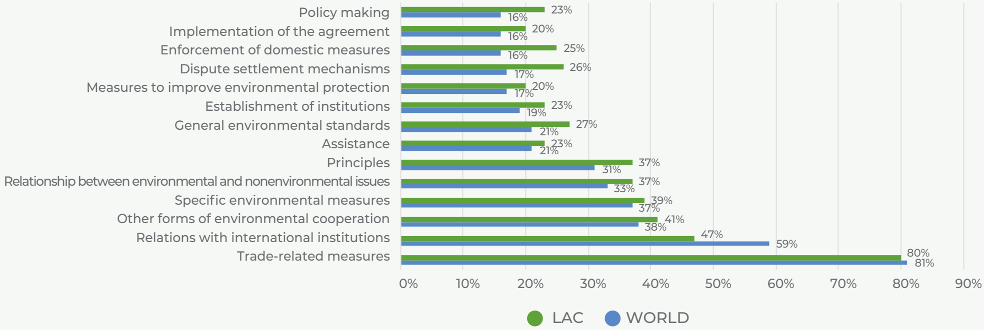
Fourth, specific environmental measures are included in 37% of the agreements signed during the period in question: the most common EPs relate to hazardous waste and biodiversity. Weber (2021) finds that the environmental impact is greater when specific clauses are included.

Fifth, measures on coherence between environmental and nonenvironmental issues are included in 33% of the agreements, mainly those seeking coherence with domestic trade or investment policies.

Figure 2.

Types of Environmental Provisions Included in Trade Agreements

Percentage of agreements signed between 1947 and 2021 containing at least one environmental provision, by group



Source: Authors based on the TREND database.

EPs relating to principles are found in almost a third of the agreements. The most common of these is a mention of the environment in the preamble to the agreements, one of the weakest and least enforceable types of EP. However, some important EPs fall within this group, such as the precautionary principle included in the Peru–Colombia agreement, based on which insufficient scientific evidence cannot be used to reject measures to protect the environment.

Assistance measures are included in 21% of global agreements, the most common of which is technical assistance or training provided by another signatory.

Another group of standards that are also found in 21% of the agreements are general environmental standards that stress it is inappropriate to relax environmental measures to attract investment.

The remaining measures are included in less than 20% of the agreements. The least common categories include obligations such as enforcement of domestic measures, dispute settlement mechanisms, or implementation of the agreement.

According to Weber (2021), strong enforcement mechanisms have an even greater impact on CO_2 emissions than specific environmental measures included in the agreements. Only 16% of the agreements include EPs related to implementation, most of which seek to establish a contact point for environmental issues, provisions for public participation in implementing these, and communication measures on the actions taken to implement the agreement.

The structure of measures in LAC is similar to these global patterns. However, there is a larger share of mechanisms for dispute resolution, enforcement of domestic measures (mainly binding obligations), and policy-making (mainly public participation in the adoption of environmental measures).

The agreements with the highest number of EPs involving an LAC country are the United States–Mexico–Canada Agreement (USMCA) and the agreements between the United States and Peru, Panama, Colombia, and Chile. Also noteworthy are the agreements between the EU and LAC countries (Central America, Colombia, Peru, Cariforum). Indeed, the EU–Cariforum agreement marked the start of the inclusion of EPs in EU agreements.

One of the countries whose agreements most often contain EPs is Chile, whose 2004 agreement with Singapore was the first in the region to include an environmental chapter. Chile is also unusual in having signed agreements with enforceability clauses (Weber, 2021). Its agreements with other LAC countries are among those with the highest number of EPs, particularly those with Brazil, Argentina, Ecuador, Uruguay, and Colombia.

LAC's agreements with Canada include stronger enforcement clauses than those with the EU. **Canada's agreements with LAC countries have some of the highest numbers of EPs, particularly those with Panama, Honduras, Colombia, and Peru.**

4. MEASURES TO REDUCE DEFORESTATION

Forests are an essential resource for human livelihoods and a critical factor for sustainable development. They provide global public goods and are a core component of the fight against climate change, as (i) they are the planet's main CO_2 sinks, absorbing 2.6 gigatons per year, which is equivalent to a third of the anthropogenic gases released by burning fossil fuels; (ii) they provide habitat for a large share of land-based biodiversity while harboring high levels of genetic diversity; and (iii) they provide humanity with a wide range of environmental services, such as regulating water flows, providing drinking water, protecting soils, and providing a large amount of food and raw materials (FAO, 2022a; Friedlingstein et al., 2020; IPCC, 2019; World Bank, 2016).

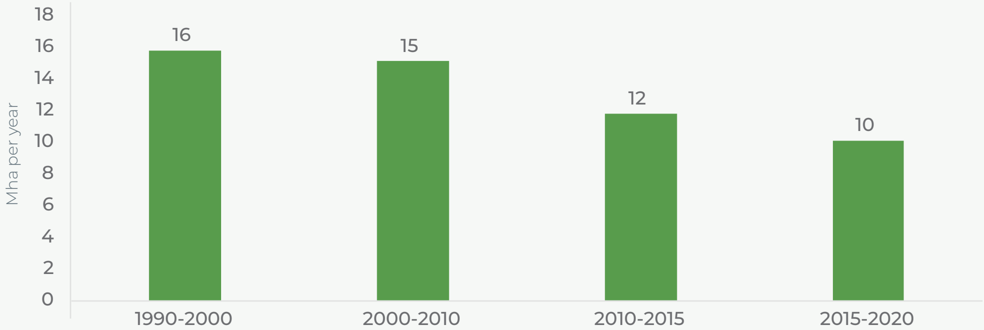
However, **the last 30 years have seen a significant increase in global tree cover loss,** bringing the issue to the forefront of public debate. The world is estimated to have lost approximately 420 million hectares (Mha) of forest to deforestation between 1990 and 2020.[5] This figure represents 10% of the world's total forest area (FAO, 2020). All the same, the data shows that the rate of global forest loss is slowing.

In fact, the annual deforestation rate has been declining since 1990–2000, such that 6 Mha less forest was cut per year in 2015–2020 than the annual average for the 1990s (figure 3). Although this trend seems encouraging, deforestation remains a global challenge. Even if this rate of reduction is maintained, it will take about another 25 years to reach Sustainable Development Goal (SDG) 15 ("Life on Land"), which focuses on halting global deforestation (FAO, 2022a).

5 · There is currently no consensus on the definition of deforestation. There are two conflicting criteria: "loss of tree cover" and "land use." Global Forest Watch (Hansen et al., 2013) publishes based on satellite imagery applying the loss-of-tree-cover criterion, which only considers the biophysical properties of forests (minimum height thresholds, canopy cover, and tree cover). In this case, the methodology used does not distinguish if the logging occurred in rotation forests where the tree surface will grow back and deforestation is not permanent. The second methodology, which is used in FAO calculations, defines deforestation as the conversion of forests to other uses, such as agriculture and infrastructure. Unlike the previous methodology, this approach does not consider loss of tree cover to be deforestation if it is temporary and is regenerated naturally or through forestry activities. This article uses FAO data, as this is the benchmark in the international debate on global deforestation and for IPCC assessments of the impact of deforestation on climate change (Brown and Zarin, 2013).

