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# Sustainable bond issuances in international markets, 2014–2022

Characteristics,  
trends and greenium  
in Latin America and  
the Caribbean

Helvia Velloso  
Daniel E. Perrotti



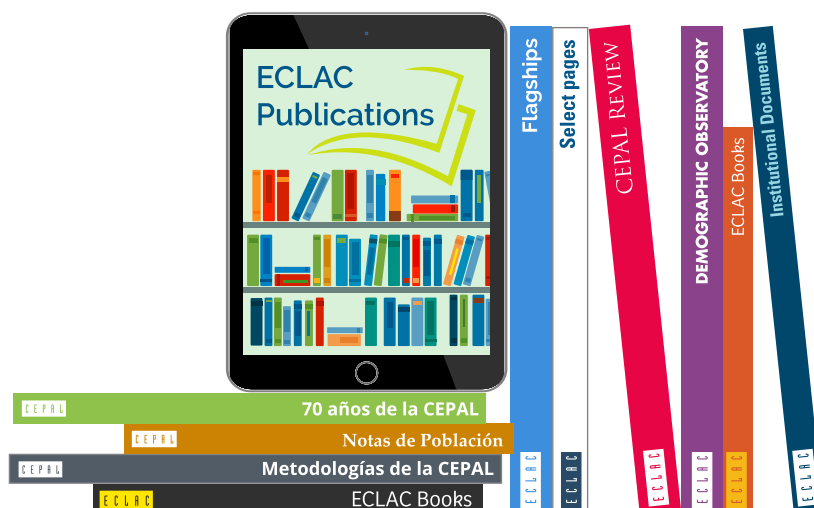
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Characteristics, trends and greenium in  
Latin America and the Caribbean

Helvia Velloso  
Daniel E. Perrotti



UNITED NATIONS

**ECLAC**

This document has been prepared by Helvia Velloso, Economic Affairs Officer, and Daniel E. Perrotti, Research Assistant, of the Economic Commission for Latin America and the Caribbean (ECLAC) office in Washington, D.C. The authors are grateful to Andrés Valenciano, Acting Chief of the same office, and Georgina Núñez, Economic Affairs Officer in the Division of Production, Productivity and Management of ECLAC, for their valuable comments.

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United Nations publication  
ISSN: 1728-5437 (electronic version)  
ISSN: 1727-9909 (print version)  
LC/TS.2023/186  
LC/WAS/TS.2023/5  
Distribution: L  
Copyright © United Nations, 2023  
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Printed at United Nations, Santiago  
S.23-01157

This publication should be cited as: H. Velloso and D. E. Perrotti, "Sustainable bond issuances in international markets, 2014–2022: characteristics, trends and greenium in Latin America and the Caribbean", *Studies and Perspectives series-ECLAC Office in Washington, D.C.*, No. 25 (LC/TS.2023/186-LC/WAS/TS.2023/5), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2023.

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## List of acronyms

BNDES	Brazil's Development Bank (Banco Nacional de Desenvolvimento Econômico e Social)
CBI	Climate Bonds Initiative
CVM	Brazil's Security and Exchange Commission (CVM Comissão de Valores Mobiliários)
ECLAC	Economic Commission for Latin America and the Caribbean
EIB	European Investment Bank
EMDE	Emerging Market and Developing Economies
ESG	Environmental, Social and Governance
FTSE	Financial Times Stock Exchange
GBP	Green Bond Principles
GFSR	Global Financial Stability Report
GHG	Greenhouse Gases
GSSS	Green, social, sustainability and sustainability-linked bonds
ICMA	International Capital Market Association
IDB	Inter-American Development Bank
IFC	International Financial Corporation
IMF	International Monetary Fund
IPCC	United Nations Intergovernmental Panel for Climate Change
KPI	Key Performance Indicators
LAC	Latin America and the Caribbean
NAFIN	Mexico's Development Bank (Nacional Financiera)
OLS	Ordinary Least Squares
PSM	Propensity Score Matching
SBG	Sustainability Bond Guidelines
SBP	Social Bond Principles
SLB	Sustainability-linked Bond
SLBP	Sustainability-Linked Bond Principles
SPT	Sustainability Performance Targets
UNFCCC	United Nations Framework Convention on Climate Change



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## Abstract

This document examines the evolution of Latin America and the Caribbean (LAC)'s international issuance of sustainable bonds —green, social, sustainability and sustainability-linked bonds (GSSS)—since the region's first international green bond was issued in December 2014. Reaching a cumulative total international GSSS bond issuance of US\$ 100 billion in the 2014-2022 period, four main trends are identified. First, the share of GSSS bonds in the region's total international bond issuance has increased significantly, jumping from less than 1% in 2018 to 32% in 2022. Second, while initially most issuances were of green bonds, the region has moved toward a diversification of the sustainable instruments used, with sustainability and sustainability-linked bonds becoming the region's most used GSSS instruments since 2021. Third, since Chile issued the first sovereign international green bond in June 2019, sovereign GSSS bond issuances have become the driver of the region's overall international sustainable issuances, accounting for the largest share of the GSSS total. Finally, applying a propensity score matching (PSM) methodology to compare the behavior of GSSS and conventional bonds issued by LAC public and private agents in the primary market in this eight-year period, a statistically significant "greenium" —the amount by which the yield on a GSSS bond is lower than an otherwise identical conventional bond—was found, evidence of investors' willingness to accept a lower financial yield in pursuit of a social responsibility agenda.



## Introduction

The international consensus on the Sustainable Development Goals (SDGs) and the 2030 Agenda poses great challenges in terms of mobilizing resources. The amounts necessary to meet the seventeen SDGs far exceed the scope of traditional financing for development. In the case of Latin America and the Caribbean (LAC), public financing falls short of what is needed for this task and must be complemented with private flows, which in fact make up the bulk of the region's external financing. The challenge is to combine public and private resources and identify innovative financing sources that will provide the leverage needed to maximize the impact of financing for the 2030 Agenda (ECLAC, 2017a).

In 2010, the Green Climate Fund was established by 194 countries party to the United Nations Framework Convention on Climate Change (UNFCCC), creating with it the concept of "climate finance." Climate finance refers to "local, national or transnational financing—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change."<sup>1</sup> International finance has gone further and coined the term "sustainable finance" which, "according to the Spanish stock market supervisory, the National Securities Market Commission, aims the economic growth of nations toward more human and balanced development, by satisfying current needs and envisioning a better future for new generations. Therefore, sustainable finance, in addition to strict financial criteria such as profitability, risk, and liquidity, is mainly based on satisfying environmental, social, and governance (ESG) needs" (Bernabé Argandoña et al. (2022), p.1).

Two other underlying forces have supported the drive towards sustainable finance. One is of a political and regulatory nature, the efforts unleashed by the 2015 Paris Climate Agreement and the need to finance US\$ 1 trillion a year in investments for renewable energy and other initiatives to limit global warming. The other is market-driven, the growing financial appeal of ESG investing, as global awareness of climate change and environmental and social impact grows, clean technologies mature, and the costs of renewable energy decline.

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<sup>1</sup> UNFCCC, Introduction to Climate Finance [online] <https://unfccc.int/topics/introduction-to-climate-finance>.

In this context, alternative financial instruments have become increasingly available to investors interested in Latin America and the Caribbean (LAC), which could help it to address two goals: a) allocate funds to bridge the development gap and b) encourage investment in sustainable development projects. Green (or blue), social, sustainability and sustainability-linked (GSSS) bonds are an example of these instruments, and the issuance of GSSS bonds by Latin American and Caribbean issuers in international markets from December 2014, when the region's first green bond was issued, to December 2022, is the focus of this report.

This document is structured as follows. The first chapter examines the origins of the global sustainable bond market, the definition and types of sustainable bonds available to issuers and investors, and a timeline of the use of these bonds by Latin American and Caribbean issuers within the global context. The second chapter offers a deeper look at the evolution, main trends and traits of the international sustainable bond issuances by LAC issuers in the eight-year period, as well as the critical challenges for growing the use of these instruments. One of them is the perception by many of the region's issuers that these bond issuances may be costly and not offer a discernable reward in terms of lower borrowing costs, which leads to the third chapter, where an empirical analysis is applied to examine whether a "greenium"—the amount by which the yield on a GSSS bond is lower than an otherwise identical conventional bond—can be found in the period analyzed. Finally, we conclude with some thoughts on the possibilities and challenges for the future growth of the region's sustainable bond market.

## I. Financing sustainability: on the origins of the sustainable bond market

As interest in innovative financial instruments to promote sustainable economic activities grows and sustainable bonds continue to develop down new paths, it is helpful to examine the recent origins of these instruments. The first green bonds were issued by AAA-rated multilateral institutions—the European Investment Bank (EIB) in 2007 and the World Bank in 2008.

The EIB issued a “climate awareness bond” in May 2007. The funds raised were earmarked for investment in future EIB lending projects within the fields of renewable energy and energy efficiency. It was an equity index-linked bond. The returns of the bonds were to be linked to the performance of a new equity index expressly created for this transaction by the Financial Times Stock Exchange (FTSE)—the FTSE4Good Environmental Leaders Europe 40 Index (EIB, 2007).

In November 2008, the World Bank issued a green bond that created the blueprint for the market and a new way to connect financing from investors to climate projects. The publication in 2007 of a report by the United Nations Intergovernmental Panel for Climate Change (IPCC) linking human action to global warming, along with increasing occurrences of natural disasters, prompted a group of Swedish pension funds interested in investing in climate action projects to turn to the World Bank for help to find these projects around the world. Investors wanted a safe place to put their money and know they were making a difference. The resulting World Bank issuance was the first to define criteria for eligible green bond projects, and the first where investors received assurance, through a second-party opinion provider, that eligible projects would address climate change. The World Bank was also the first to commit to investor reporting on the use of green bond proceeds and expected project impacts, setting the standard for the market and forming the basis for the green bond principles coordinated by ICMA, the International Capital Markets Association (The World Bank, 2018 and 2019). Use of proceeds, transparency, allocation, and impact became the key features of green bonds, supported by the important regular reporting.

## A. Definitions and types of sustainable bonds

As its name suggests, a green bond is a fixed-income debt security that raises funds from investors interested in projects that generate environmental benefits. Green bonds are issued with the purpose of financing solutions for climate-related problems. The global green labeled market has seen exponential growth since its inception. From 2007 to 2020 it grew to around US\$ 1 trillion according to the Climate Bonds Initiative (CBI), which estimates an average annual growth rate in this period at approximately 95% (CBI, 2020).

As part of a larger trend in socially responsible and environmental, social and governance (ESG) investing, the definition of green bonds has widened to include a broader range of socially conscious debt labels, such as social and sustainability bonds. Green, social and sustainability bonds are any type of bond instrument where the proceeds will be exclusively applied to eligible environmental and/or social projects. They are called “use of proceeds” bonds. In September 2019, when Italian utility Enel issued the first sustainability-linked bond (SLB) in international markets with a target of increasing installed energy capacity to at least 55% by the end of 2021, a second type of bond structure emerged. Today, there are two types of structure in the sustainable debt market: “use of proceeds” and “target linked.”

SLBs are bonds whereby the proceeds from the issuance are not limited to green or sustainable purposes (unlike “use of proceeds” bonds) and may be used for general corporate purposes or other purposes. Instead, the SLBs are linked to the performance of certain key performance indicators (KPIs) in achieving pre-defined sustainability performance targets (SPTs), and depending on whether this is achieved, certain characteristics of the SLBs may vary (e.g., coupon rate). Issuers are thus committing explicitly to future improvements in sustainability outcomes with a pre-defined timeline. SLBs are a forward-looking performance-based instrument. The SLBs are meant to complement green, social and sustainability bonds, enabling more issuers to access financing for sustainable investments.

Market participants have recognized the International Capital Markets Association (ICMA) principles as a standard for issuing sustainable bonds in international capital markets. ICMA publishes these procedural guidelines on a yearly basis. They are a “collection of voluntary frameworks with the stated mission and vision of promoting the role that global debt capital markets can play in financing progress towards environmental and social sustainability.”<sup>2</sup> These sets of recommendations target all participants in the market. The Green Bond Principles (GBP), the Social Bond Principles (SBP), the Sustainability Bond Guidelines (SBG) and the Sustainability-Linked Bond Principles (SLBP) have become increasingly important in international markets, with several sovereign and corporate issuers around the world taking them as a reference to develop their own frameworks for the issuance of sustainable bonds.

The four core components for alignment with the green, social and sustainability bond principles, which belong to the first type of market structure, are: 1) Use of Proceeds, 2) Process for Project Evaluation and Selection, 3) Management of Proceeds, and 4) Reporting. The two key recommendations for heightened transparency are: Sustainable Frameworks and External Reviews.

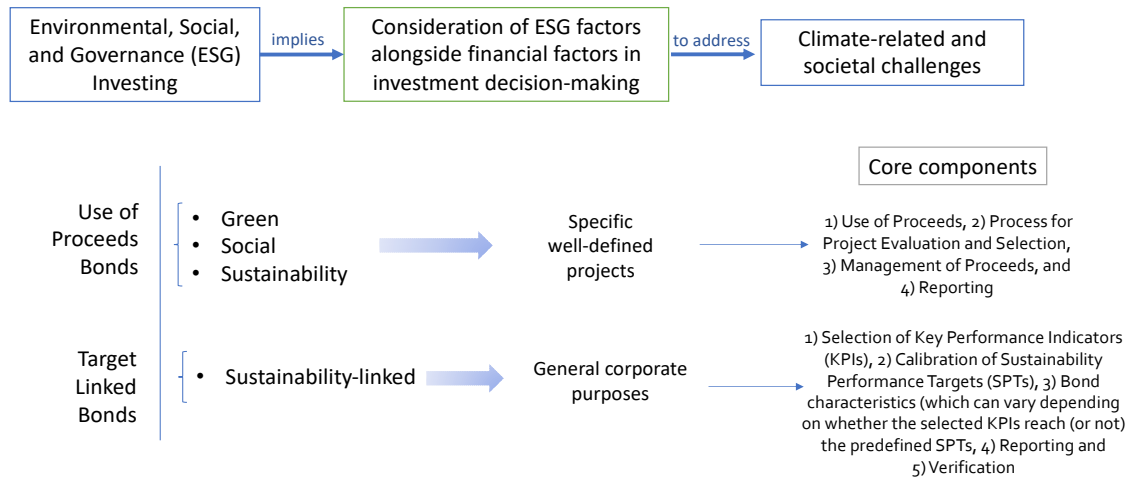
In the case of sustainability-linked bonds, proceeds are intended to be used for general purposes, hence the use of proceeds is not a determinant in its categorization. The five core components for alignment with the SLBPs are: 1) Selection of Key Performance Indicators (KPIs), 2) Calibration of Sustainability Performance Targets (SPTs), 3) Bond characteristics (which can vary depending on whether the selected KPIs reach (or not) the predefined SPTs, 4) Reporting and 5) Verification (figure 1, box 1).

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<sup>2</sup> ICMA, “Sustainable Finance” <https://www.icmagroup.org/sustainable-finance/> and Kelly et al (2021).



**Figure 1**  
**Types of sustainable bond instruments**



Source: Elaborated by authors based on ICMA and other market sources.

**Box 1**  
**Types of sustainable bond instruments and ICMA principles**

The ICMA Principles outline best practices for the issuance of bonds serving social and/or environmental purposes through global guidelines and recommendations that promote transparency and disclosure, thereby underpinning the integrity of the market.