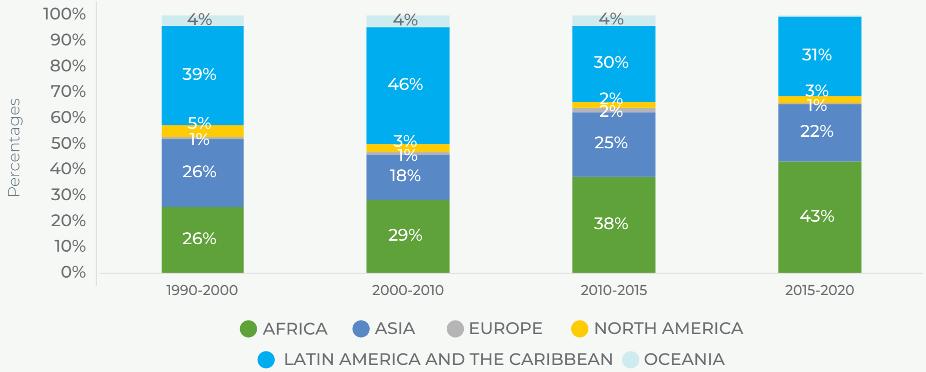
Between 2010 and 2015, **Africa was the continent that lost the largest area to deforestation, overtaking LAC, which had previously topped the list.** This shift is due to a significant decline in the average rate of deforestation in LAC, which fell from 6.1 Mha in the 1990s to half that in 2015–2020. The data for 2015–2020 show that more than 40% of global deforestation occurred in Africa. LAC is next in order of importance, accounting for a third of the total, while Asia ranks third with more than 20% of forest cover loss (figure 4). These three regions account for more than 90% of global deforestation.

Figure 3.
Global Deforestation Rate



Source: INTAL (IDB) based on FAO (2020).

Figure 4.
Deforestation Rate by Region



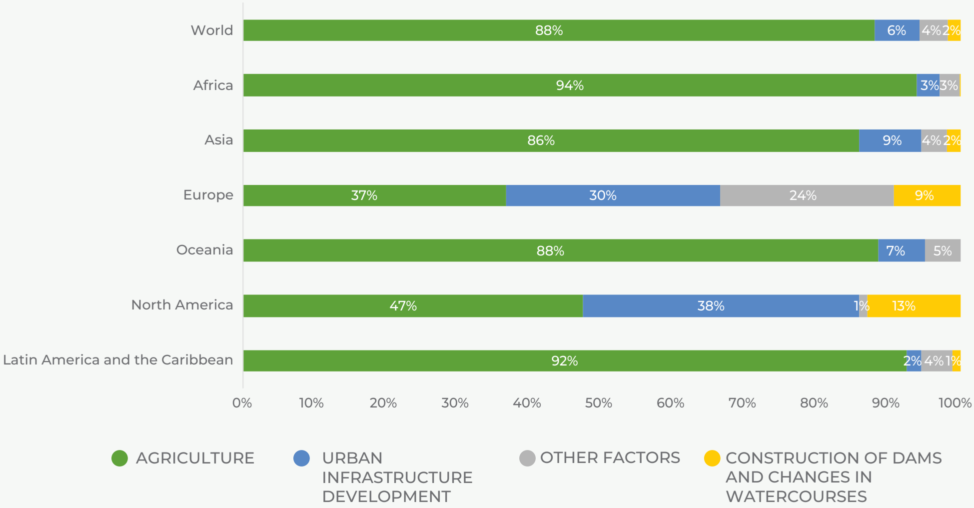
Source: INTAL (IDB) based on FAO (2020).

The empirical evidence suggests that **carbon sequestration is highest in subregions where tropical forests are abundant**—these are where the main global deforestation hotspots are currently located (Xu et al., 2021; Schimel, Stephens, and Fisher, 2014; Lewis et al., 2009). Tropical forests in Central Africa, South America, and Southeast Asia concentrate carbon stocks of up to 130 t/ha, while Northern Hemisphere forests retain only a third of this value (Farrokhi et al., 2023).

The most significant driver of global deforestation appears to be the expansion of the agricultural frontier, be it for commercial or subsistence agriculture (Pendrill et al., 2022; FAO, 2022b; Jayathilake et al., 2021; Seymour et al., 2019; Laurance et al., 2014; Lewis, Edwards, and Galbraith, 2015; Hosonuma et al., 2012; Kissinger et al., 2012; Gibbs et al., 2010; Geist and Lambin, 2002). FAO (2022b) estimates that about 90% of global deforestation in 2000–2018 was associated with growth in the agricultural sector (including livestock). This driver is particularly strong in Africa and LAC, where agricultural activity accounts for 95% and 94% of deforestation, respectively. It also accounts for 86% and 88% in Asia and Oceania, respectively, while in North America and Europe, the main drivers of deforestation are other factors that are less significant globally (figure 5).

Figure 5.
Drivers of Deforestation by Region, 2000–2018

Percentages



Source: INTAL (IDB) based on FAO.

Deforestation-intensive products are concentrated in a handful of commodities that are closely linked to agricultural and forestry activities. Their characteristics vary by country and continent. According to calculations by Pendrill et al. (2019) for 2005–2013, regional trends for Latin America show that beef has the highest "deforestation content"[6] (more than 60% of deforested land is used for beef production). However, other products also stand out in specific countries, including oilseeds and cereals, especially in Argentina (47%) and Paraguay (49%), and coffee in Honduras (17%), Ecuador (10%), and Peru (7%). In Asia, palm oil, forestry products, and rubber are the main drivers of deforestation, while in Africa it is beef, although coffee and cocoa are also relatively important.

Although deforestation is mainly driven by domestic demand, **a considerable share of the products associated with forest loss are major export products.** This factor is particularly significant given that global demand for these commodities is constantly increasing, putting more pressure on land-use change (Pendrill et al., 2019; Wood et al., 2018; Mayfroidt et al., 2013; Yu et al., 2013; Weinzettel et al., 2013). International trade thus creates a link between supply and demand for land use between different countries (Farrokhi et al., 2023). Countries with a deficit in the domestic supply of land-intensive products must thus rely on the international market for their supply, creating incentives for production to be increased in countries where land is a relatively abundant factor. If international demand cannot be met by increasing land productivity, one alternative is to expand the agricultural frontier through deforestation.