**Green Bonds:** ICMA Green Bonds Principles (GBP) published in June 2021 state that Green Bonds are any type of fixed income instrument whose proceeds or an equivalent amount will be exclusively applied to finance or refinance, entirely or partially, projects with clear environmental benefits, and which are aligned with the Core Components of the GBP. Eligible green project categories include renewable energy, energy efficiency, pollution prevention and control, environmentally sustainable management of living natural resources and land use, terrestrial and aquatic biodiversity conservation, clean transportation, sustainable water and wastewater management, climate change adaptation, circular economy adapted products, production technologies and process and/or certified eco-efficient products, and, finally, green buildings (ICMA, 2022).

**Social Bonds:** the Social Bond Principles (SBP) state that social bonds are instruments whose proceeds will be applied towards new and existing projects that directly aim to address or mitigate a specific social issue and/or seek to achieve positive social outcomes, especially but not exclusively for a target population(s) and are aligned with the Core Components of the SBP. Social project categories include providing and/or promoting affordable basic infrastructure, access to essential services, affordable housing, employment generation and programs designed to prevent and/or alleviate unemployment stemming from socio-economic crises, food security and sustainable food systems, and, finally, socioeconomic advancement and empowerment. All designated eligible Social Projects should provide clear social benefits, which will be assessed and, where feasible, quantified by the issuer (ICMA, 2023a).

**Sustainability Bonds:** according to the Sustainability Bond Guidelines (SBG), these bonds' proceeds will be allocated exclusively to the financing or refinancing of a combination of green and social projects. Due to that, SBGs are aligned with the four core components of both the GBP and SBP (ICMA, 2021b).

**Sustainability-Linked Bonds:** SLBs are target-linked instruments and can be a promising innovation to sharpen investors' focus on supporting the transition strategies of entire companies. They differ from classical green, social and sustainability bonds in that they allow financing outside of specific projects or use of proceeds categories. SLBs are more easily tracked through the assessment of key performance indicators (KPI). The issuer chooses select indicators and associated targets that it wants to achieve through the issuance of the bond. The SLB financial and/or structural characteristics can vary depending on whether the selected KPI(s) reach (or not) the predefined SPTs, i.e., additional payments to bondholders will accrue if the issuer does not meet the set targets. According to the Sustainability-Linked Bond Principles (SLBP), the aim of the SLB is to further develop the key role that debt markets can play in funding and encouraging companies that contribute to sustainability (ICMA, 2023b).

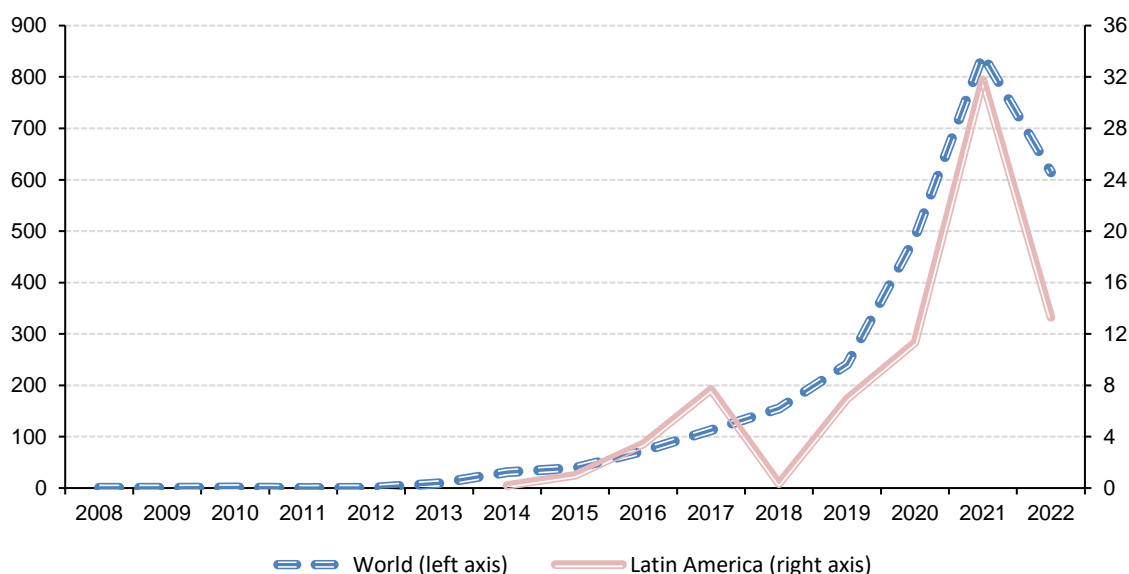
Source: Núñez, Velloso and Da Silva (2022), based on ICMA, <https://www.icmagroup.org/sustainable-finance/the-principles/>.

A number of countries in Latin America and the Caribbean have issued green bond guidelines and sustainable bond frameworks to regulate the issuance of green, social, sustainability and sustainability-linked bonds, taking ICMA's Guidelines and Principles as a reference (Núñez, Velloso and Da Silva (2022), p.15-18). Regarding reporting, countries' legislative and regulatory environment can contribute to improve its quality. Núñez, Velloso, Lehuedé, Da Silva and Poveda (2023) review the global developments in norms and regulations regarding sustainability disclosure and the progress that some Latin American and Caribbean countries have made in this area (Núñez et al (2023), part II).

## B. Sustainable bonds in Latin America and the Caribbean: a timeline

Since the world's first green bonds were issued in 2007 and 2008, the market for sustainable bonds has expanded. In 2014, the market's growth took off, and from then until 2021 it closed at record highs each year (figure 2). According to the Climate Bonds Initiative, the wider bond market started to react more strongly after the first US\$ 1 billion green bond was issued by the International Financial Corporation (IFC) in March 2013 (CBI, 2020). As the green bond market grew in size, liquidity became important and was greatly aided by new issues of more than US\$ 1 billion.

Figure 2  
Total annual sustainable bond issuances in international markets, 2008–2022  
(Billions of dollars)



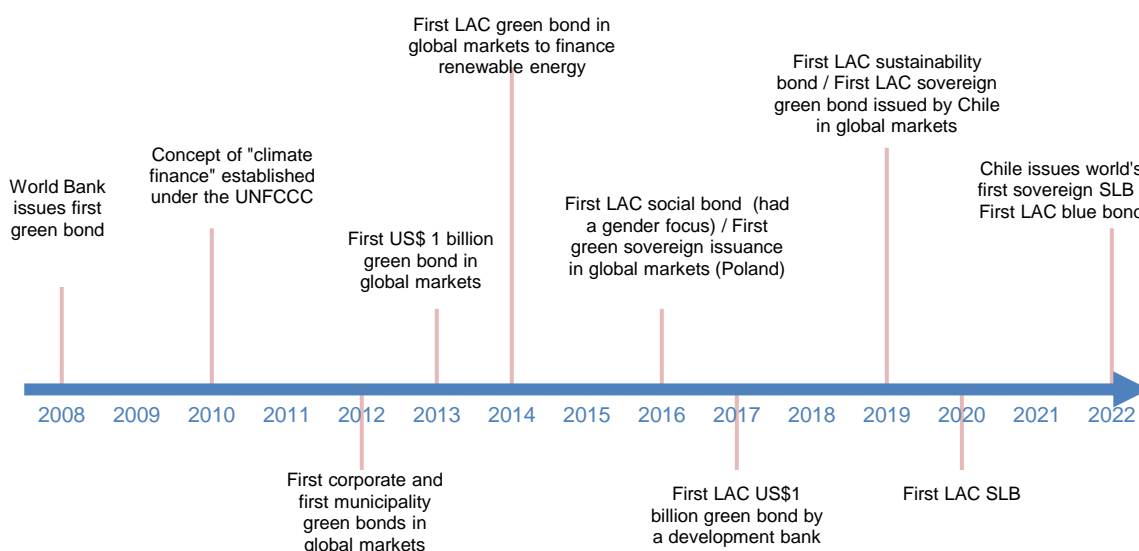
Source: Elaborated by authors with data from Dealogic. Includes green, social and sustainability bonds. Data extracted on 30 October 2023.  
Note: In 2022, higher global interest rates and borrowing costs led to a slowdown in both conventional and sustainable bond issuances.

In **December 2014**, Peru's Energía Eólica, a wind farm operator, became the first Latin American issuer to sell a green bond in international markets when it issued a US\$ 204 million 2034 bond with a coupon of 6%. While this transaction was not the first to finance renewable energy in Latin America (two bonds to finance wind farms in Oaxaca, Mexico, were sold in 2012)<sup>3</sup>, it was the first from the region to be certified by auditors as complying with a series of green bond conditions. Those requirements included the funding being used specifically for a project that has describable, quantifiable and/or assessable environmental benefits (ECLAC (2017b), p.31).

<sup>3</sup> The refinancing of the Oaxaca II and IV wind farms involved Rule 144A/RegS project bonds of about US\$ 152 million and US\$ 154 million, respectively, in August 2012.

Since then, sustainable bond issuances from the region have generally followed the global trend. They accounted on average for a 3% share of the world's sustainable issuances from 2014 to 2022 according to data from Dealogic. In this eight-year period the region accomplished several milestones (figure 3).

**Figure 3**  
Latin America and the Caribbean sustainable bond market milestones, 2014–2022  
(Timeline)



Source: Elaborated by authors based on "Capital Flows to Latin America and the Caribbean" reports of the ECLAC office in Washington D.C., CBI (2020) and The World Bank (2019).

In **2016**, the region issued its first social bond in international markets, a 10-year bond issued in Japanese yen in the Samurai market (US\$ 94 million equivalent) by Banco del Estado de Chile (BancoEstado), with a 0.480% coupon. It had a women entrepreneur focus, with proceeds directed to BancoEstado's "Crece Mujer Emprendedora" (Grow Entrepreneurial Woman) program, to provide entrepreneurial women in Chile with resources and reduced barriers to accessing financial services.

In **2017**, Brazilian Development Bank (BNDES) issued Brazil's first US\$ 1 billion green bond to finance wind and solar projects, maturing in 2024 and with a 4.75% coupon. It was the first time that a Brazilian bank had issued a green bond in the international market, and it contributed to improve market liquidity. The funds obtained were to go towards financing environmentally sustainable projects, certified by a company specialized in the environmental area, aiming at new or already existing wind or solar generation projects in the portfolio of the Bank. Between 2003 and 2016, in the wind power sector alone, BNDES approved 87 credit operations totaling R\$ 28.5 billion in credit, increasing the installed capacity by about 10.7 gigawatt (GW). The release of this bond, which was listed on the Luxembourg Green Exchange, added to the other BNDES's initiatives to promote the dissemination of best social and environmental management practices. The issuance also encouraged the access of other Brazilian issuers to the green bond market (ECLAC, 2017b).

This was not exactly the region's first US\$ 1 billion green bond. Before that, in September 2016, Mexico City's Airport Trust (connected to Mexico's development bank NAFIN) had issued the largest green bond to date in Latin America to finance a new carbon-neutral airport in Mexico City. Its construction was suspended in December 2018, however, and the bonds issued to finance the airport were partially repurchased through a buyback operation (box 2).

**Box 2****Mexico City Airport Trust green bond issuances**

In September 2016, Mexico City's Airport Trust issued the largest green bond to date in Latin America, raising US\$ 2 billion through a two-tranche jumbo bond, which received the certification from the Climate Bond Initiative. The two tranches were issued separately with US\$ 1 billion face values with 10-year and 30-year maturities and 4.25% and 5.50% coupon rates, respectively. The proceeds were to be used to finance Mexico City's new airport, which aimed to be carbon neutral, utilize 100% clean energy, and be efficient in its water usage. One year later, they were followed by other jumbo issuances of a US\$ 1 billion 10-year bond and a US\$ 3 billion 30-year bond, with 3.88% and 5.50% coupon rates, respectively. In total, Mexico City Airport Trust issued US\$ 6 billion of green bonds in 2016 and 2017 to finance the construction of the new carbon-neutral airport.

The project was first announced in September 2014 and cancelled in late 2018 after a public referendum in which a majority voted that the new airport should be built at a different location. As a result, the newly elected Mexican government announced it was halting the airport's construction, and construction was suspended in December 2018. The government launched a buyback package capped at US\$ 1.8 billion—less than two-thirds of the US\$ 6 billion outstanding bonds in the market. The remaining bonds were transferred to a new project, prompting S&P to withdraw its green certification, in effect leaving many investors in breach of their own rules and highlighting the possibility of other hidden risks arising in the growing green bond market.

Source: Elaborated by authors, based on ECLAC (2017b) and market sources.

In **2019**, Chile became the region's first sovereign to issue green bonds in international markets, selling US\$ 1.42 billion in 2050 notes on 17 June at a historically low coupon of 3.5%. According to the SEC filing, US\$ 523 million from the new issue was to fund renewable energy facilities and other projects to protect the environment (including clean transportation, energy efficiency, renewable energy, biodiversity conservation, and sustainable water management), and US\$ 895 million to buy back bonds maturing between 2020 and 2047. Ahead of the transaction, Chile worked with the Inter-American Development Bank (IDB) and the ESG ratings agency Vigeo Eiris to develop a framework for the green bond. Chile became the second sovereign issuer after the Netherlands to receive certification from the Climate Bonds Initiative. On 25 June, Chile tapped international markets a second time with another green bond issuance, this time in euros. It issued a EUR 861 million (US\$ 981 million equivalent) 2031 bond with a 0.83% coupon.

Also in **2019**, the region issued its first sustainability bond, with proceeds to be used for a combination of green and social projects. On 24 October, Chile's Celulosa Arauco y Constitución S.A. completed an offering of US\$ 500 million of 4.20% notes due 2030 and US\$ 500 million of 5.15% notes due 2050, achieving the lowest coupon rate in the company's history for a 30-year bond. Both these bonds were issued in alignment with the four core components of the Green Bond Principles, 2018, and the Social Bond Principles, 2018, as administered by ICMA. Celulosa Arauco was the first forestry company and the first issuer in Latin America to ever issue sustainable bonds.

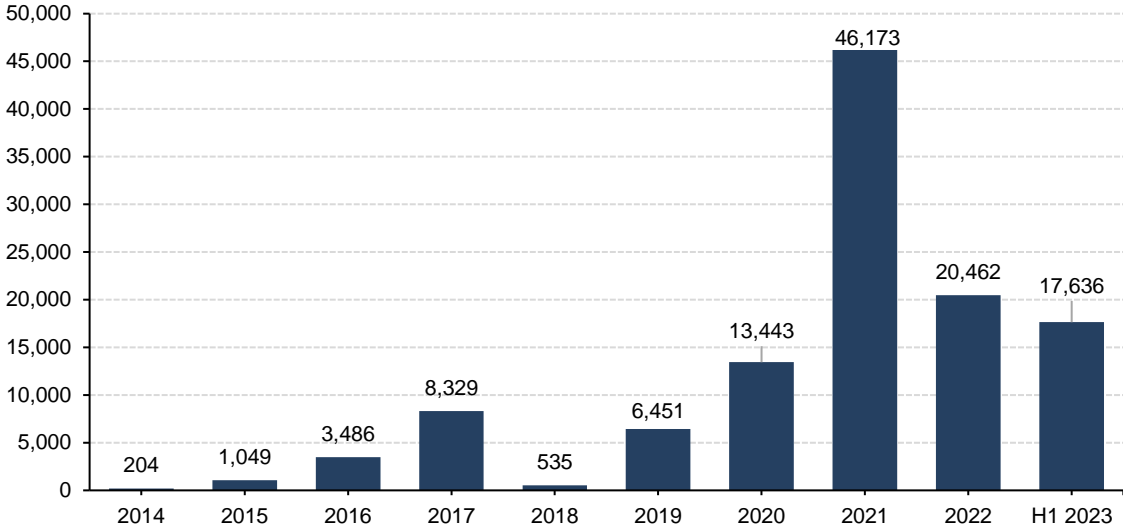
In **2020**, the region's first SLB was issued on 10 September by Suzano, a Brazilian company also in the forestry and paper sector. It was a US\$ 700 million 2031 bond with a 3.750% coupon tied to Sustainable Development Goal (SDG) 13 on climate action, which the company reopened on 16 November 2020 to add US\$ 500 million.