In response to this global problem and in the absence of a binding multilateral agreement[7] to halt the destruction of forests, particularly tropical forests, **some developed countries are using trade policy as a unilateral tool to restrict imports of deforestation-intensive goods** to make consumption and production patterns more sustainable and environmentally friendly. One such precedent has emerged in the United States, which has temporarily blocked imports of Peruvian forest products as part of a sector-specific arrangement within the

7 · Following the methodology of Pendrill et al. (2019), the total amount of deforestation embodied in the production of a given commodity in a specific year is calculated as the total deforestation attributed to the land use that produced that commodity in the previous T years, divided by T (where T is the amortization time).
7 · The most far-reaching international agreement on this matter is the Glasgow Declaration on Forests and Land Use, signed at the 2021 UN Climate Change Conference (COP26) by more than 140 countries. In it, the signatories expressed their willingness to work collectively to "halt and reverse forest loss and land degradation by 2030," but the declaration contains no binding clause to that effect (Abdenur, 2022).

free trade agreement between the two countries on the grounds that they are made from illegally harvested timber.[8,9] In the same vein, the United States is currently considering implementing trade measures to combat the international deforestation associated with the processing of agricultural commodities (US Department of State, 2023). Meanwhile, the United Kingdom included provisions in schedule 17 of the Environment Act 2021[10] that prohibit the importation of any commodity with a risk of deforestation if the processing of the product violates local law in the exporting country. This standard requires importers to follow a due diligence process to ensure that products are deforestation-free. However, the regulations specifying the requirements for compliance with this process and the universe of goods covered by the measure have yet to be formalized (Cosbey et al., 2023). Finally, through state-owned enterprises such as COFCO International, the country's largest food retailer, the People's Republic of China has recently proved itself willing to curb deforestation driven by commodity exports. Indeed, in November 2023, it sealed a deal worth more than US$30 million to purchase soybeans from Brazil that includes a clause requiring the oilseed to be deforestation-free, the first time a provision of this sort has been specified.[11]

The most concrete example of such initiatives is the EU's Regulation on Deforestation-Free Products (EUDR),[12] which will come into force in June 2023 as part of the strategy to combat climate change embodied in the EU's Green Deal.[13] The main objective of the EUDR is to minimize the consumption and domestic production of goods from supply chains with ties to deforestation or forest degradation. To this end, the EUDR prohibits European exports to third markets and the sale of goods in the EU market that do not comply with a set of procedures and measures designed to ensure that goods are deforestation-free. It covers a list of commodities that are consumed

8 · For more information, see the following USTR press release (2023): https://ustr.gov/aboutus/policy-offices/press-office/press-releases/2023/october/ustr-announces-enforcement-action-block-ille gal-timber-imports-peru.
9 · In 2021, the US FOREST Act was introduced in the US Congress, which aims to restrict the entry of goods made from illegally deforested land in the country of origin. It is currently stalled in the Senate Finance Committee (IDB, 2023).
10 · Environment Act 2021, United Kingdom. Available at: https://www.legislation.gov.uk/ukpga/2021/30/enacted#:~:text=An%20Act%20to%20make%20provision,that%20fail%20to%20meet%20environmental.
11 · https://www.reuters.com/sustainability/land-use-biodiversity/chinas-cofco-modern-farming-group-sign-deforestation-free-soybean-deal-2023-11-08/.
12 · https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1115.
13 · This consists of a package of initiatives whose main objective is to make the EU carbon neutral by 2050. It focuses on making the EU economy environmentally sustainable, addressing climate change mitigation, adaptation to new climate conditions, biodiversity conservation, and the promotion of a just transition to a circular, low-carbon economy. The Green Deal seeks to integrate environmental considerations into all policies and sectors and to stimulate innovation and green investment to achieve climate and sustainability goals.

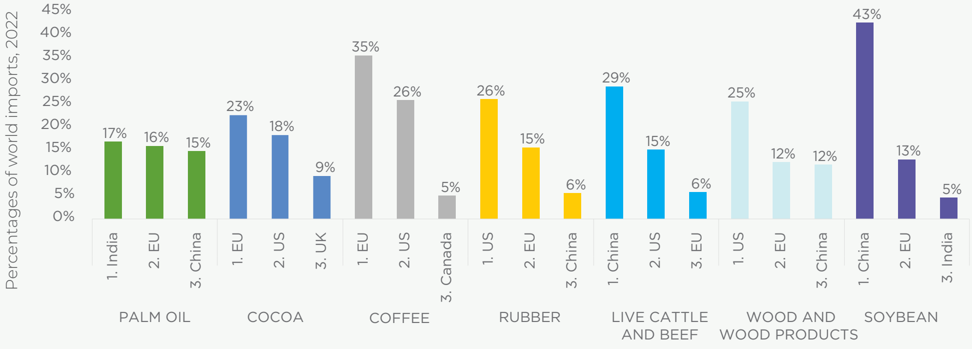
at high rates in the EU and are closely linked to the expansion of the global agricultural frontier, such as beef, timber, palm oil, soy, coffee, rubber, cocoa, and products that derive from these industries, such as leather, chocolate, cellulose, and furniture.[14] Unless a company can prove through the due diligence process established by the law (box 1) that the products covered by the EUDR have been produced on farms or plantations or farms that have not been deforested since December 31, 2020, importing these into the EU market and exporting them to third countries will be prohibited.

As noted by Calvo et al. in chapter 2, although the EUDR will enter into force in June 2023, most of the obligations established by the due diligence process will not apply until December 2024. This includes the geolocation of the land where the goods to be traded were grown or reared and the traceability process for the final products and/or the inputs used to produce them.[15] The EUDR thus poses significant challenges for exporting countries, as compliance will require strengthening the institutional capacity of central and subnational governments and implementing sustainable production practices (Calvo et al., 2023).

The EU is one of the world's largest importers of deforestation-intensive commodities on the international market. When global purchases are broken down by the origin of the products covered by the EUDR, the data reveals the bloc to be among the world's top three importers for almost all these products. Coffee and cocoa-based products are particularly significant: the EU is the largest global importer, absorbing 35% and 23% of the total supply, respectively (figure 6). The entry into force of the due diligence process will have an impact on i) international trade in raw materials by excluding international suppliers from the European market if their products represent a high risk of deforestation and/or if they do not adapt their production processes to the EUDR's requirements, and ii) the EU's capacity to obtain supply from countries that meet these requirements.

14 · The Commission intends to propose a gradual extension of the list of products to be regulated and to review and update the list regularly on the basis of new data.
15 · For more information on the due diligence process, see annex A.

Figure 6.
Main Importers of Products Covered by the EUDR



Source: INTAL (IDB) based on WITS.
Note: EU data does not include intrabloc trade.

The implementation of this measure will have an impact on LAC's foreign sales. This will vary according to each country's importance as a supplier, the relative significance of the different export sectors, the role of these in regional deforestation, and each country's capacity to comply with the due diligence process required by the law, among other factors. Based on the universe of tariff codes identified in annex I of the EUDR and the data on average export values for the same group of goods in 2019 and 2021,[16] the implementation of the standard will mean that more than US$23 billion in LAC exports to the EU will have to comply with the requirements of the due diligence process established by law to enter the EU market (table 1).[17] This represents 15% of LAC's foreign sales of these products. A breakdown of the value of exports by product type reveals the goods with the most significant shares to be soybeans (43%), wood (22%), and coffee (34%). LAC is one of the primary sources of EU imports of soybeans and coffee, accounting for 53% and 27% of the bloc's international purchases, respectively. The LAC export sectors most exposed to the EUDR are palm oil (54%), coffee (34%), and cocoa (18%), although the EU absorbs a high share of the region's global exports of almost all products.