In **2022**, Chile issued the world's first sovereign SLB in March, becoming the first country to use sovereign debt to fund its long-term climate initiatives and accelerate its energy transition. In June, the Commonwealth of the Bahamas issued the region's first blue bonds in global markets. It was a two-part deal totaling US\$ 385 million in dollar-denominated blue notes (US\$ 235 million in seven-year notes and US\$ 135 million in 14-year notes), which was partially guaranteed in the amount of US\$ 200 million by the Inter-American Development Bank (IDB). Moody's and S&P Global Ratings assigned the proposed bonds a triple A rating. Both agencies cited the guarantees from the IDB as a reason for the high ratings.

Proceeds from the bond were to fund the preservation of the country’s ocean and marine life through a blue economy program.

At the end of this eight-year period—from December 2014 to December 2022— Latin American and Caribbean’s sustainable bond market grew to a cumulative total of US\$ 100 billion. Including the first half of 2023, the market has reached US\$ 118 billion (figure 4).

**Figure 4**  
**LAC international GSSS bond issuance, 2014–H1 2023**  
*(Millions of dollars)*



Source: ECLAC (2023b), based on data from Dealogic and Latin Finance.



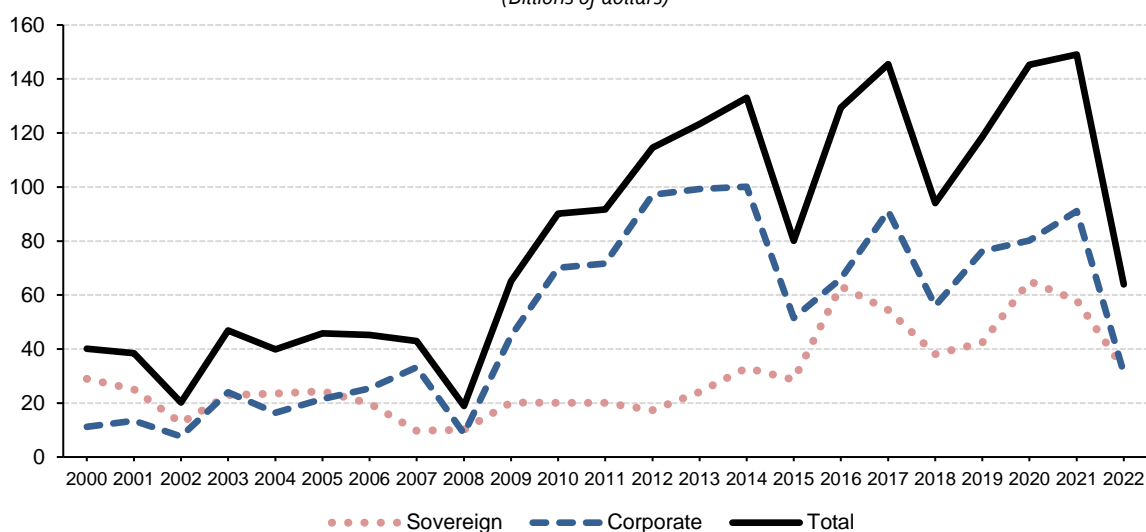
## II. Sustainable bond issuances in Latin America and the Caribbean, 2014–2022

Achieving the transition to net-zero emissions by 2050 will require substantial climate mitigation investment in emerging market and developing economies (EMDEs), which currently emit around two-thirds of greenhouse gases (GHG) according to the International Monetary Fund (IMF)'s October 2023 Global Financial Stability Report (GFSR). These countries will need about US\$ 2 trillion annually by 2030 to reach that ambitious goal, according to the International Energy Agency, a fivefold increase from the current US\$ 400 billion of climate investments planned over the next seven years. The IMF projects that growth in public investment will be limited, however, and that the private sector will therefore need to make a major contribution toward the large climate investment needs for EMDEs. The private sector will need to supply about 80% of the required investment and this share rises to 90% when China is excluded (IMF (2023), chapter 3).

Financial markets' focus has increasingly moved towards climate action and the achievement of the SDGs by 2030. Interest in financial instruments with the purpose of financing sustainable projects and strategies has increased sharply, a positive development towards facilitating private sector sustainable activities and investment. An overwhelming 96% of institutional investors participating in a survey by Natixis Investment Managers in May 2020 said they have a key role to play in addressing global challenges, such as climate change, the need for infrastructure development, and social and economic inequality. 60% of respondents in the survey said they would be willing to invest in projects that help address societal challenges as long as they meet their portfolios' long-term goals (Natixis, 2020).

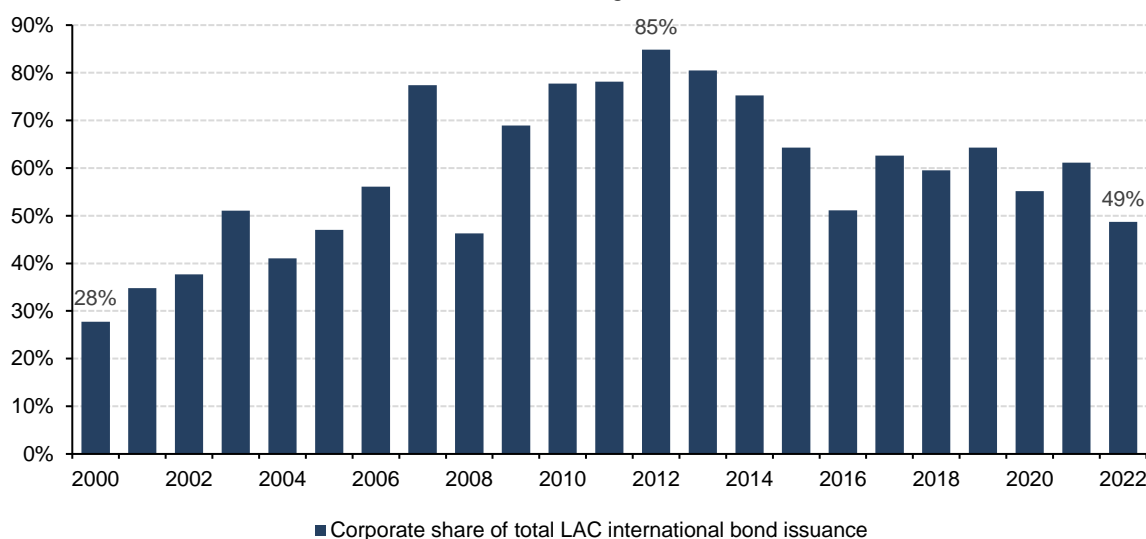
In this context, it is important to stress that Latin American and Caribbean (LAC) corporate bonds emerged as a mainstream product in the global credit space in the past twenty years, as external funding shifted from sovereign issuers to corporations and banks. From 2009 to 2021 the corporate sector became the main driver of the region's international debt issuances (figure 5). The share of LAC corporate debt issuances in the LAC total amount issued in international debt markets also increased sharply, from 28% in 2000 to a peak of 85% in 2012 (figure 6). The region's private sector was also the first to issue green bonds in international bond markets, and until June 2019, when the first sovereign green bond was issued in international markets, all LAC green bond issuances were from the corporate sector.

**Figure 5**  
Annual LAC international bond issuance by issuer type, 2000–2022  
(Billions of dollars)



Source: Bustillo and Velloso (2013), p.55. Updated to 2022. The data includes only bonds issued in the international market.

**Figure 6**  
Annual LAC corporate share of the total international bond issuance, 2000–2022  
(Percentage)

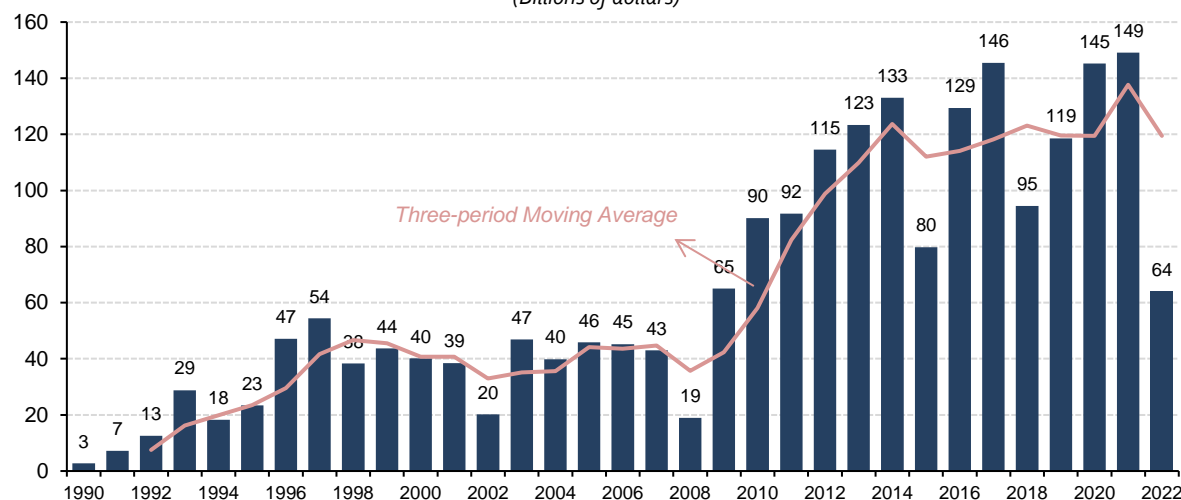


Source: Authors' elaboration based on data compiled for ECLAC (2023a). The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

In 2022, however, the corporate share in the LAC total bond issuance fell to below 50% for the first time since 2008. Total LAC bond annual issuance in 2022 was the region's lowest annual amount since 2008 (figure 7), as global interest rates increased and led to higher borrowing costs. The largest slowdown was observed in the corporate sector, with overall corporate bond issuance in international markets (including private banks, private non-banks, quasi-sovereign, and supranational entities) declining by 66%. Issuance from private non-bank corporates fell by 70% (table 1). Going forward, incentives will be needed to create an attractive investment environment and unlock the necessary private climate finance in the region.



**Figure 7**  
Annual LAC international bond issuance, 1990–2022  
(Billions of dollars)



Source: ECLAC (2023a), p.7.

**Table 1**  
LAC international bond issuances by sector, 2022  
(Millions of dollars, percentages, and number of deals)

	Private banks	Private non-banks	Quasi-sovereign enterprises	Supranational entities	National governments (sovereign issuances)	Total
Total 2022	1,347	19,178	5,208	5,392	32,764	63,889
Year-on-year growth (percentages)	-84%	-70%	-59%	-15%	-43%	-57%
Share of Total (percentages)	2%	30%	8%	8%	51%	100%
Number of deals	8	34	8	28	29	107
Deals year-on-year decline	-30	-80	-8	-2	-25	-145

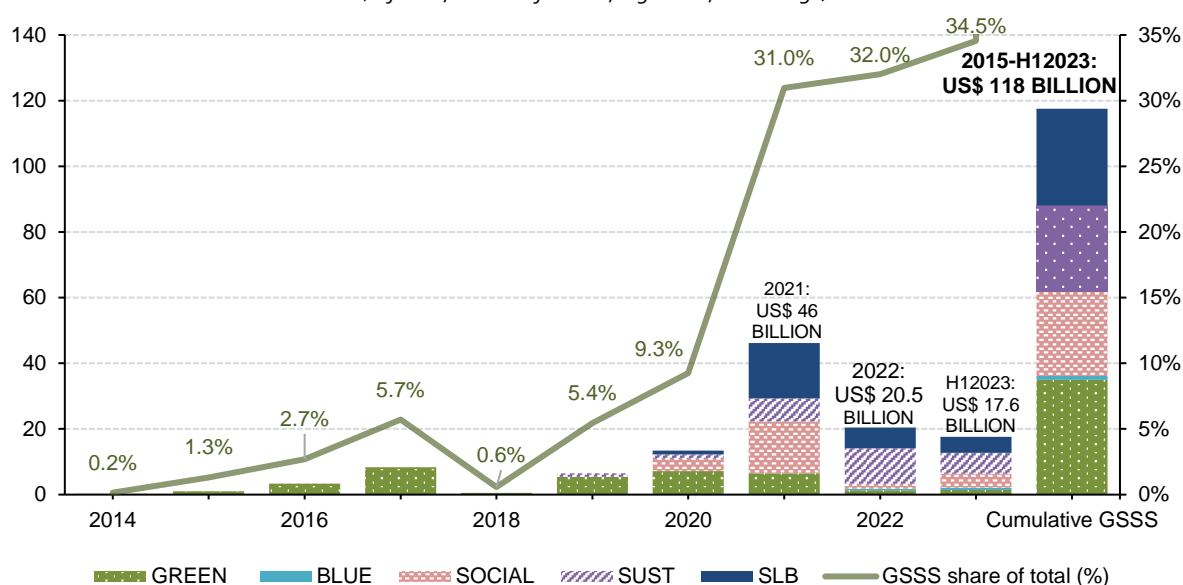
Source: ECLAC (2023a), p.9.

## A. Evolution

The overall evolution of international GSSS bond issuances from Latin America and the Caribbean points to four main trends. The first trend is one of rapid growth and resilience. The share of GSSS bonds in the region's international bond issuance total has increased significantly, jumping from less than 1% in 2018 to 32% in 2022, despite the slowdown in volumes due to tightening financial conditions and higher global interest rates. If the first half of 2023 is added, this share has increased further, to 34.5% at the end of June. The share increase highlights the resilience of these instruments in face of adverse global conditions (figure 8).

The second trend, also captured in figure 8, is one of diversification. While initially most issuances were of green bonds, the region has moved toward a larger variety of sustainable instruments used. Since 2021, sustainability and sustainability-linked bonds have become the most used GSSS instruments by the region's international bond issuers. The third and fourth trends include the higher participation of the region's sovereign sector in the total international GSSS bond issuances since 2020, and the presence of a "greenium" —the amount by which the yield on a GSSS bond is lower than an otherwise identical conventional bond.

**Figure 8**  
**Annual LAC international GSSS bond issuance, 2014–2022**  
 (Left axis, Billions of dollars; Right axis, Percentage)



Source: Nuñez, Velloso and Da Silva (2022), figure 2, p.19. Data updated to June 2023.

During this eight-year period, Latin America and the Caribbean's international GSSS bond issuances were thus marked by *growth and resilience, instrument diversification, increasing sovereign sector market share*, and by the existence of a *greenium*. These trends will be discussed in detail in the following sections and chapter.

## B. Main characteristics and trends

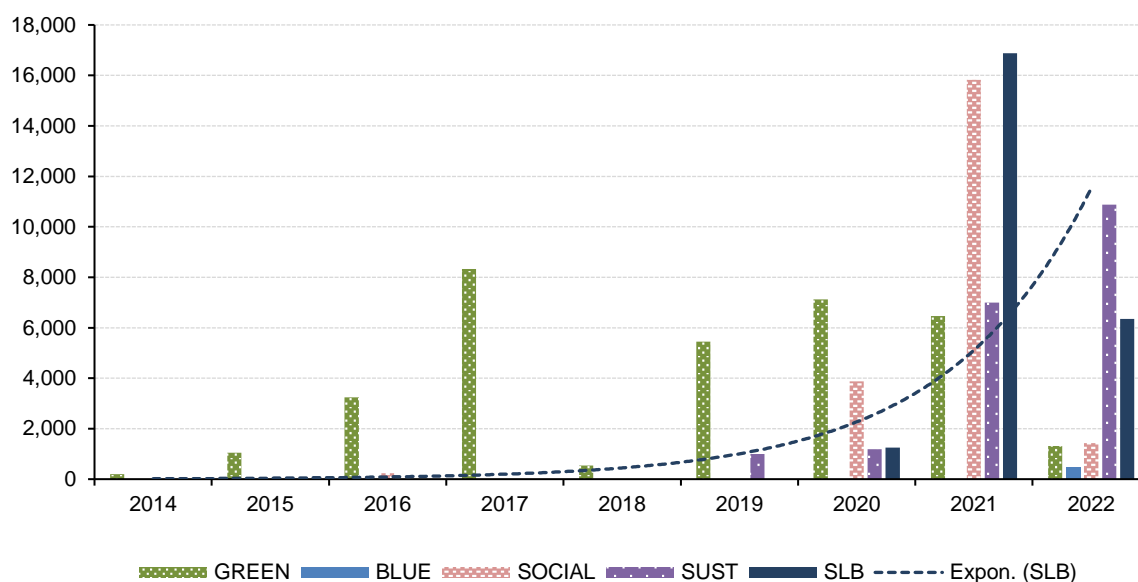
With an average share of 3.2% of the world's sustainable issuances in the 2014-2022 period according to data from Dealogic, Latin America and the Caribbean international GSSS bond issuances remain a minor participant in the global sustainable bond market. However, there is growing interest in sustainable financing and an upward trend in sustainable bond issuances from the region.

As of December 2022, eighty-one LAC issuers had issued one hundred eighty international GSSS bonds in eleven different currencies from December 2014 to December 2022. Forty-five of those issuances came from the sovereign sector, eighty-nine from the private sector, and the rest from supranational entities and quasi-sovereign issuers (state-owned enterprises). Most of the bonds issued during this period were directed at financing renewable energy, sustainable agricultural and forestry initiatives. However, while the initial issuances from the region were mostly of green bonds, in the past three years there has been a move towards a diversification of the instruments used to finance sustainable economic activities and growth.

### 1. Distribution by types of instruments

In the early part of the 2014-2022 period, green bonds were the most used sustainable instruments in the region, but as the market grew, and the attention moved from an environmental-only focus to a broader perspective that included addressing social and sustainability concerns, the use of other instruments —such as social, sustainability and sustainability-linked bonds— started to grow. In particular, the issuance of social bonds increased after the onset of the COVID-19 pandemic, and the use of SLBs by the corporate sector grew exponentially after ICMA released its Sustainability-Linked Bond Principles (SLBP) in June 2020 (figure 9).

**Figure 9**  
**Annual LAC international GSSS bond issuances by type of instruments, 2014–2022**  
*(Millions of dollars)*



Source: Nuñez, Velloso and Da Silva (2022), figure 12, p.25. Data updated to end of 2022.

For the period as a whole, green bonds were the most used instrument. However, SLBs and sustainability bonds were LAC issuers most frequently used sustainable instruments in 2021 and 2022.

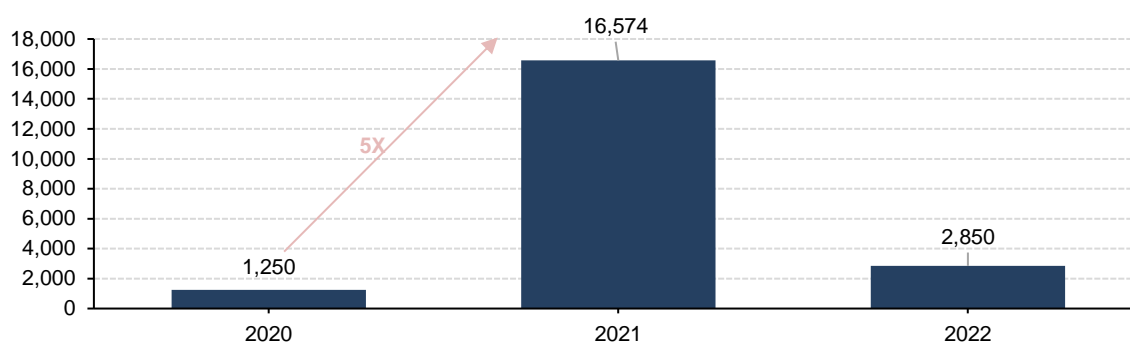
SLBs are defined by ICMA as “any type of bond instruments for which the financial and/or structural characteristics can vary depending on whether the issuer achieves predefined sustainability/ESG objectives” (ICMA, 2020, p.2). As observed in the timeline described in the previous chapter, the first SLB in the region was issued by Suzano, a Brazilian company in the forestry and paper sector, on 10 September 2020. It was a US\$ 700 million 2031 bond with a 3.750% coupon tied to SDG 13 on climate action, which the company reopened on 16 November 2020 to add US\$ 500 million.<sup>4</sup> In 2021, SLB issuance in the region increased by a factor of thirteen, surging to US\$ 16.6 billion (figure 10) and becoming the region’s most frequently used sustainable instrument.

However, the share of SLBs in the region’s total international GSSS bond issuance fell to 31% in 2022 from 37% in 2021. According to a Moody’s report on global sustainable finance (Moody’s, 2023), “greater market scrutiny and heightened greenwashing fears may dampen near-term growth, especially for sustainability-linked bonds.” In addition, higher global interest rates and tighter financial conditions had an important impact on corporate issuers, especially high-yield issuers. The SLBs are attractive because of their inclusiveness. In 2021, for example, 60% of the region’s SLB issuances came from the high-yield sector, with the instrument opening doors for non-investment grade companies. On the other hand, in 2022, investment-grade issuers—sovereign and corporate combined—accounted for 66% of total overall LAC bond issuances in international markets (ECLAC, 2023a).

Sustainability bonds took first place in 2022 with a share of 53%, as Chile issued US\$ 4 billion worth of sovereign sustainability bonds (2/3 of its total sovereign ESG bond issuance), and Mexico US\$ 2.8 billion. For the eight-year period however, they are the fourth most used instrument with a 20% share (figure 11), behind green bonds (34%), SLBs (24%) and social bonds (21%).

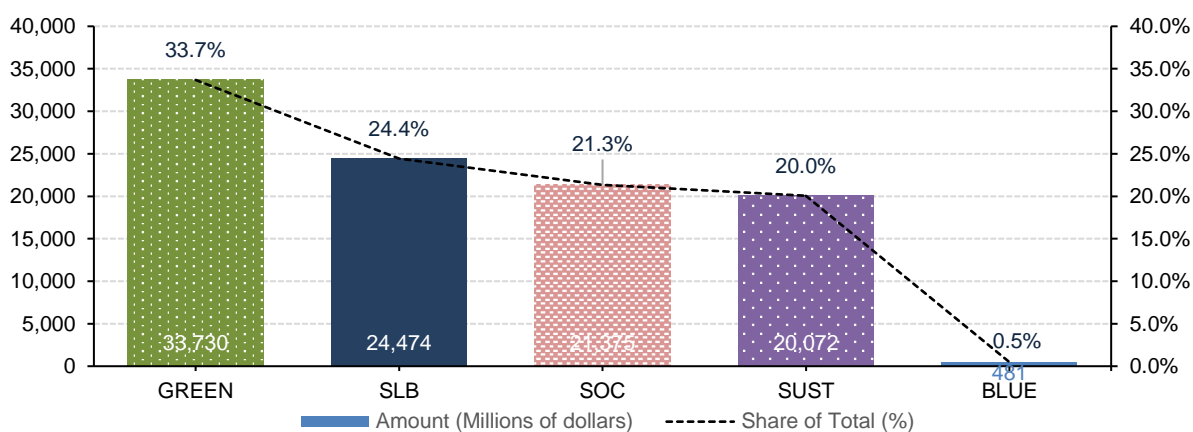
<sup>4</sup> The company has committed to reduce its greenhouse gas emissions intensity by 15% by 2030. If by 2025 it is not on track to achieve this target, there will be a one-time coupon step-up of twenty-five basis points.

**Figure 10**  
LAC international SLB bond issuances, 2020–2022  
(Millions of dollars)



Source: Nuñez, Velloso and Da Silva (2022). Figure 13, p.26. Updated to 2022.

**Figure 11**  
Distribution of LAC international GSSS bond issuances by type of instruments, 2014–2022  
(Left axis, Millions of dollars; Right axis, Percentage)



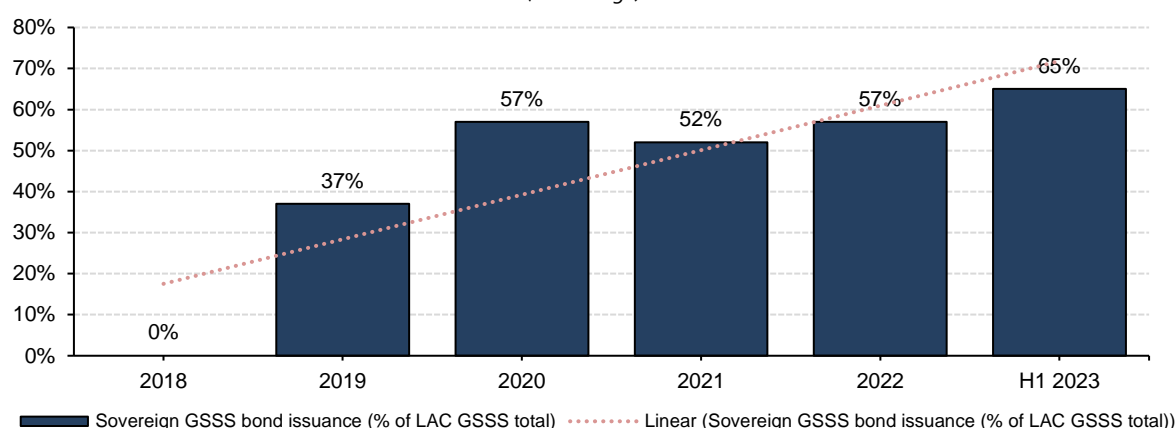
Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

The increased use of sustainability and sustainability-linked bonds by LAC sovereigns in the past three years is underscored by two other milestones reached in 2022: Chile issued the first sovereign SLB in the world in early March 2022, a US\$ 2 billion 20-year bond, and Uruguay the region's second sovereign SLB, an innovative US\$ 1.5 billion 12-year bond, offering not only accrued additional payments to bondholders should the sovereign not meet the set target, but also a reduction in the coupon rate should they meet the target earlier than expected.

## 2. Distribution by types of issuers

One major trend in the region's sustainable bond issuances in the past five years has been the larger role national governments are now playing in the sustainable bond market. In June 2019, Chile issued the region's first green sovereign bond in international markets. From then to 2022, seven countries—Chile, Ecuador, Guatemala, Mexico, Peru, Bahamas, and Uruguay—in order of appearance in the international markets, issued green (or blue), social, sustainability, and sustainability-linked bonds. The sovereign sector has thus become the driver of the region's overall international sustainable issuances, accounting for the largest share of the GSSS total since 2020 (figure 12).

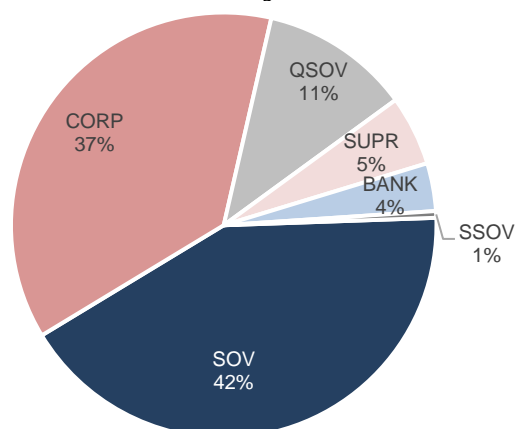
**Figure 12**  
Sovereign bonds as a share of LAC international GSSS bond issuances, 2018–H1 2023  
(Percentage)



Source: ECLAC (2023b), figure 6, p.11.

For the eight-year period, sovereign issuers accounted for 42% of the total amount issued, followed by the private non-bank sector, which accounted for 37% (figure 13). Despite this recent trend of a more prominent role for the sovereign sector in the past five years, the distribution of the total LAC international GSSS issuance from December 2014 to December 2022 by type of issuers underlines the importance of the corporate sector in the development of the region's capital markets, and the role it can play in the mobilization of resources for a sustainable future in the region.

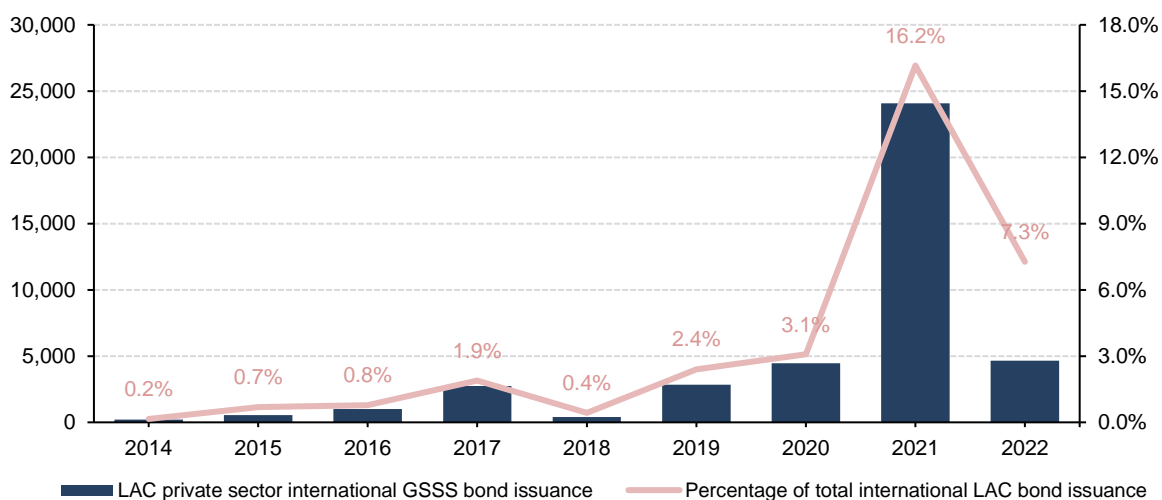
**Figure 13**  
LAC international GSSS bond issuances by type of issuers, 2014–2022  
(Percentage)



Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others. Note: Sov=sovereign, Corp=corporate (private non-bank), QsoV=quasi-sovereign (state-owned companies), Supr=supranational entities, Bank=private banks, and SsoV=sub-sovereign (states, cities, and provinces).

Corporate GSSS bond issuances, including private banks and private non-banks, accounted for an average 11% of LAC total private sector international bond issuance in the eight-year period and for an average 4% of the region's total amount (including all types of issuers). More importantly, this share was on an upward trend from 2019 to 2021. In 2021, the share of private sector GSSS bonds in the total increased fivefold from the previous year. However, in 2022, it declined by more than half, as tighter global financial conditions had a strong impact on the region's private corporate sector (figure 14).