16 · Data for 2020 was excluded from the calculations because it was considered an atypical year, given the effects of the pandemic on international trade flows.
17 · Although not all LAC exports are deforestation-intensive, the EUDR does not indicate how the risk indicators to be published by the EU will be calculated and whether they will be differentiated by the different geographic areas of the countries. These aspects will be clarified when the regulations for the EUDR are published in the Official Journal of the EU. Regardless, to enter the EU market, all exports must be deforestation-free and comply with the due diligence process established by law. The stringency of this process will depend on the benchmarking system devised by the European Commission.

Table 1.
LAC Exports Covered by the EUDR

Millions of US dollars and percentages, averages for 2019 and 2021

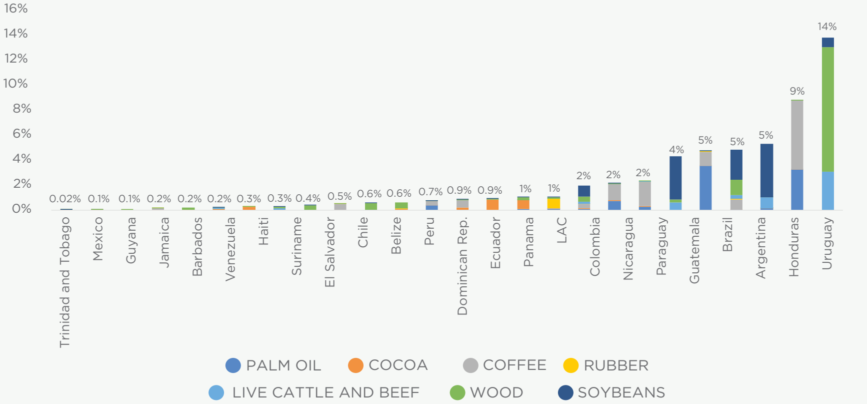
PRODUCT	EXPORTS FROM LAC TO THE EU		SHARE OF LAC EXPORTS TO THE EU IN EXPORTS TO THE WORLD	SHARE OF EU IMPORTS FROM LAC IN IMPORTS FROM THE WORLD
	Millions of US$	%	%	%
Soybeans	9,948	43%	15%	53%
Coffee	4,247	18%	34%	27%
Wood	5,034	22%	13%	2%
Live cattle and beef	1,972	8%	9%	9%
Palm oil	1,311	6%	54%	9%
Cocoa	487	2%	18%	2%
Rubber	207	1%	5%	0%
Subtotal	**23,207**	**100%**	**15%**	**7%**

Source: INTAL (IDB) based on COMTRADE.

When the share of exports to the EU affected by the regulation is calculated in relation to the total export basket of each LAC country, the results show some variation between countries.[18] **On average, the MERCOSUR countries are more exposed than the rest of the subregions, as they are major global suppliers of beef, soybeans, and cellulose and have close trade relations with the EU (figure 7).** In Central America, Honduras (9%), Guatemala (5%), and Nicaragua (2%) are significant due to their comparative advantage in the production of coffee and palm oil and the importance of the EU market as a destination for these products. Finally, in the aggregate for LAC, exports covered by the standard account for 2% of total exports. Again, exports of soybeans, wood products, and coffee account for much of the exposure.

18 · $X_{i,g,d}$ / *Xitot* where $X_{i,g,d}$ are the exports of products g (covered by the EUDR) from country i to destination d (EU); Xitot are the total exports of country i to the world.

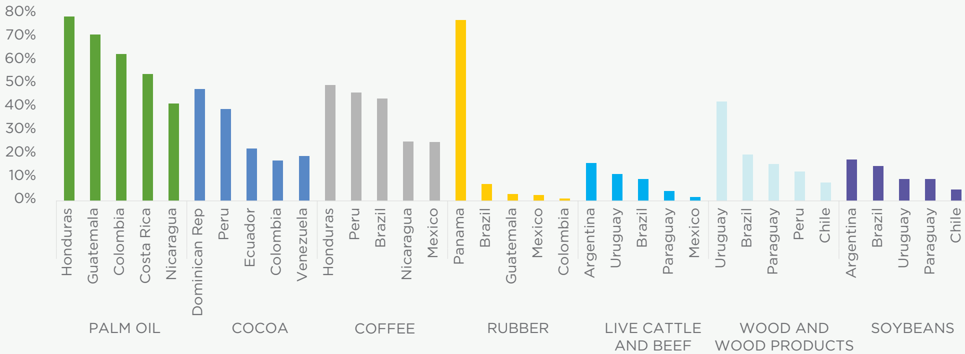
Figure 7.
Exposure of LAC Countries to EU Deforestation-Free Requirements, Averages for 2019 and 2021



Source: INTAL (IDB) based on COMTRADE.

However, **analyzing the impact at the sector level reveals different results.** When we calculate the indicator as the share of exports of each of the products covered by the EUDR to the EU over exports of the same good to the world, countries whose export baskets are not significantly exposed[19] in general may reveal themselves to be more exposed. For example, while just 1% of Peru's export basket is exposed, the EUDR affects 46% and 39% of its total foreign sales of coffee and cocoa, respectively (figure 8). Similarly, 48% of the Dominican Republic's cocoa exports to the world would be affected.

Figure 8.
Sector-Specific Exposure of LAC Countries to EU Deforestation-Free Requirements, Averages for 2019 and 2021



Source: INTAL (IDB) based on COMTRADE.

19 · $X_{i,g,d}/X_{i,g,w}$, where Xi,g,d are exports of product *g* (covered the EUDR) from country *i* to destination d (EU); $X_{i,g,w}$

In this context, some countries in the region[20] have expressed their concern over the EU measure at the WTO Committee on Agriculture, arguing that "the country assessment criteria and benchmarking system are inherently discriminatory and punitive in nature. Its most likely effect will be to generate trade distortion and diplomatic tensions, without benefits to the environment. Furthermore, it imposes additional controls, entails reputational risks for companies, and is likely to penalize producers in developing countries, especially smallholder farmers and SMEs." They also expressed concern about "...uncertain and discriminatory nature of the scope of products; definitions that are not multilaterally agreed; retroactive cut-off date; burdensome due diligence mechanism and subjective risk assessment criteria; costly and impractical traceability and geo-localization requirements; and insufficient unilaterally defined transition period, which could increase costs and have negative social and economic consequences for developing countries."[21]

20 · Argentina, Brazil, Colombia, Guatemala, Paraguay, Peru, Honduras, Ecuador, and Bolivia.
21 · https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/G/AG/GEN213.pdf&Open=True.

5. CARBON-RELATED BORDER ADJUSTMENT MECHANISMS

In the absence of coordinated climate action, countries with more ambitious targets are resorting to border adjustment mechanisms. A border adjustment is a levy on the carbon embodied in products imported from an economy with a lower carbon price than the importing country or on imported products whose embodied carbon has not been priced. In other words, the price of certain carbon-intensive goods would be adjusted to reflect carbon emissions from their production processes (Dietrich Brauch et al., 2021). Adjustments could also be made by refunding the domestic carbon price that companies pay when they export their products to compensate for the higher carbon price they face domestically compared to companies in the country they are exporting to.