**Figure 14**  
**LAC private sector international GSSS bond issuances, 2014–2022**  
*(Left axis, Millions of dollars; Right axis, percentage)*

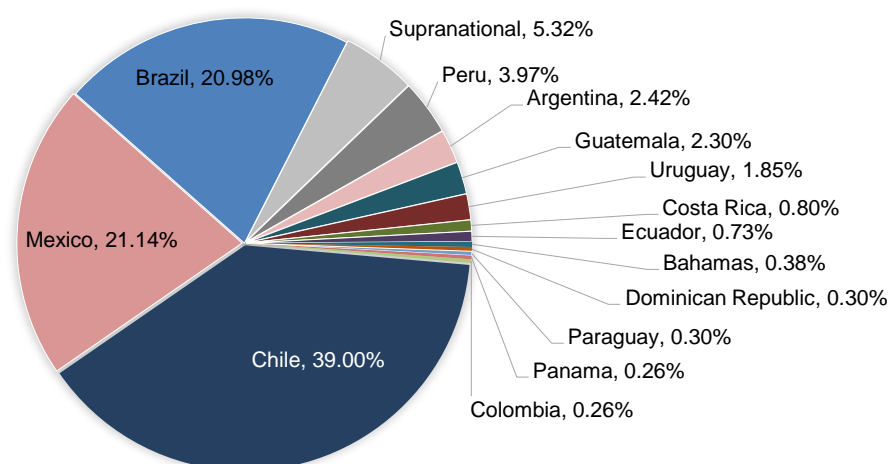


Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

### 3. Country, sectoral and currency distribution

Latin America and the Caribbean's international GSSS bond issuances (including sovereign and corporate issuances) in the 2014-2022 period came from fourteen countries —Argentina, Bahamas, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Mexico, Panama, Paraguay, Peru, and Uruguay— and two supranational entities, CAF Development Bank of Latin America and the Central American Bank for Economic Integration (CABEL). The top three issuers in the period are Chile, with 39% of the total, Mexico with 21.1% and Brazil, with 21%. Together, they accounted for US\$ 81.2 billion (81%) of the total LAC GSSS bond issuance in the eight-year period (figure 15, table 2).

**Figure 15**  
**Distribution of LAC international GSSS bond issuances by country, 2014–2022**  
*(Percentage)*



Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

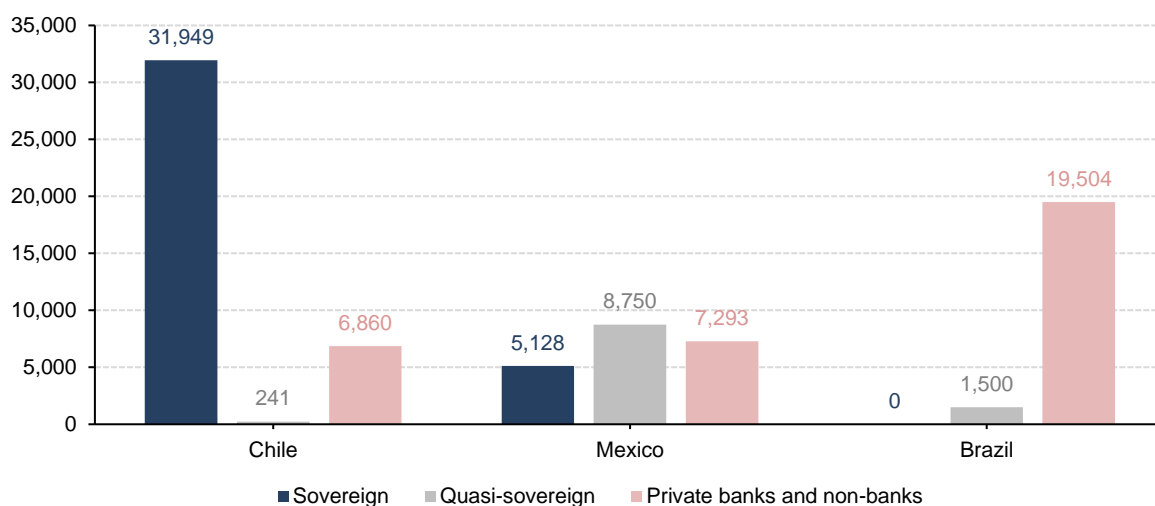
**Table 2**  
**LAC international GSSS bond issuances by country and sector, December 2014-December 2022**  
*(Millions of dollars and percentages)*

Countries	Private banks	Private non-banks	Quasi-sovereign enterprises	National governments (sovereign issuances)	Supranational entities	Total	Share
Argentina	100	1 816		510		2 426	2.4%
Bahamas				385		385	0.4%
Brazil	2 000	17 504	1 500			21 004	21.0%
Chile	316	6 544	241	31 949		39 050	39.0%
Colombia		259				259	0.3%
Costa Rica	500		300			800	0.8%
Dominican Republic		300				300	0.3%
Ecuador		400		327		727	0.7%
Guatemala		1 800		500		2 300	2.3%
Mexico		7 293	8 750	5 128		21 172	21.1%
Panama		263				263	0.3%
Paraguay	300					300	0.3%
Peru	30	1 184	600	2 157		3 971	4.0%
Supranational					5 328	5 328	5.3%
Uruguay		350		1 500		1 850	1.8%
<b>Total</b>	<b>3 246</b>	<b>37 713</b>	<b>11 391</b>	<b>42 457</b>	<b>5 328</b>	<b>100 134</b>	<b>100%</b>

Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

While most of Chile's International GSSS bond issuances came from the sovereign sector, Brazil's and Mexico's are mostly from the corporate sector (figure 16). Chile issued US\$ 32 billion in sovereign GSSS bonds from June 2019 to December 2022. Of this total, US\$ 16 billion were social bonds, which accounted for 75% of all LAC social bonds issued in the eight-year period. Mexico issued US\$ 5 billion in sovereign GSSS bonds in the period, all of them sustainability bonds. In the case of Brazil, all its GSSS issuances originated in the corporate sector, and it accounts for almost half of all the region's GSSS issuances from the private sector.

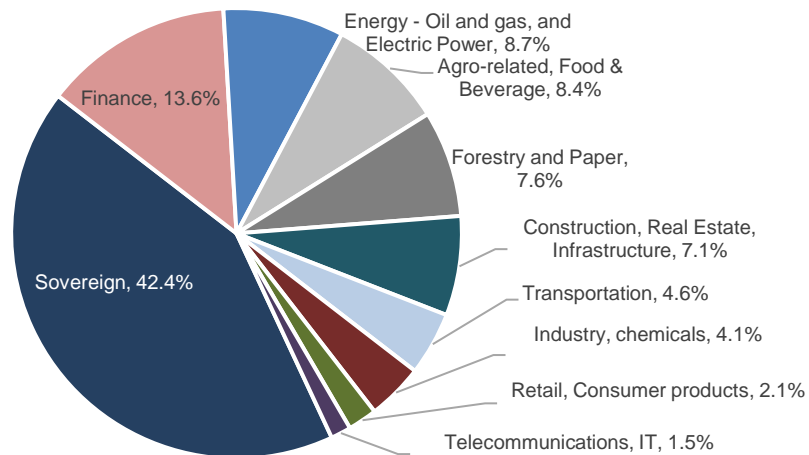
**Figure 16**  
**Top three LAC issuers of GSSS international bonds, 2014–2022**  
*(Millions of dollars)*



Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

From a sectoral perspective, 42% of the LAC international GSSS debt issuance came from the sovereign sector, primarily due to Chile's large sovereign GSSS issuances since 2019. Without the sovereign sector, the financial sector accounted for the highest share, 14%, followed by the energy sector with a share of 9% (figure 17).

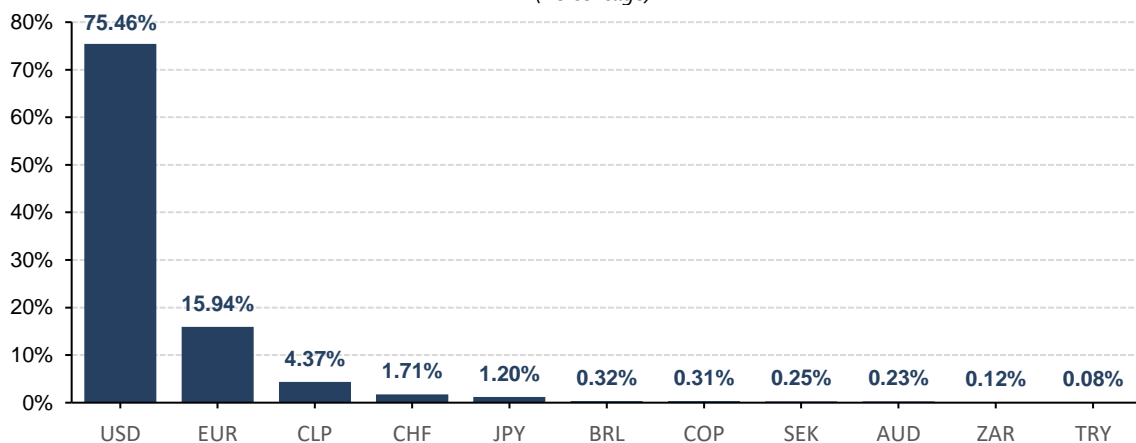
**Figure 17**  
Distribution of LAC international GSSS bond issuances by sector, 2014–2022  
(Percentage)



Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others. Note: the sovereign sector includes three green bond issuances by Argentina's provinces of La Rioja and Jujuy totaling US\$ 510 million.

Finally, the region issued international GSSS bonds in eleven different currencies, although the largest share was issued in United States dollars (75.5%), followed by euros (15.9%). Chilean pesos came in third place with a share of 4.4%, again due to Chile's large sovereign GSSS bond issuances (figure 18). There were issuances in other local currencies, including Brazilian reais (0.32%) and Colombian pesos (0.32%).

**Figure 18**  
Distribution of LAC international GSSS bond issuances by currency, 2014–2022  
(Percentage)



Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.



## C. Critical challenges

The LAC international sustainable debt market has grown strongly since December 2014. Table 3 summarizes the amount of international GSSS debt issued in millions of dollars since then, including data for the first half of 2023. As previously indicated, the top three issuers in the region are Chile, Mexico, and Brazil.

**Table 3**  
**LAC GSSS international bond market from 2014 to first half of 2023, as of 30 June 2023**  
*(Millions of dollars, percentages, and numbers)*

Country	Amount of GSSS debt issued (Millions of dollars)	% of LAC GSSS bond market	Number of issuers	Number of deals	Number of Benchmark Deals <sup>a</sup>	% Benchmark Issuance <sup>a</sup> by Amount	Average instrument size (Millions of dollars)
Chile	45 224	38.4%	15	54	39	94%	837
Mexico	26 105	22.2%	17	36	23	93%	725
Brazil	21 754	18.5%	24	41	30	89%	531
Supranational	7 156	6.1%	3	40	4	46%	179
Peru	6 466	5.5%	6	9	4	81%	718
Argentina	2 426	2.1%	7	8	1	29%	303
Guatemala	2 300	2.0%	3	3	3	100%	767
Uruguay	1 850	1.6%	2	2	1	81%	925
Ecuador	1 383	1.2%	2	4	1	47%	346
Costa Rica	1 200	1.0%	3	3	1	42%	400
Colombia	658	0.6%	2	4	0	0%	165
Bahamas	385	0.3%	1	2	0	0%	193
Dominican Republic	300	0.3%	1	1	0	0%	300
Paraguay	300	0.3%	1	1	0	0%	300
Panama	263	0.2%	1	1	0	0%	263
<b>Total</b>	<b>117 768</b>	<b>100.0%</b>	<b>88</b>	<b>209</b>	<b>107</b>	<b>85%</b>	<b>563</b>

Source: Authors' elaboration based on data compiled by the ECLAC Washington Office and on Bernabé Argandoña et al (2022). Data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

<sup>a</sup> A benchmark bond provides a standard against which the performance of other bonds can be measured. Its size offering generally means at least US\$ 500 million, thus LAC deals that were at least US\$ 500 million in size have been included as benchmark deals.

They have also issued the largest number of benchmark issuances, contributing to expanding and strengthening the liquidity of the region's GSSS international bond market. Chile's has the highest number of benchmark deals, with 30 of its 39 benchmark deals being sovereign bond issuances. In the case of Brazil, all 30 benchmark issuances came from the corporate sector. Benchmark issuances may contribute to unlocking private climate finance in the region.

However, many LAC issuers still face challenges to participate in the GSSS international bond market, including a lack of knowledge and capacity development, difficulties in identifying and creating green portfolios, and lack of standardized monitoring mechanisms. Complex issuance procedures (including the definition of what is green or sustainable) and demanding reporting process and impact measurement, may create barriers to some of the region's issuers (Bernabé Argandoña et al (2022), p.6-7).

In the case of "use of proceeds" bonds (green/blue, social and sustainability bonds), issuers tend to have their own criteria or definitions of an eligible green, social or sustainability project, with varying levels of specificity and detail. This lack of clarity and transparency can be a dissuading factor for an investor concerned that the use of proceeds does in fact match their own investment guidelines (Baker McKenzie, 2019). Moreover, regarding post-issuance reporting, market practice on frequency, the actual level of detail disclosed, and statement of non-compliance all vary. A March 2019 Climate Bond Initiative study found that only 68% of the green bonds studied benefited from regular post-issuance reporting, with only 53% providing reporting on allocation/impact metrics (CBI, 2019). This can lead to a lack of confidence on whether these bonds actually follow common accepted use of proceeds/requirements. With no single

global standard or recognized legal definition, and most of the market criteria based on voluntary compliance, it is difficult to conclusively say if some bonds are indeed having the desired environmental and/or social impact, raising fears of “greenwashing” (making false or misleading statements about the environmental benefits of a product or practice), “green hushing” (under-reporting or under-communicating sustainable practices) or “green wishing” (unattainable green targets).<sup>5</sup>

The use-of-proceeds sustainable bonds may be perceived as overly complex to many issuers, given the multiplicity of criteria, the lack of harmonized disclosure reporting guidelines and standards they may need to comply with, the absence of common definitions of which activities may be considered sustainable, and too many market players—stock exchanges, rating agencies, second party reviewers, disclosure reporting guidance, certifiers, index providers, industry bodies such as ICMA and the CBI, and the increasing numbers of active buy-side industry groupings focused on sustainability—who sometimes may have overlapping roles (Baker McKenzie, 2019). The target-oriented sustainability-linked bonds (SLBs), on the other hand, enable more issuers to access sustainable bond markets as they allow more flexibility in how to use the bond’s proceeds (could be used for general corporate purposes, for example), and greater diversification across geography, bond maturity, industry, or bond rating.<sup>6</sup> However, as indicated earlier, higher global interest rates in 2022 had a significant impact on the issuance volume of these bonds, precisely because many of the region’s SLBs were previously placed by high-yield issuers, who are highly vulnerable to higher borrowing costs.

The specific characteristics and procedures of the “use of proceeds” sustainable bonds, and the critical demand for quality, size, and recurrence of projects may reinforce a lack of supply and scalability challenges, reducing the participation of many of the LAC corporate and sovereign issuers in the international sustainable bond market. These may also lead to issuer fatigue and confusion, and to them opting out from issuing these instruments despite their societal benefits and positive impact on public image, especially if it is not clear whether there is a demonstrable reward in terms of improved pricing or lower borrowing costs. In this regard, the empirical analysis to be described in the next chapter suggests that there was a demonstrable reward associated with the region’s international GSSS bond issuances in the period analyzed.

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<sup>5</sup> It is in this context that the International Sustainability Standards Board (ISSB) was established in November 2021 at the United Nations Climate Change Conference (COP26) to deliver a global baseline of sustainability disclosures that meet capital market needs. The ISSB standards build significantly from existing reporting frameworks and standards. The ISSB was created by the International Financial Reporting Standards (IFRS) Foundation in response to a global consultation in 2020 and confirmed the growing and urgent demand among investors and key stakeholders for a consistent, international set of sustainability reporting standards and disclosures. In June 2023, the ISSB issued its inaugural standards—IFRS S1 and IFRS S2 (see Núñez et al., 2023).

<sup>6</sup> For a detailed analysis of the use of SLBs by LAC issuers see Núñez, Velloso and Da Silva (2022).

### III. The benefits of being sustainable in Latin America and the Caribbean: in search of a greenium

As shown in the previous chapters, Latin America and the Caribbean's international GSSS bond market and debt products have grown rapidly in recent years. Many policymakers and market participants view GSSS bonds as an important instrument for raising funding for sustainable purposes and helping price climate risks. However, many issuers perceive these instruments as costly and overly complex and are unsure whether they have a demonstrable reward. Through an empirical analysis, this chapter will focus on whether a "greenium," the amount by which the coupon rate associated with a GSSS bond issuance is lower than that of a comparable conventional bond, can be found in the December 2014-December 2022 period. Put in different words, this chapter will examine whether investors in this eight-year period were willing to pay a higher price for ESG investments in Latin America and the Caribbean than for non-ESG investments.

#### A. Literature review<sup>7</sup>

Recent academic literature on green bond issuance and the existence or not of a green premium point to several important observations that could shed light on the benefits of future sustainable bond issuances in Latin America and the Caribbean. First, most papers support the claim that green bonds trade at a negative premium compared to similar conventional bonds for euro (EUR) and U.S. dollar (USD)-denominated bonds. Second, the yield that arises from being green differs by the nature and riskiness of the borrower as well as bond rating. Third, external review and financial disclosure are associated with the existence of a green premium and can thus aid issuers in reducing the cost of debt. Lastly, the literature points to the fact that investors do indeed value the environmental attributes of green bonds. There is evidence of their willingness to accept a lower financial yield in pursuit of their social responsibility agenda. While green bonds are potentially beneficial for issuers, they can also provide an advantage for investors to balance their portfolios with long term safe investments.

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<sup>7</sup> The authors are grateful to the valuable contribution of Gloria Li, intern at the ECLAC Washington Office in 2021, to this section.

While more studies have emerged along with the growth of the global green bond market, the data source of green bonds is not standardized as there has yet to be a global consensus on the definition of a “green” bond. Empirical papers have therefore utilized a range of definitions from a range of different commercial and non-commercial data sources to conduct their analysis. Most used are the bonds labeled as green by the issuer following the guidelines of ICMA’s Green Bond Principles (GBP) since their compliance with the GBP is visible on Bloomberg Bond Radar. Some papers also collect green bonds data from the Climate Bonds Initiative (CBI) and Environmental Finance. Other papers have utilized Dealogic, Thomson Reuters Eikon and even national data to compile their databases. National data is often used in the studies of green bonds denominated in currencies other than the EUR and USD. Since different compliance standards exist for being “green,” it is often the case that bonds aligned with GBP might not be present in the CBI database. The papers in this literature review often go through meticulous lengths to select the final green sample. However, due to the heterogeneity of green labeling and data source compilation of green bonds, the consensus of the results should be further scrutinized if a standard definition of “green” comes to exist.

The early studies of green bonds from 2015 to 2017 often utilized Ordinary Least Squares (OLS) regressions to compare green and conventional yields with a small existing sample of green bonds. In the secondary market, Barclays (2015) measure the option adjusted spread between green and non-green bonds, which is the spread of a fixed income security rate and the risk-free rate of return, then adjusted to consider an embedded option. The study only utilized U.S. labeled green bonds in compliance with GBP and found that green bonds trade at tighter spreads (17 basis points less) than otherwise similar conventional papers. The paper predicted that the spread gap between green bonds and conventional bonds would increase. Furthermore, it pointed out that having environmental-focused investors as the marginal buyer of green debt could reduce trading activity and lead to greater price stability and encourage U.S. issuers of green bonds.

Among the first studies of the existence of green premium in primary markets, Ehlers, Torsten and Packer (2017) utilized a simple regression to compare the credit spreads at issuance between EUR and USD-denominated green bonds and conventional bonds from the same issuer from 2014 to 2017. Choosing bonds issued at the closest possible date allows it to control for issuer-specific idiosyncratic factors such as credit risk. The paper found that green bond yields at issuance were between 10 basis points (bps) (AAA-rated issuers) to 45 bps (A- and BBB-rated issuers) lower than those of non-green bonds from the same issuer. Therefore, the negative premium for green bonds was greater for riskier borrowers. However, out of the twenty-one green bonds studied, five were actually priced at spreads above the matched conventional bonds, suggesting that not all issuers can take advantage of the yield discount at issuance.

Since then, noting the limitations of OLS regression design, many papers have utilized a matching or propensity score matching method to study the extent of green premium in USD and EUR-denominated bonds. Matching up characteristics of green and conventional bonds diminishes confounding factors<sup>8</sup> and further isolate the effect of being labeled green on the bond yield. Generally, these papers reached a consensus that USD and EUR-denominated green bonds trade at lower yields or higher prices compared to non-green counterparts from the same issuer. It has also been found that rating and external review are responsible for the observed negative green premium.

Zerbib and David (2018) and Bour (2019) define the green premium in the secondary market as the yield differential between these two types of bonds after controlling for the difference in liquidity. Both papers utilize a matching method to construct synthetic conventional bonds to remove all unobservable differences between green and non-green bonds and have continued to set an example for other studies in the secondary market. From a sample of USD and EUR denominated supranational, sovereign, municipal, corporate and financial bonds, Zerbib and David found a small but significant

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<sup>8</sup> A confounder is a variable that influences both the dependent and independent variables, causing a spurious association.

negative premium (2 bps) for green bonds in comparison with similar conventional bonds. Bour (2019) found that investors are willing to sacrifice 23.3 bps of yield to invest in green bonds over otherwise similar conventional bonds.

Focusing only on EUR-denominated bonds in the primary market, Gianfrate, Gianfranco and Peri (2019) also used a propensity matching method to study the premium as the difference between the actual spread achieved by green bonds at issuance and the spread that these would have achieved if they had been a conventional bond. They observed a larger negative premium (18 bps) for green bonds from 2013 to 2017, which becomes even more negative (21 bps) when the sample is restricted to corporate issuers. One important outcome of this study for the issuance perspective is that such a premium is significant relative to the potential costs of getting the green label or rating. For example, the Climate Bonds Initiative asks for a flat fee equal to 0.1 basis points of the issue value in order to certify the green label, which is low relative to the gains from the premium.

Supporting Gianfrate, Gianfranco and Peri (2019)'s claim that green labeling is cheap and beneficial for issuers, Bour (2019) and Baker, Bergstresser, Serafeim and Wurgler (2018) also found that certain green signaling efforts such as green label by GBP, external certification by CBI, external review of green proceeds and other forms of financial disclosure could also be associated with greater green premium. Baker, Bergstresser, Serafeim and Wurgler (2018) found that in the U.S. municipal bonds market, the premium doubles or triples for bonds that are not only self-labeled as complying with GBP (as seen on Bloomberg) but also externally certified as green and publicly registered with the Climate Bonds Initiative. Bour (2019) did not find any explanatory power of GBP alignment and CBI certification over green bond premium. However, if those two methods are combined with external verification such as third-party review and assurance provision, then the premium would be higher. The results from these studies imply that certification and external verification could help reduce information asymmetry and the fear of green washing. Hence, issuers should take advantage of these tools to further capture higher premium at issuance.

Nuñez, Velloso, Lehuedé, Da Silva and Poveda (2023), conducting an empirical exercise on the relationship between corporate debt issuers' ESG disclosure scores (obtained from Bloomberg) as a proxy indicator of corporate reputation and the cost of debt financing as measured by the coupon rate at the date of bond issuance in primary markets, find that companies with better ESG scores have comparatively lower borrowing costs. Country- and sector-specific conditions may have an impact on this relationship as well. Country-specific circumstances that could affect this relationship may include not only macroeconomic and financial conditions, but also their ESG standards. The idea is that ESG practices can enhance a company's reputation which, in turn, can change how the market perceives its business model. Companies with higher levels of disclosure and transparency in their ESG reporting can benefit from lower capital costs by significantly affecting investors' and creditors' perceptions of their reputation, thus influencing their borrowing costs.

Apart from the important observation listed above, some papers have also contributed to a discussion of the effect of credit rating on green premium, which has shown to have mixed results. A study by the Aalto University School of Business Department of Finance found that investors pay a premium of 19 to 28 basis points for green investment grade bonds relative to non-green investment grade bonds. In addition, the negative green premium does not persist for high-yield unrated or non-investment grade bonds (Saturna Capital, 2018). Bour (2019) found that within investment grade bonds, A and non-rated bonds exhibit a significantly lower green bond premium compared to the baseline of AA-rated bonds. However, Zerbib and David (2018) observed that the negative premium is more pronounced for financial and low-rated bonds.

The discussion of green premium for Latin America and the Caribbean green bond issuances could benefit from more studies pertaining to emerging markets. However, such studies are scarce due

to the slow development of the green market when not taking Chinese issuances into account. Nonetheless, several papers on global issuances shed light on the benefits of green bond issuances for investors and issuers, as well as the factors that contribute to investors willingly paying a higher premium. Nanayakkara and Colombage (2019) compiled corporate green bonds and conventional bonds from twenty-five countries during 2016 and 2017 and found that in general, corporate green bonds trade at a premium of 63 bps compared with similar conventional bonds. They argue that markets can trade green bonds at a premium to provide a lower risk investment opportunity for investors who intend to balance their portfolios with environmentally friendly investment options. At the same time, issuers can benefit from low cost of capital to finance environmentally friendly investments.

Kaprun and Scheins (2019) compiled a global dataset from CBI, Bloomberg, and Thomson Reuters. They also found evidence of a negative premium for green bonds of 15 bps in the primary market. However, controlling for other relevant bond characteristics, the denomination of bonds in EUR and USD are associated with more significant green premiums while CNY (Chinese Yuan) bonds have yields similar to their conventional counterparts. Furthermore, the authors argue that external verification, the very first issuance, entity of issuance, listing of green bonds on exchanges and overall environmental sentiment and policies all contribute to the green premium.

A systematic literature review by MacAskill, Roca, Liu, Stewart, and Sahi (2021) confirms that 70% of the papers in their sample show the existence of a green premium in the secondary market while 56% show the existence of the premium in primary markets. Echoing the observations of previous papers with global datasets, they found that government-issued investment grade green bonds that follow defined green bond governance and reporting procedures are associated with higher premiums.

Hence, for countries in the LAC region to further their issuances of green bonds to fulfill the demands for green infrastructure and energy, the following factors would be beneficial according to the literature review. First, sovereign or investment grade issuances are most likely to be associated with a green premium. Second, the denomination of green bonds in hard currency such as USD and EUR could also help boost the premium. Third, while countries should continue to develop their climate and environmental policies, it is also crucial for issuers to pursue bond governance rules such as alignment with Green Bond Principles, Certification by Climate Bonds Initiative and external review and financial disclosure about the use of proceeds.

## **B. Building a database**

A database with evidence from the region was assembled to examine whether a “greenium” can be found in the international GSSS bond issuances from Latin America and the Caribbean over this eight-year period (December 2014-December 2022). It consists of data on all the region’s international bond issuances in the period, including the issuer, the issuer’s country and sectoral classification, the issuance amount (in millions of dollars), the coupon rate at issuance, bond maturity, bond type (GSSS or traditional bonds) and a categorical variable indicating whether the issuer has an investment grade or a speculative grade classification. The dataset brings together the history of the LAC bond issuances in international markets in these eight years, with data that has been compiled by the ECLAC Washington Office since 2000 from Dealogic, LatinFinance and Bloomberg, among other sources, for the preparation of its periodic reports “Capital Flows to Latin America and the Caribbean.”<sup>9</sup> For the purposes of this section’s empirical exercise, perpetual bonds were excluded from the dataset and the coupon rate, as in Núñez, Velloso, Lehuedé, Da Silva and Poveda (2023), is used as a measure of the issuer’s borrowing costs. Table 4 shows descriptive statistics of the dataset.

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<sup>9</sup> The Capital Flows to Latin America and the Caribbean” reports can be found at <https://www.cepal.org/en/about/headquarters-and-offices/eclac-washington-dc> or <https://www.cepal.org/en/taxonomy/term/8134>.

**Table 4**  
**Dataset descriptive statistics**  
*(Number of observations, Mean, and Standard deviation)*

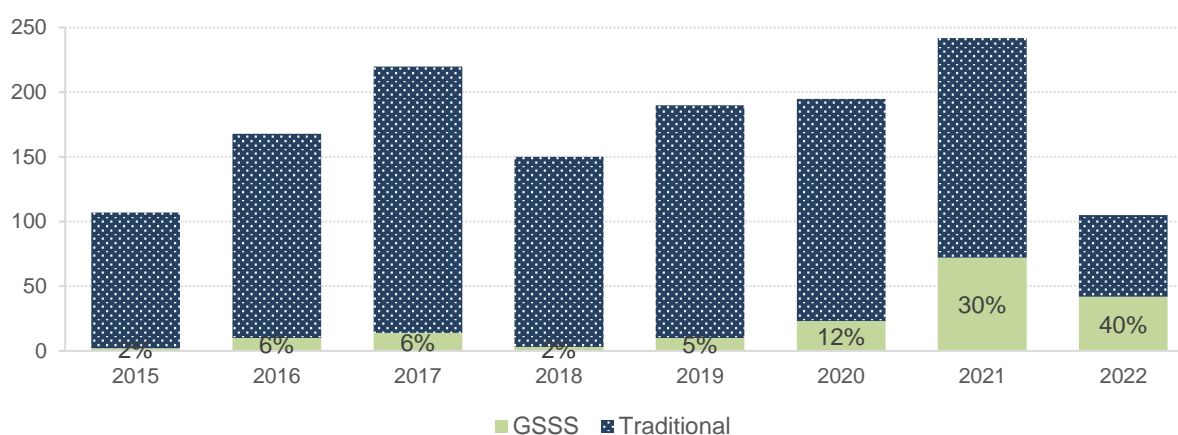
Variable	GSSS Bonds			Traditional Bonds			Full Database		
	# Obs.	Mean	Std. dev.	# Obs.	Mean	Std. dev.	# Obs.	Mean	Std. dev.
Coupon (%)	176	0.041	0.025	1201	0.052	0.029	1377	0.50	0.03
Amount (US\$ Million)	176	564	497	1201	673	660	1377	659	645
Maturity in years	176	12.07	9.52	1201	11.45	9.92	1377	11.53	9.87
Investment Grade (% share of total)	176	0.67	0.47	1201	0.56	0.50	1377	0.57	0.49

Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

Some takeaways from Table 1 are: 1) GSSS bonds are just a minor part (roughly 13%) of total issuance during the eight-year period; 2) GSSS bonds show coupon rates that on average are 110 basis points below traditional bonds;<sup>10</sup> 3) the GSSS bond issuances' average amount (the mean) is US\$ 109 million below that of traditional bonds; 4) the GSSS bond's average maturity is about six months longer than traditional bonds (12.07 vs. 11.45 years); 5) on average, more GSSS bonds (as a share of the region's total GSSS bond issuances) are classified as investment grade than traditional bonds (as a share of the region's total traditional bond issuances); and, 6) the variables' standard deviation does show more variability in traditional bonds, which in part is due to the larger sample of traditional bonds compared to the GSSS ones.

Even though GSSS bonds are a minor part of total LAC bond issuance in international markets, the importance of these financial instruments has been growing, as seen in the previous chapters. The share of GSSS bond issuances in the region's total issuance amount has increased since the region's first green bond was issued, to over 30% since 2021 (figure 8, p.24) and to an average 35% of the total number of issuances (number of deals) in 2021 and 2022 (figure 19).