The EU is not alone in proposing a border adjustment mechanism: Canada, the United Kingdom, and the United States have also included instruments of this sort in their climate change agendas. Border adjustment is part of the EU's Fit for 55 policy package, which aims to reduce net GHG emissions by at least 55% by 2030 compared to 1990 levels. **To achieve this, the EU intends to gradually replace free emissions allowances with a carbon border adjustment mechanism (CBAM)[22].** The goal of the CBAM is to ensure that carbon is priced equally for imports and domestic products. In other words, companies that want to sell their products on the EU market will have to purchase carbon allowances equal to the carbon price that would have been paid to produce the goods in the EU. Although the CBAM came into force in 2023, the actual rates will not apply until 2026. According to UNCTAD (2022), the scheme will address carbon leakage and reduce

22 · The EU Emissions Trading Scheme (EU ETS) provides free emissions allowances to domestic industrial manufacturers up to a certain limit, but they have to buy additional permits at auctions or on the secondary market. Sectors with a high risk of leakage are allocated most, if not all, of the allowances they need "for free," to avoid pressuring these industries to relocate outside the EU (Columbia, 2021). However, free allowances have been criticized for hampering the EU ETS by reducing the ambition of emissions-intensive trade-exposed (EITE) sectors to reduce emissions and for being inconsistent with the EU's goal of net-zero emissions by 2050 (Beaufils et al., 2023).

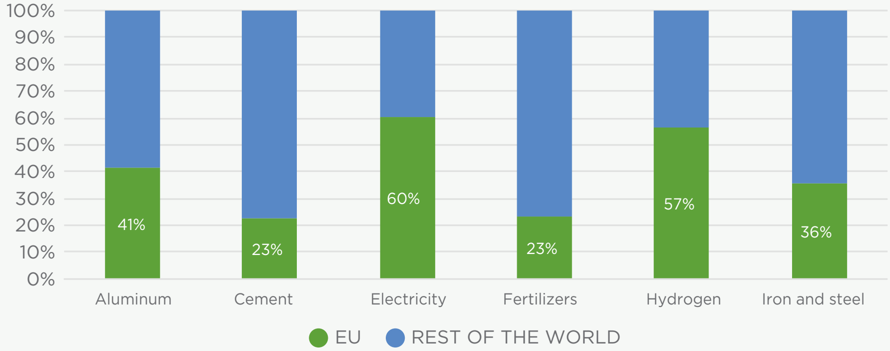
emissions but will also lead to trade diversion: trade within the EU is expected to increase, while flows from trade partners will be diverted to other regions. Total exports from developing countries will fall more than those from developed countries, as the former use more carbon-intensive production methods in the targeted sectors. However, the CBAM also aims to encourage third-country producers trading with the EU to use more efficient technologies that produce lower GHG emissions (Cárdenas and Cazzolo, 2023).

The products initially affected by the CBAM are aluminum (HS chapter 76), cement (heading 2523), electricity (heading 2716), fertilizers (chapter 31), hydrogen (subheading 280410), and iron and steel (chapters 72 and 73). By 2030, sectors such as petroleum refining, fuels, all metals, pulp and paper, glass and ceramics, organic acids and chemicals, air and sea transportation, and lime will be added (European Union, 2023). Agriculture is one of the other sectors that is becoming part of the EU climate agenda. In chapter 4 of this publication, Cabrini et al. analyze the potential impact of implementing a carbon adjustment mechanism at the EU border on the international beef trade, with a particular focus on Argentinian beef exports.

The EU is a major importer of the products included in the first phase of the mechanism (figure 9), accounting for 60% of global imports of electricity, 57% of hydrogen, 41% of aluminum, and 36% of iron and steel. However, these products account for only a small share of world trade: together, they represent 5% of global imports and 6% of the EU's.

Figure 9.
EU Share in World Imports of Products Included in the CBAM

Average percentages for 2019 and 2021

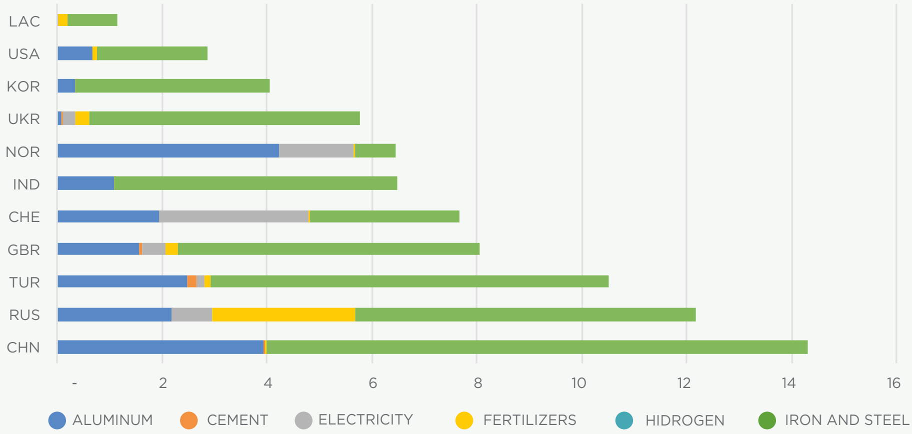


Source: Authors based on COMTRADE.

The CBAM therefore has important implications for the EU's trade relations. The first concern relates to the substantial costs that non-EU partners are likely to face due to increased tariffs on CBAM-affected products imported by the EU. Countries such as China, Russia, Turkey, and China are likely to be among the most affected in terms of the value of exports to the EU (figure 10).

Figure 10.
Main Exporters of Products Affected by CBAM and LAC

In thousands of dollars, averages 2019 and 2021



Source: Authors based on COMTRADE.

The initial impact for LAC is comparatively small because exports of this group of products to the EU do not account for a large share of the region's total foreign sales (table 2). In the average for 2019 and 2021,[23] LAC exports to the EU from the six sectors that will be affected by the CBAM amounted to US$1.76 billion, representing just 0.1% of the region's total external sales and 1.6% of exports to the EU. However, the CBAM will have a greater effect on some countries and sectors: in the case of fertilizers and hydrogen, the EU's share as a destination for LAC exports amounts to 14.0% and 23.1% of the total, respectively. Moreover, the region is not a major supplier of any of these products to the EU, which increases the likelihood of EU buyers seeking alternative markets if LAC products do not comply with the new requirements.

23 · We used data from these two years to ensure the information was up-to-date and had a high degree of coverage while avoiding the records for 2020, which include the impact of the Covid-19 pandemic on trade.

Table 2.
Exports from LAC Covered by the CBAM

Millions of dollars and percentages, average for 2019 and 2021

PRODUCT	EXPORTS FROM LAC TO THE EU		SHARE OF LAC EXPORTS TO EU IN TOTAL LAC EXPORTS	SHARE OF EU IMPORTS FROM LAC IN TOTAL EU IMPORTS
	Millions of US$	%	%	%
Aluminum	139	8%	3.6%	0.2%
Cement	21	1%	3.9%	0.8%
Electricity	0	0%	0.0%	0.0%
Fertilizers	494	28%	14.0%	3.4%
Hydrogen	0	0%	23.1%	0.0%
Iron and steel	1.100	63%	5.2%	0.5%
Total	1,755	100%	5.5%	0.5%

Source: Authors based on COMTRADE.