**Figure 19**  
**LAC international bond issuances, GSSS vs traditional bonds, 2015–2022**  
*(Number of deals)*

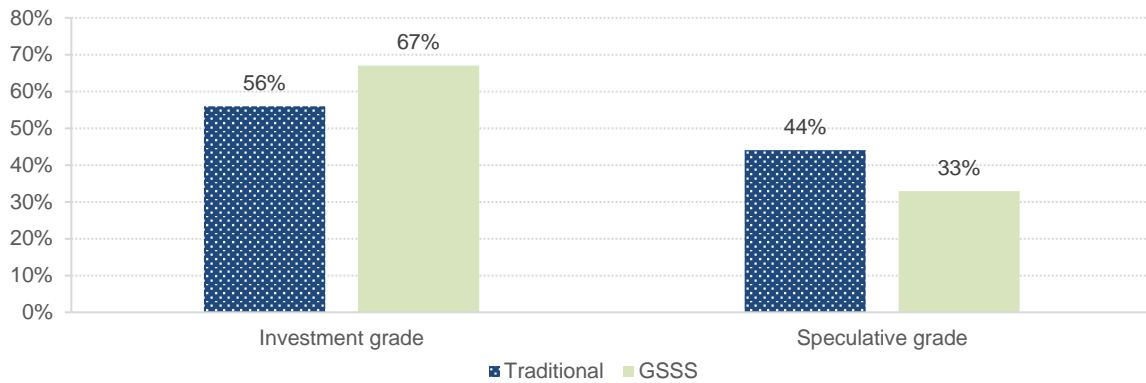


Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

<sup>10</sup> As indicated in the literature review section, this cannot be considered an accurate measure of the "greenium" because confounding variables should be considered for an unbiased estimation.

The distribution by bond rating (whether the bond has been assigned an investment grade or a speculative grade) shows that investment grade issuers accounted for a 67% share of the total GSSS bonds issuances in the dataset, compared with 56% for traditional bonds (figure 20). These numbers suggest that non-investment grade issuers have more access to the traditional international bond market than to the international GSSS bond market, which may be due to the perception of an extra cost associated with a GSSS bond issuance or a lack of awareness regarding the benefits of these instruments.

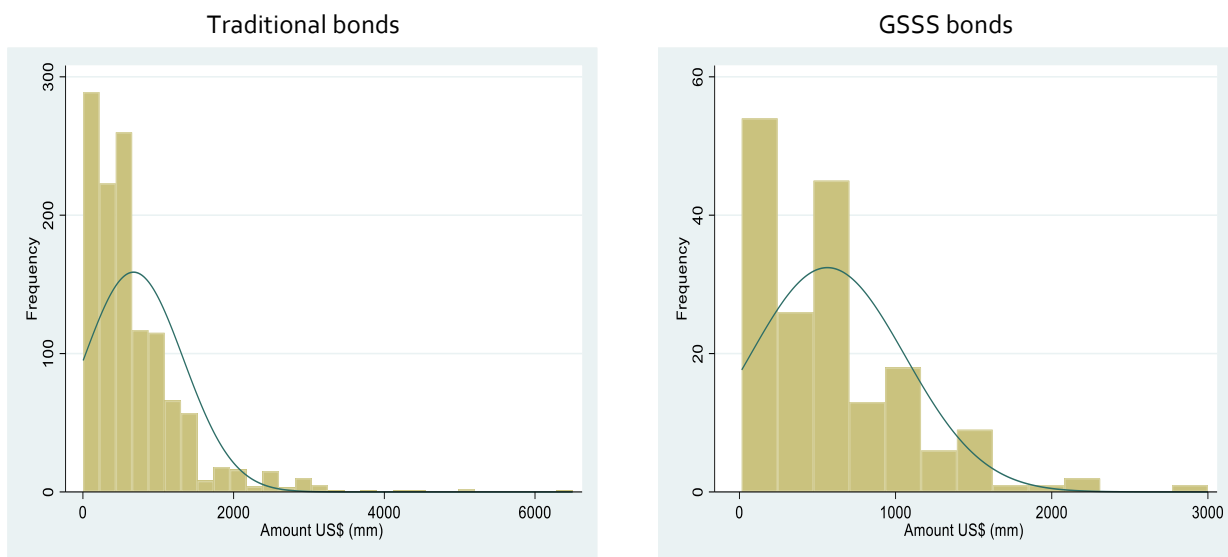
**Figure 20**  
**LAC international bond issuances by credit rating, GSSS vs traditional bonds, 2015–2022**  
*(Percentage of total issuance for each type of bond)*



Source: Authors’ elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

Figure 21 presents the histograms of the issuance amount for traditional and GSSS bonds in the eight-year period. Most of the cumulated frequencies for both types of bonds lie on issuances below US\$ 1 billion.

**Figure 21**  
**Histogram of the issuance amount, 2015–2022**  
*(Traditional vs. GSSS bonds)*



Source: Authors’ elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.



Finally, the dataset's descriptive statistics for the sovereign and corporate sectors indicate that, when considering all bonds (traditional and GSSS), sovereign issuances have on average a higher amount, coupon rate, and average maturity than corporate issuances (table 5). The sovereign issuances' average amount in the period is more than double that of the corporate sector, and their maturity was six years longer on average than that of corporate bonds. The difference in average coupons is relatively small, with the sovereign average coupon higher by 19 basis points. However, in the case of GSSS bonds, the sovereign average coupon was almost 100 basis points lower than the corporate average coupon.

**Table 5**  
**Dataset descriptive statistics by sector**  
(Millions of dollars, basis points, and years)

Sector	GSSS Bonds			Traditional Bonds			Full Database		
	Average issuance amount (in millions of dollars)	Average coupon (in bps)	Average maturity (in years)	Average issuance amount (in millions of dollars)	Average coupon (in bps)	Average maturity (in years)	Average issuance amount (in millions of dollars)	Average coupon (in bps)	Average maturity (in years)
Sovereign	957	337	16.61	1 141	544	15.97	1 117	517	16.05
Corporate	432	434	10.55	519	508	9.96	508	498	10.04
Simple Difference (sovereign-corporate)	525	-97	6.06	622	36	6.01	609	19	6.01

Source: Authors' elaboration based on data compiled by the ECLAC Washington Office. The data includes only bonds issued in the international market and is based on market sources, including Dealogic, LatinFinance and Bloomberg, among others.

## C. Methodology

The methodology used in this chapter's empirical analysis to estimate the potential greenium in LAC GSSS bond issuances in the December 2014–December 2022 period is the Propensity Score Matching (PSM) presented in Gianfrate and Peri (2019). The basic idea is to find the effects of a treatment group (GSSS bonds) in an outcome of interest (the coupon rate), compared with the outcome from a similar but not treated group or control group (traditional bonds). Ideally, we would like to know what the coupon rate of the GSSS bonds would have been if they were issued as traditional bonds.

A simple comparison would be just using all the bonds in the database and estimating the average coupon average for the two groups (traditional and GSSS), as was done in the previous section. As pointed out in the literature review, this approach is inconvenient because other variables (or confounding factors) affect both the outcome and the treatment. A confounder is a variable that influences both the dependent and independent variables, causing a spurious association. The estimates of this simple comparison are thus biased and inefficient because the samples from the treated and control groups are not balanced. The imbalance means that the differences between the treated and control groups cannot be attributed to the treatment because the selection bias persists. Basically, there is a missing data problem because we do not have the contrafactual outcome of the treated unit (the outcome that it would have been had it not been treated).

To overcome this challenge, which is known in the literature as Observational Design, a matching methodology, Propensity Score Matching (PSM) in particular, is used. Matching tries to pair treatment units to control units based on observed confounding variables to reduce or eliminate the selection bias or the effects of the confounding variables. The general idea behind the matching literature is dealing with a control group with an acceptable match for a treated group when the experiment is not random, or, in other words, randomize the treatment.

More formally, we are asking about the conditions for using the control group:

$$E[Y_i(0)|D_i = 0]$$

As a good proxy of the treatment group:

$$E[Y_i(1)|D_i = 1]$$

For estimating the impact of the treatment on our output of interest. Where  $E[\ ]$  is the expected value,  $Y_i(\ )$  is the potential outcome (in our case, the coupon rate) of unit (in our case, bond)  $i$ , and the values 0 and 1 refer to the potential outcome of unit  $i$  if not exposed or exposed to the treatment, respectively.  $D_i$  denotes a categorical variable related to group affiliation: being part of the control group when  $D_i = 0$  and of the treatment group when  $D_i = 1$

To estimate the impact of the treatment by comparing the outcome of the treatment and control groups, we have:

$$E[Y_i(1)|D_i = 1] - E[Y_i(0)|D_i = 0]$$

By adding and subtracting the contrafactual  $E[Y_i(0)|D_i = 1]$ , or the outcome participants would have experienced, on average, had they not participated, we have:

$$E[Y_i(1)|D_i = 1] - E[Y_i(0)|D_i = 1] + E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]$$

which can be decomposed into two terms:

- 1) The average treatment effect on the treated group (ATT):

$$E[Y_i(1)|D_i = 1] - E[Y_i(0)|D_i = 1]$$

- 2) And the selection bias:

$$E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]$$

The matching methods assume that all relevant differences between the two groups are captured by their observables (confounding)  $X$ :

$$Y(0) \perp D|X$$

and the selection from the non-treated pool of a control group in which the distribution of observed variables is as similar as possible to the distribution in the treated group:

$$0 < Prob\{D = 1|X = x\} < 1 \text{ for } x \in \tilde{X}$$

which means that matching must be performed over the *common support* region.

$$p(x) = Prob\{D = 1|X = x\}$$

For 1 and 2:

$$Y(0) \perp p(X) \text{ 1 for } X \text{ in } \tilde{X}$$

To allow for unbiased comparisons, it is necessary to pair (match) units from the treatment and non-treatment groups that share a similar probability of assignment to the treatment, conditional on the vector of observed covariates. With only one covariate, the matching can be performed straightforwardly. However, when there is more than one covariate (confounding) that affects both the treatment and the outcome, the propensity score is generally applied, which is a balancing score in the sense that conditional to it, the distribution of observed confounding variables will be appropriately similar between the treated and control units. In this sense, according to Rosenbaum and Rubin (1983), matching each treated unit to one or more controls can reduce or eliminate the selection bias if the confounding variables are observable.

The idea is to find a unit identical in every other characteristic to the one that received the treatment except for being treated and compare the difference in the outcome. Ideally, it should be the same unit in both states. Because this is impossible, what matching estimators do is select from the non-treated group those units that are more similar (in terms of covariate values) to the treated unit and then compare both. In our case, we look for issuances with similar amounts, maturity, and other characteristics except for the greenness of the bond.

The PSM estimator provides a matching score, or probability of participation, based on the observed characteristics of unit  $i$ :

$$P(X) = P(D = 1|X)$$

Where  $X$  is a vector of observed characteristics of the unit  $i$ .  $P(X)$  is the propensity score function (e.g., Logit or Probit). It is important to note that all the observed characteristics of the unit  $i$  should be reflected in  $P(X)$ .

Before applying PSM, the following two conditions should be met:

1) *The conditional independence condition*: which refers that only observable (or measurable) characteristics determine participation (and outcome):

$$Y(0), Y(1) \perp D|X, \forall X$$

This implies that the selection bias or  $E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]$  is zero.

2) *The common support condition*: which states that units with similar covariate values have a positive probability of being part of the treatment or control group:

$$0 < P(D = 1|X) < 1$$

This condition avoids units in the treatment group with probabilities that do not have any likelihood of being part of the control group (perfect identification).

If conditions 1 and 2 are met, the PSM estimator for ATT is given by:

$$ATT_{PSM} = E_{P(X)|D=1}\{E[Y(1)|D = 1, P(X)] - E[Y(0)|D = 0, P(X)]\}$$

Where  $E_{P(X)|D=1}$  is the expected value of the probability of participation in the intervention conditional to the treatment. In other words, the PMS is the averaged outcome between the treatment and control groups within the common support region, weighted by the propensity score of those units under treatment.

After applying the PSM methodology, the results should meet the *balance condition*, which means that the treatment and control groups should be as similar as possible, approaching a random process. If this condition is not met, the propensity scores must be re-estimated by changing the propensity function or modifying (e.g., including linear functions with more interaction terms or polynomial specifications) and/or adding covariates.

In sum, the Propensity Score Matching (PSM) methodology includes the following steps:

1. Identifying the confounding variables that affect both the treatment (GSSS bonds) and the output (coupon rates).
2. Calculate propensity scores for the whole sample of bonds to predict the probability of being GSSS labeled bonds using Logit or Probit score functions.
3. Use the propensity scores to match the treatment group (GSSS bonds) with the control group (traditional bonds), following the nearest neighbor matching method and neighbor matching one-to-one.

4. Calculate the Average Treatment Effect on the Treated (ATT) to check for the possible existence of a greenium statistically. This step is conditional to the next one.
5. The balance of the confounding variables and propensity score should be checked with the matched treatment and control groups. If not acceptable, different specifications of the propensity score functions or alternative matching strategies should be tried.
6. If there is a good balance of the confounding variables and propensity score, the results from the estimated ATT are finally accepted.

Following the steps above, logit and probit linear estimations and logit and probit polynomial estimations were performed, and the balance of the matched data was checked (Annex 1). The results indicate the presence of a statistically significant greenium in the eight-year period examined.

## D. Results

Applying the Propensity Score Matching methodology, which deals with non-experimental methods, the Average Treatment Effect on the Treated (ATT) was estimated with logit and probit linear and polynomial propensity score functions. They showed a statistically significant greenium between 55 and 69 basis points but with some concerns regarding the balance of the matched confounding variables. The introduction of polynomial augmented functions led to a better balance and a statistically significant greenium between 55 and 63 basis points for LAC issuances from December 2014 to December 2022 (table 6). A LAC issuer during this period, therefore, paid a lower coupon—between 55 to 63 basis points less— on an international GSSS bond issuance in the primary markets than on a traditional bond.<sup>11</sup>

**Table 6**  
**PSM analysis results**  
(Millions of dollars, basis points and years)

Type of estimation	ATT	Std.Error	Note
Logit linear	-0.0069***	0.0023	Concerns about the balance according to the variance ratio
Probit linear	-0.0055**	0.0025	Concerns about the balance according to the variance ratio
Logit polynomial	-0.0059***	0.0024	Concerns about the balance of the maturity confounding variable
Probit polynomial	-0.0058***	0.0021	Acceptable balance on the matched data. Some issues persist
Logit polynomial with augmented interaction	-0.0063**	0.0026	Better balance of the matched confounding than previous estimates
Probit polynomial with augmented interaction	-0.0055*	0.0025	Better balance of the matched confounding than previous Probit results

Source: Author's elaboration. Number of treated units: 176; number of untreated: 1,201.

Note: (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level.

As a robustness analysis, these last two models were estimated with different numbers of matching neighbors (annex 2). The results show similar ATT values to those already estimated. These findings align with most literature that positively identified greenium on international debt issuances.

<sup>11</sup> For more detailed steps of the empirical analysis see annex 1.

## IV. Conclusion

This report examined the evolution of Latin America and the Caribbean (LAC)'s international issuance of sustainable bonds—green (or blue), social, sustainability, and sustainability-linked bonds (GSSS)—since the region's first green bond was issued in international markets in December 2014. Reaching a cumulative total GSSS bond issuance of US\$ 100 billion in the 2014-2022 period, four main trends are identified.

First, the volume and share of international GSSS bonds in the region's total international bond issuance has increased significantly. The participation share jumped from less than 1% in 2018 to 32% in 2022, a sharp five-year increase. In 2022, the GSSS bonds participation improved despite a reduction in volumes due to tighter financial conditions. These instruments thus showed growth and resilience during the eight years analyzed.

Second, while initially green bond issuances were predominant, the region has moved toward a diversification of the sustainable instruments used. Following the broader trend in socially responsible and ESG investing, the definition of green bonds widened to include a broader range of socially conscious debt labels, such as social and sustainability bonds. Sustainability and sustainability-linked bonds have become LAC bond issuers most used GSSS instruments since 2021.

Third, since Chile issued the region's first sovereign international green bond in June 2019, sovereign GSSS bond issuances have become the driver of the region's overall international sustainable issuances, accounting for the largest share of the GSSS total. For the eight-year period, sovereign issuers accounted for 42% of the total amount issued, followed by the private non-bank sector, which accounted for 37%. While the public sector has an important role to play, scalable solutions require significant commitments of private-sector resources. However, for many private sector issuers it is unclear whether GSSS bonds—which are often perceived as complex and costly due to the multiplicity of criteria and lack of harmonized disclosure reporting guidelines and standards—offer a demonstrable reward in terms of improved pricing or lower borrowing costs.