In some LAC countries, the sectors covered by the CBAM account for a high proportion of total exports to the EU. Although the amounts in question are mostly small, the exports of specific products from some countries are more severely impacted, such as aluminum for the Bahamas, Belize, Brazil, Mexico, and Venezuela; cement for Colombia; fertilizers for Chile and Trinidad and Tobago; and iron and steel for Brazil, Mexico, and Venezuela (table 3). According to Conte Grand et al. (2022), the potential expansion of CBAM products in the EU could increase the impact to 14% of LAC countries' exports.

Table 3.
EU's Share in Total LAC Exports in the Sectors Covered by the CBAM by Country

Average percentages of the total for 2019 and 2021

COUNTRIES	ALUMINUM	CEMENT	ELECTRICITY	FERTILIZERS	HYDROGEN	IRON AND STEEL
ARG	1.5%	0.1%	0.0%	0.0%	0.0%	2.8%
BHS	100.0%	0.0%	0.0%	100.0%	0.0%	67.4%
BRB	3.4%	0.0%	0.0%	0.0%	0.0%	25.7%
BLZ	79.4%	0.0%	0.0%	0.0%	0.0%	15.0%
BOL	5.2%	0.0%	0.0%	0.0%	0.0%	2.9%

BRA	4.6%	0.0%	0.0%	0.1%	1.4%	9.6%
CHL	0.6%	0.0%	0.0%	26.9%	0.0%	0.9%
COL	0.4%	41.2%	0.0%	3.0%	0.0%	2.5%
CRI	0.9%	0.0%	0.0%	0.4%	0.0%	3.1%
DOM	0.4%	0.0%	0.0%	1.4%	0.0%	0.5%
ECU	0.1%	0.0%	0.0%	0.2%	0.0%	1.0%
SLV	0.2%	0.0%	0.0%	0.2%	0.0%	0.1%
GTM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GUY	53.0%	0.0%	0.0%	100.0%	0.0%	32.9%
HTI	0.1%	100.0%	0.0%	0.0%	0.0%	1.7%
HND	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
JAM	0.0%	0.0%	0.0%	75.9%	0.0%	1.0%
MEX	1.1%	0.4%	0.0%	2.5%	0.0%	1.6%
NIC	4.0%	0.1%	0.0%	46.2%	0.0%	3.9%
PAN	0.1%	2.6%	0.0%	1.6%	0.0%	4.8%
PRY	0.1%	0.0%	0.0%	0.0%	0.0%	2.8%
PER	0.8%	0.0%	0.0%	0.1%	0.0%	1.4%
SUR	18.0%	14.5%	0.0%	0.0%	0.0%	53.4%
TTO	0.7%	0.0%	0.0%	14.8%	0.0%	2.3%
URY	0.4%	0.0%	0.0%	0.0%	0.0%	2.6%
VEN	18.0%	12.8%	0.0%	0.0%	0.0%	32.2%
LAC	3.6%	3.9%	0.0%	14.0%	23.1%	5.2%

Source: Authors based on COMTRADE.

Several aspects of the implementation of CBAM need to be taken into account **to minimize the impact of the measure on trade and the economy and to support the objective of reducing the impacts of climate change.**

First, it should be noted that the proposed methodology for calculating the CBAM is based on the carbon content of the product (including both direct and indirect emissions) and the difference between the EU carbon price and that of the trading partner.[24] Direct emissions are those from sources owned or controlled by the company. Indirect emissions include emissions from the generation of electricity purchased and consumed by the company. In this context, the first challenge facing LAC countries is **the availability of tools for measuring emissions.**[25] There are over 100 carbon accounting methodologies, each of which yields different results

24 · Two electricity-intensive sectors, aluminum and steel, will initially continue to receive carbon offsets in the EU to cover their indirect emissions, resulting in only their direct emissions being taken into account. However, this will only be the case until these offsets are phased out (Maliszewska et al., 2023).

25 · The CBAM does not include scope 3 emissions. This is an optional reporting category that allows the inclusion of the remaining indirect emissions that are a consequence of the company's activities but occur at sources that are not owned or controlled by the company, emissions that result from the value chain. https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf..

and presents these in different ways (Dietrich Brauch et al., 2021). One option is to use nationally determined benchmark emissions levels for the products in question. Another is to use benchmark levels specific to the exporting country needing to comply with the CBAM. Since emissions intensities for a given product may vary considerably from one country to another, this design feature may make the system less effective at achieving its objectives (WTO, 2022).

For carbon-competitive developing countries—which is the case for most LAC countries—implementing **a comprehensive accounting system that accurately measures emissions** is essential to enable them to prove their competitiveness (Dietrich Brauch et al., 2021). However, it should be noted that this would entail considerable administrative and compliance costs for governments and companies. The CBAM requires producers to provide proof of the GHG emissions embodied in their products. This could impose a significant technical and administrative burden on less developed countries, which already face some of the highest trade barriers in the world, as they may not have the capacity to calculate these emissions and administer this mechanism (Berahab, 2022).

The CBAM also takes into account the carbon price in the country of origin in order to avoid double taxation. Between October 2023 and December 2025, data will only be collected to improve the methodology for calculating indirect emissions, but from then on, importers will present certificates and pay the carbon price difference. There are currently around 70 carbon-pricing initiatives worldwide, covering less than 24% of global GHG emissions.[26] Most have been adopted in developed economies.

Only five countries in LAC have implemented a national carbon-pricing system: Argentina, Chile, Colombia, Mexico, and Uruguay. The schemes take the form of taxes in all these countries except Mexico, which also has an Emissions Trading Scheme. In LAC, carbon prices are no higher than US$5 per metric ton (World Bank, 2023), while in the EU, allowances trade at between US$85 and US$105. In other words, all countries in LAC will have to pay the CBAM to enter the European market, to a greater or lesser extent. This has serious implications: the CBAM would imply a net financial transfer from LAC to the EU. To avoid this, LAC countries could adopt policy reforms focusing on the products covered by the CBAM to

26 · Data from https://carbonpricingdashboard.worldbank.org/map_data, accessed November 1, 2023.

avoid or minimize these transfers. These could entail some form of carbon pricing to generate domestic revenues and use them to support countries' transition to a low-carbon economy or to compensate sectors for possible cost increases (World Bank, 2023; Cárdenas and Cazzolo, 2023).

In this sense, **the CBAM will have distributional consequences at the international level that are potentially important for LAC countries.** Given that many of the EU's LAC partners do not have a carbon-pricing system in place and the prices of those that do are generally much lower, the debate revolves around whether the revenues generated by the CBAM should be transferred to the budget of the implementing country or used specifically to support climate change mitigation actions, for example in developing countries.

In the absence of adjustment measures, carbon-pricing policies may have a greater impact on low-income regions and exporters of fossil fuels and emission-intensive products (WTO, 2022). In addition, smaller firms could be more affected by carbon-pricing schemes as they would be unable to invest in less carbon-intensive technologies and production processes (UNCTAD, 2022). Logic suggests that resources to support climate change mitigation should be allocated where the effectiveness of decarbonization spending is greatest—that is, in developing countries, which tend to use less efficient technologies and have more potential to replace high-carbon energy with low-carbon energy (Bellora and Fontagné, 2022; WTO, 2022).

An additional problem with the CBAM calculation is that **there is a wide variety of policies to reduce emissions,** ranging from carbon pricing to regulation or subsidies. An exporting country may claim that it can achieve the same GHG emissions reduction target with an instrument other than a carbon tax. Difficulties arise in comparing the implicit price of different instruments and considering whether this implicit price should be taken into account when calculating border adjustments (Bellora and Fontagné, 2022).

This difficulty also raises questions about **compatibility with multilateral international trade rules.** Border adjustments will inevitably be assessed differently depending on the extent of each country's environmental regulations, its technology levels, the availability of carbon pricing, and other issues. Consequently, even if the border carbon tax is applied through a common standard, some experts argue that there will still be discrimination in practice, which would violate one of the WTO's principles, most-favored-nation (MFN) treatment. This obliges member countries to refrain from discriminatory trade practices and to grant the same benefits that apply to a particular product to all similar products from member countries. In other words, a border adjustment could violate MFN treatment regarding other countries' exports of similar products (Byeongho et al., 2021).

In its review of the EU's trade policy, the WTO deemed that the CBAM was consistent with the established rules (WTO 2023a and 2023b). The mechanism was analyzed in the light of the MFN principle and GATT article XX, which contains provisions on exceptions, stating that countries may adopt policies that are inconsistent with GATT disciplines but are necessary to protect human, animal, or plant life or health (paragraph b), or relating to the conservation of exhaustible natural resources (paragraph g) (Conte Grand et al., 2022). Interventions must not constitute a means of arbitrary or unjustifiable discrimination or disguised protectionism (Liebreich, 2021; Dietrich Brauch et al., 2021). Moreover, Article II, paragraph 2 of the GATT allows parties to impose additional charges as long as they are equivalent to an internal tax on domestic products. Even if border adjustment were to be implemented and additional charges imposed on imported products to account for their carbon emissions, certain rules, such as national treatment and MFN treatment, would still have to take precedence. For this reason, it is critical that the carbon intensity of each imported product is accurately calculated to ensure that there are no miscalculations that could lead to less favorable treatment of foreign products (Dietrich Brauch et al., 2021). If the CBAM qualifies as an indirect tax, has the objective of protecting the health and life of humans and animals, preserving the life of plants, or conserving nonrenewable natural resources and does not discriminate against imports, it should comply with WTO law.

Border adjustments could lead to trade conflicts between regions imposing such levies and those that must pay them (Byeongho et al., 2021; WTO, 2022). More generally, some WTO members have called for a careful analysis of whether the CBAM risks becoming a barrier to trade (Cárdenas and Cazzolo, 2023). For example, some simulations have shown that it would be optimal for some economies to implement countermeasures against the CBAM to limit the adverse economic effects of this (Böhringer, Carbone, and Rutherford, 2016).

It would be more advantageous for large exporters of energy products to impose retaliatory tariffs than to accept the EU's unilateral tariffs. These reciprocal tariffs will offset the effect of the CBAM, thereby strengthening the price competitiveness of their energy products, which would increase non-EU exports of energy products (Byeongho et al., 2021).

Even if other countries choose to adopt such systems, the structure of each national system will vary, as will the many assumptions needed to calculate the appropriate tax in each case. Border carbon taxes will thus differ not only by product and destination market but also by country of origin and company, which would be a significant departure from the WTO's MFN principle (Berahab, 2022). While the proliferation of carbon-pricing schemes points to the urgency of addressing climate change, they may lead to a complex system of national and regional regimes, creating tensions that could derail climate diplomacy and trade liberalization at a time when these are needed more than ever (WTO, 2022).

In addition to WTO agreements, concerns have also been raised that border adjustments could violate the commitment to **common but differentiated responsibilities (CBDRs)** enshrined in the Paris Agreement. This is the principle of equity on which the global climate regime is based (WTO, 2022). According to this principle, all governments are responsible for addressing climate change but not equally so—economies that industrialized earlier have contributed more to environmental degradation than emerging or newly industrializing economies.

The CBDR principle also reflects differences in countries' economic capacity to contribute to mitigation and adaptation efforts. If a border adjustment mechanism is introduced by high-income economies with more ambitious mitigation targets, the adverse terms-of-trade effects would be concentrated in low-income regions, potentially bringing such schemes into tension with the CBDR principle (Böhringer et al., 2022). However, claims that border adjustment mechanisms are incompatible with the Paris Agreement could be successfully rebutted if it is argued that they would foster ambition at the national level and help address leakage, based on articles 2.1 and 4.1 of the Paris Agreement, which relate to strengthening the global response to climate change and achieving a balance between sources of carbon production and sequestration

(Dietrich Brauch et al., 2021).

However, border adjustment mechanisms could have other positive effects in the fight against climate change: most importantly, they could encourage foreign countries directly affected by border adjustment to adopt more ambitious carbon pricing to avoid it (Böhringer et al., 2022). They could also encourage countries to diversify their economies away from producing emissions-intensive goods. Compliance with border adjustments would require firms to report the amount of carbon emissions embodied in the products they trade in order to calculate the tariff associated with them. Compliance with this requirement could help increase the transparency of carbon emissions and motivate companies and individuals to make more climate-friendly investment and purchasing decisions (WTO, 2022).

6. CONCLUSION

Despite the global nature of climate change, mitigation responses are still only implemented at the national level. As a result, commitment levels vary significantly between countries. This disparity in policies can lead to carbon leakage, which means that reductions in domestic emissions may not lead to a fall in global emissions, and economies with more ambitious climate policies may lose competitiveness.

Given this context and the difficulty of achieving coordinated action at the global level, **possible strategies for offsetting carbon leakage include trade-related mechanisms** such as including provisions in trade agreements and applying unilateral trade policies. The proliferation of these measures will have a significant impact on international trade flows and will particularly affect some countries and sectors in LAC.

The inclusion of EPs in trade agreements has increased exponentially in recent decades, and most of the agreements in force now contain clauses related to climate change. This trend is also evident in LAC. Agreements between countries in the region and the United States include the highest number of such provisions; at the intraregional level, Chile's agreements are noteworthy in this regard.

The empirical evidence shows that countries with EPs in their agreements have lower emissions and that signing agreements may lead to changes to domestic environmental legislation. However, the unilateral measures implemented by some of the most environmentally ambitious economies reveal that agreements only have a limited impact on achieving climate goals, especially those set out in the Paris Agreement.

There are two noteworthy measures that the EU has recently implemented as part of its Green Deal and that are also on the agendas of other major economies: a ban on imports of goods from deforested areas and border taxes based on carbon content.

Given that LAC is the region with the second highest rate of deforestation in the world after Africa and that the comparative advantage of several countries in the region is concentrated in sectors such as agriculture and livestock, **the EU's ban on imports of goods from deforested areas requires special attention.** A significant proportion of goods affected by the EUDR are exported to EU economies, and these goods will need to be adapted to the new requirement in the immediate future to continue to access this market.

Another measure to limit carbon leakage at the heart of the trade agenda is the CBAM, which seeks to ensure that foreign competitors face the same carbon costs as domestic producers. The CBAM is expected to help reduce carbon leakage and provide incentives for carbon pricing in the rest of the world, thereby helping fight climate change. However, it could also have adverse effects on relatively less developed regions, which is true of most of LAC. Although the direct impact on exports is relatively small, some sectors in certain countries will be disproportionately affected, and the challenges will be greater for economies with fewer resources to meet the requirements of border adjustment systems. LAC countries will also need to consider the redistributive effects of the CBAM and the possibility of it triggering trade conflicts or issues with other multilateral agreements, such as the Paris Agreement.

To minimize the negative economic impact of these environmentally motivated trade measures and to maximize the impact on emissions reductions, **LAC countries should begin by monitoring the technical aspects of the measures applied by their partner countries** so that they are better prepared when measures start to be applied. Key capabilities to achieve this include capacity building, knowledge of methodologies, and data collection.

With regard to the provisions of trade agreements, **more evidence needs to be generated on whether the inclusion of environmental standards is a barrier to trade.** Berger et al. (2018) find that the more environmental measures are included in agreements, the greater the negative impact on trade; however, they find no evidence of "green protectionism" associated with these measures and against the competitiveness of developing countries. Second, while some agreements contain **provisions on implementation, this tends to be poorly documented**, and empirical evidence is limited to a few specific cases. Third, more research is needed on the long-term environmental effects of environmental standards in agreements and the transmission channels between these standards and the environmental impact of trade. Fourth, there is a need to **examine why countries adopt environmental regulations,** especially the more enforceable ones. Some researchers suggest that they were already in the process of implementing them; others argue that they do so in response to pressure from trading partners. Even if the same type of measures are at stake and the same country is a signatory to two environmental agreements with EPs, the scope, forms of implementation, and commitments enshrined in these may differ. Our analysis based on these databases is a useful starting point, but **more detailed studies are needed to compare the scope of each agreement and the commitments they entail.**

In the specific case of the due diligence process for the EUDR, one important factor is capacity-building in **certifying the traceability** of the value chains for commodities at risk of deforestation.

With regard to the CBAM, in addition to an **accounting, verification, and management system,** LAC countries need to implement a carbon-pricing system that limits the transfer of revenues to the EU (and other economies applying similar mechanisms) through border adjustments, thus raising revenues that can be reinvested at the national level for environmental purposes. Those that already have systems in place need to align their prices with those of the EU market. **Harmonizing carbon-pricing systems within LAC** would have the added benefit of avoiding the costs of multiple systems being in place, which not only creates tensions but also increases compliance and administrative costs. Regional coordination is essential in this regard.

At the same time, LAC countries need to **adapt commodity production to the challenges posed by climate change** by introducing technologies to increase productivity and sustainability. These include innovations such as bio-inputs, 4.0 technologies, and plant and animal genetics. International trade plays a fundamental role in this process and can have a positive impact on climate change through the technical channel.

In this regard, given the shortage of fiscal resources in the region, LAC's economies **need to access external financing,** which is increasingly available to support investments aligned with climate objectives, including reducing GHG emissions (Dietrich Brauch, 2021). To do so, the international community must find a multilateral solution to effectively mobilize the international financing for developing countries contemplated in the Paris Agreement. This needs to be used to support mitigation strategies, the productive transformation required by climate change, and the adaptation of value chains to increasingly frequent "green" trade restrictions.

At the 2023 Conference of the Parties of the UNFCCC (COP 28), the parties reached an agreement on implementing the loss and damage fund. Commitments to the fund totaled more than US$700 million. The second replenishment of the Green Climate Fund was boosted by six countries pledging new funds, bringing total pledges to US$12.8 billion from 31 countries, with more contributions expected. Multilateral development banks are also strengthening their capacity to invest in assets that are socially, environmentally, and economically sustainable. In particular, the IDB Group plans to triple direct and mobilize climate finance in LAC to reach US$150 billion over the next decade.

Another important factor at the multilateral level is maintaining the WTO's transparency mechanisms and its role as a forum for dialogue, as this could help mitigate possible trade frictions resulting from any of these measures. LAC would do well to present its position at these and other international forums, given that many of the countries in the region are among the lowest global emitters of GHGs but would be among the most affected by measures such as those being adopted by advanced economies. Similarly, LAC countries have only limited resources for transitioning to a low-carbon economy.

Addressing climate change through trade policy poses profound challenges for the region, which must adapt quickly to minimize negative impacts on the economy and maximize climate change mitigation. LAC could play a key role in promoting sustainable practices while fostering economic growth and resilience to climate challenges. This could be achieved by viewing trade not as a threat to the environment but as a vital tool in achieving the triple aim of increasing prosperity, reducing inequality, and mitigating climate change.

ANNEX
MAIN FEATURES OF THE DUE DILIGENCE PROCESS

There are three stages to the due diligence process for the DFP[27]

1) The first step entails collecting basic information on the product to be traded, including a product description, quantities, the country where it was produced, contact information for the trading partner, and so on. The new requirements include the geolocation of the land where the product has been grown or reared; conclusive, verifiable information guaranteeing the traceability of the finished products and/or raw materials used; and verifiable references that the goods have been produced in compliance with the relevant legislation in the producing country.

2) During the second stage, companies must analyze and assess the risk of potential noncompliance in the supply chain based on the information gathered during the first stage and a classification system to be developed by the Commission[28], which will classify countries according to the risk they present for producing products that are not deforestation-free. There will be three categories: low risk, standard risk, and high risk[29] Some additional assessment criteria will also be included, such as i) the forested area of the country of origin of the good and the region from which it is sourced; ii) the prevalence of deforestation or forest degradation in the country, region, and specific origin of the good; iii) corruption levels, the prevalence of falsification of documents and data in the country; iv) the risk of products being mixed with others of unknown origin or produced in areas affected by deforestation or forest degradation; and vi) additional information such as certifications. If the goods in question are found to be deforestation-free, they will be permitted to enter and leave the EU.

3) If the risk assessment is unsatisfactory, the third stage in the process will be set in motion, whereby companies will have to implement risk mitigation measures to reduce their risk levels to zero. These might

27 · For a more detailed analysis, see chapter 2 of this publication, "The Impact of the EU Green Deal on Exports from Argentina." These obligations will apply from the end of December 2024 and the end of June 2025 for MSMEs.
28 · This is referred to in the law as benchmarking system.
29 · When the law enters into force, all countries will be classified as standard risk. The list of low- and high-risk countries will be published by December 30, 2024, and will be updated as new evidence becomes available.

include requests for additional information, data or documentation, surveys, or independent audits. If countries are classified as low risk according to the benchmarking system, they will be able to access a simplified due diligence procedure that will allow them to dispense with stages 2 and 3.

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