Despite the complexity associated with these sustainable bond issuances, investors did reward issuers that sought to finance sustainable investment strategies in the period analyzed, and this is the fourth trend identified. Applying a propensity score matching (PSM) methodology to compare the behavior of GSSS and conventional bonds issued by LAC public and private agents in the primary market in this eight-year period, a statistically significant “greenium” —the amount by which the yield on a GSSS bond is lower than an otherwise identical conventional bond— was found. According to the empirical analysis results, LAC issuers during this period paid between 55 to 63 basis points less on the coupon of an international GSSS bond issuance in the primary markets than on a traditional bond.

Many LAC issuers still face challenges to participate in the GSSS international bond market, however. They include a lack of knowledge and capacity development, difficulties in identifying and creating green portfolios, and lack of standardized monitoring mechanisms. Standardization, including common global definitions and norms upon which issuers and investors could agree, is needed to grow and expand the region’s sustainable bond market. It is also important to adopt high standards of disclosure and reporting, and policymakers could facilitate how companies disclose and report the information associated with their sustainable activities.

Nuñez et al. (2023) describe the results of a survey conducted by the Economic Commission for Latin America and the Caribbean (ECLAC) to gather information from LAC jurisdictions on the standards they apply for ESG disclosure. The survey was intended for countries’ capital market regulators and the goal was to map sustainability reporting standards applicable to listed companies in Latin America and the Caribbean. The conclusion reached is that there is an opportunity for the region to begin to coordinate and adopt common criteria in the face of the convergence of standards at the international level. It is possible to unify visions from different actors, so that the region acts as a bloc, with information that global investors can easily access to make the region a more attractive investment destination.<sup>12</sup> With more and better ESG disclosure information, regional companies could feature more prominently on the radar of global institutional investors and indices. A significant part of private investment is currently being channeled through them, but the region thus far has a small weight in emerging market indices.

Finally, in the countries where GSSS bonds are less established due to issuances’ small size, lack of appropriate institutional arrangements for GSSS bond management, and high transaction costs, the support from multilateral development banks could contribute to the expansion of the GSSS bond markets, through a constructive use of guarantees, help with the structuring and evaluation of sustainable projects, as well as with certifications and impact evaluations.<sup>13</sup>

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<sup>12</sup> When disclosure is framed within a policy, for example, as is the case of Brazil with the sustainable finance policy of its Securities and Exchange Commission (CVM Comissão de Valores Mobiliários), the positive effect may be even greater, contributing to protecting investors from greenwashing practices. See August Pina (CVM, Brazil)’s remarks at “Private Finance Sector Progress to Face the Challenge of Climate Change,” available online at <https://www.cepal.org/en/events/private-finance-sector-progress-face-challenge-climate-change>.

<sup>13</sup> See Deschryver and de Mariz (2020) and Bernabé Argandoña et al. (2022).

## Bibliography

- Baker, Malcolm, Bergstresser, Daniel, Serafeim, George and Wurgler, Jeffrey (2018), "Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds", Working Paper 25194, *National Bureau of Economic Research (NBER)*, October 2018 [online] <https://www.nber.org/papers/w25194>.
- Baker Mckenzie (2019), "Critical challenges facing the green bond market," report by Michael Doran and James Tanner, *International Financial Law Review (IFRL)*, October/November [online] [https://www.bakermckenzie.com/en/insight/publications/2019/09/-/media/files/insight/publications/2019/09/iflr-green-bonds-\(002\).pdf](https://www.bakermckenzie.com/en/insight/publications/2019/09/-/media/files/insight/publications/2019/09/iflr-green-bonds-(002).pdf).
- Barclays (2015), "The Cost of Being Green," *Credit Research*, U.S. Credit Focus, 18 September [online] [https://www.environmental-finance.com/assets/files/US\\_Credit\\_Focus\\_The\\_Cost\\_of\\_Being\\_Green.pdf](https://www.environmental-finance.com/assets/files/US_Credit_Focus_The_Cost_of_Being_Green.pdf).
- Bernabé Argandoña, L.C., Cruz Rambaud, S., López Pascual, J. (2022) "The Impact of Sustainable Bond Issuances in the Economic Growth of the Latin American and Caribbean Countries" *Sustainability* 2022, 14, 4693 [online] [https://www.researchgate.net/publication/360053198\\_The\\_Impact\\_of\\_Sustainable\\_Bond\\_Issuances\\_in\\_the\\_Economic\\_Growth\\_of\\_the\\_Latin\\_American\\_and\\_Caribbean\\_Countries#fullTextFileContent](https://www.researchgate.net/publication/360053198_The_Impact_of_Sustainable_Bond_Issuances_in_the_Economic_Growth_of_the_Latin_American_and_Caribbean_Countries#fullTextFileContent).
- Bour, Tom (2019) "The Green bond premium and non-financial disclosure: Financing the future, or merely greenwashing?" Master's Thesis, Maastricht University [online]. <https://finance-ideas.nl/wp-content/uploads/2019/02/msc.-thesis-tom-bour.pdf>.
- Bustillo, Inés. and Velloso, Helvia. (2013), "Debt financing rollercoaster: Latin Americana and the Caribbean access to international bond markets since the debt crisis, 1982-2012", United Nations publication, Santiago, Chile, September 2013. [online] <https://digitallibrary.un.org/record/776343?ln=en> or [https://repositorio.cepal.org/bitstream/handle/11362/2635/1/S2013301\\_en.pdf](https://repositorio.cepal.org/bitstream/handle/11362/2635/1/S2013301_en.pdf).
- CBI-Climate Bonds Initiative (2019), "Post-issuance reporting in the green bond market" March 2023 [online] [https://www.climatebonds.net/files/reports/cbi\\_post-issuance-reporting\\_032019\\_web.pdf](https://www.climatebonds.net/files/reports/cbi_post-issuance-reporting_032019_web.pdf).
- \_\_\_\_\_ (2020), Explaining Green Bonds, [online] <https://www.climatebonds.net/market/explaining-green-bonds>
- Deschryver, Pauline and de Mariz, Frederic (2020), "What Future for the Green Bond Market? How Can Policymakers, Companies, and Investors Unlock the Potential of the Green Bond Market?" *Journal of Risk and Financial Management*, 2020, 13(3),61 [online] <https://doi.org/10.3390/jrfm13030061>.

- ECLAC-Economic Commission for Latin America and the Caribbean (2017a), "Financing the 2030 Agenda for Sustainable Development in Latin America and the Caribbean. The challenges of resource mobilization." Forum of the Countries of Latin America and the Caribbean on Sustainable Development, Mexico City, 26-28 April 2017 [online] <https://repositorio.cepal.org/items/4f7f9ea7-f2fo-4c00-8993-f749711323a9>.
- \_\_\_\_\_ (2017b) "The rise of green bonds: financing for development in Latin America and the Caribbean," *ECLAC-Washington Office*, report prepared by Helvia Velloso, October 2017 [online] <https://www.cepal.org/en/publications/42230-rise-green-bonds-financing-development-latin-america-and-caribbean>.
- \_\_\_\_\_ (2023a), Capital flows to Latin America and the Caribbean: 2022 year-in-review and early 2023 developments (LC/WAS/TS.2023/1), Santiago [online] <https://www.cepal.org/en/publications/48733-capital-flows-latin-america-and-caribbean-2022-year-review-and-early-2023>.
- \_\_\_\_\_ (2023b), "Capital Flows to Latin America and the Caribbean: first half of 2023," Report prepared by Helvia Velloso (LC/WAS/TS. 2023/3), Santiago [online] <https://www.cepal.org/en/publications/49048-capital-flows-latin-america-and-caribbean-first-half-2023>.
- EIB-European Investment Bank (2007), "EPOS II – The "Climate Awareness Bond". EIB promotes climate protection via pan-EU public offering," *Investor Relations News*, 22 May 2007 [online] <https://www.eib.org/en/investor-relations/press/all/2007-042-epos-ii-obligation-sensible-au-climat-la-bei-oeuvre-a-la-protection-du-climat-par-le-biais-de-son-emission-a-l-echelle-de-l-ue>.
- Ehlers, Torsten, and Packer, Frank (2017), "Green Bond Finance and Certification" *BIS Quarterly Review* September 2017 [online] <https://ssrn.com/abstract=3042378>.
- Gianfrate, Gianfranco and Peri, Mattia (2019), "The Green Advantage: Exploring the Convenience of Issuing Green Bonds", 6 February 2019, *Journal of Cleaner Production*, Forthcoming, [online] Available at SSRN: <https://ssrn.com/abstract=3329823>.
- ICMA-International Capital Market Association (2021), "The Sustainability Bond Guidelines," June 2021 [online] <https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Sustainability-Bond-Guidelines-June-2021-140621.pdf>.
- \_\_\_\_\_ (2022), "Green Bond Principles. Voluntary Process Guidelines for Issuing Green Bonds," June 2021 with June 2022 Appendix 1, [online] <https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles-June-2022-060623.pdf>.
- \_\_\_\_\_ (2023a), "Social Bond Principles. Voluntary Process Guidelines for Issuing Social Bonds," June 2023, { [online] <https://www.icmagroup.org/assets/documents/Sustainable-finance/2023-updates/Social-Bond-Principles-SBP-June-2023-220623.pdf>.
- \_\_\_\_\_ (2023b), "The Sustainability-Linked Bond Principles. Voluntary Process Guidelines," June 2023 [online] <https://www.icmagroup.org/assets/documents/Sustainable-finance/2023-updates/Sustainability-Linked-Bond-Principles-June-2023-220623.pdf>.
- IMF-International Monetary Fund (2023), "Global Financial Stability Report", October 2023 [online] <https://www.imf.org/en/Publications/GFSR/Issues/2023/10/10/global-financial-stability-report-october-2023>.
- Kapraun, Julia and Scheins, Christopher (2019), "(In)-Credibly Green: Which Bonds Trade at a Green Bond Premium?" Proceedings of Paris December 2019 Finance Meeting EUROFIDAI - ESSEC, 5 March, [online] available at SSRN: <https://ssrn.com/abstract=3347337> or <http://dx.doi.org/10.2139/ssrn.3347337>
- Kelly, Richard, Michelle Holligan, Alan Bunbury, and Vincent McConnon (2021), "ESG: Green Bond Principles updated," Matheson, 18 June [online] <https://www.matheson.com/insights/detail/esg-green-bond-principles-updated>.
- MacAskill, S., Roca, E., Liu, B., Stewart, R.A. and Sahin, O. (2021), "Is there a green premium in the green bond market?" Systematic literature review revealing premium determinants, *Journal of Cleaner Production*, Volume 280, Part 2, 20 January 2021, 124491, ISSN 0959-6526 [online] <https://doi.org/10.1016/j.jclepro.2020.124491>.
- Moody's Investors Service (2023), "Sustainable bond issuance to rebound 10% in 2023 to \$950 billion, short of record high", *Sector in-depth*, Sustainable Finance - Global, 31 January 2023.
- Nanayakkara, Madurika and Colombage, Sisira (2019), "Do investors in Green Bond market pay a premium? Global evidence," *Applied Economics*, 51:40, 4425-4437, DOI: 10.1080/00036846.2019.1591611 [online] <https://www.tandfonline.com/doi/abs/10.1080/00036846.2019.1591611>.



- Natixis (2020), "Natixis Survey Finds Institutional Investors Putting Capital to Work to Address Global Problems," 19 May 2020 [online] <https://www.im.natixis.com/us/press-release/natixis-survey-finds-institutional-investors-putting-capital-to-work-to-address-global-problems>.
- Núñez, G., Velloso, H. and Da Silva, F. (2022), "Corporate governance in Latin America and the Caribbean: using ESG debt instruments to finance sustainable investment projects", *Project Documents* (LC/TS.2022/23), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC) [online] <https://www.cepal.org/en/publications/47778-corporate-governance-latin-america-and-caribbean-using-esg-debt-instruments>.
- Núñez, G., Velloso, H., Lehuedé, H., Da Silva, F. and Poveda, L. (2023) "ESG disclosure, corporate reputation, and financing costs: evidence from Latin America and the Caribbean", *Project Documents* (LC/TS.2023/124/Rev.1), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), 2023 [online] <https://www.cepal.org/en/publications/68029-esg-disclosure-corporate-reputation-and-financing-costs-evidence-latin-america>.
- Pastor, L., Stambaugh, R. F. and Taylor, L. A. (2022), "Dissecting Green Returns." University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2021-70 [online] available at SSRN: <https://ssrn.com/abstract=3869822> or <http://dx.doi.org/10.2139/ssrn.3869822>.
- Rosenbaum P. and Rubin D. (1983) The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1); (p. 41-55) [online] <https://academic.oup.com/biomet/article/70/1/41/240879>
- Saturna Capital (2018), "Green Bonds: A Growing Market, But Not Without Weeds", *From The Yardarm Market Commentary & Analysis*, March [online] <https://www.saturna.com/insights/yardarm/green-bonds-growing-market-not-without-weeds>.
- The Dialogue (2020), "What's the Future of ESG Investing in Latin America?" *Financial Services Advisor*, 30 June, <https://www.thedialogue.org/analysis/whats-the-future-of-esg-investing-in-latin-america/>
- The World Bank (2018), "World Bank Marks 10-Year Green Bond Anniversary with Landmark Issuance US\$ 1.3 Billion Issuances Bring World Bank Green Bond Program to US\$ 12.6 Billion" *Press Release*, 13 November 2018 [online] <https://www.worldbank.org/en/news/press-release/2018/11/13/world-bank-marks-10-year-green-bond-anniversary-with-landmark-issuance-us-1-2-billion-issuances-bring-world-bank-green-bond-program-to-us-12-6-billion>.
- \_\_\_\_\_ (2019), "10 Years of Green Bonds: Creating the Blueprint for Sustainability Across Capital Markets" 18 March 2019 [online] <https://www.worldbank.org/en/news/immersive-story/2019/03/18/10-years-of-green-bonds-creating-the-blueprint-for-sustainability-across-capital-markets.print>.
- Zerbib, Olivier David (2018), "Is There a Green Bond Premium? The yield differential between green and conventional bonds", 5 May [online] [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2889690](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2889690).



## **Annexes**

## Annex 1: Propensity Score Matching (PSM) estimations

### a) Logit linear estimation

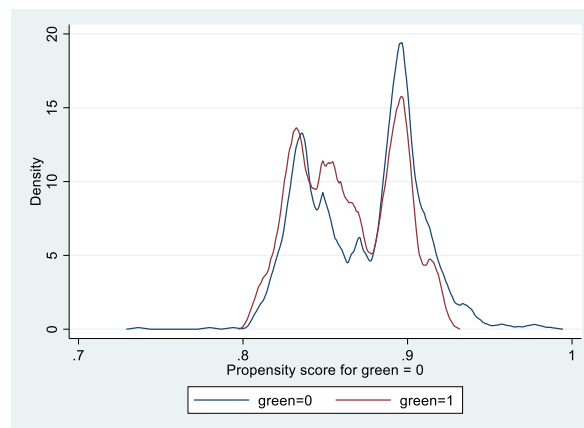
Table A1 presents the estimated ATT using a Logit score matching function and the set of confounding already described (amount, maturity, and credit rating). The result shows an ATT reflecting a statistically significant *greenium* of 69 basis points.

	Values
ATT	-0.0069***
Std. Error	0.0023
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database.  
Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

We rely on several statistics and plots presented below to check the balance of the matched data. First, to check the overlap assumption, we introduce in figure A1 the estimated density of the probability of getting each treatment level. The figure shows an acceptable overlap; in other words, each issuance has a positive probability of receiving each treatment level.

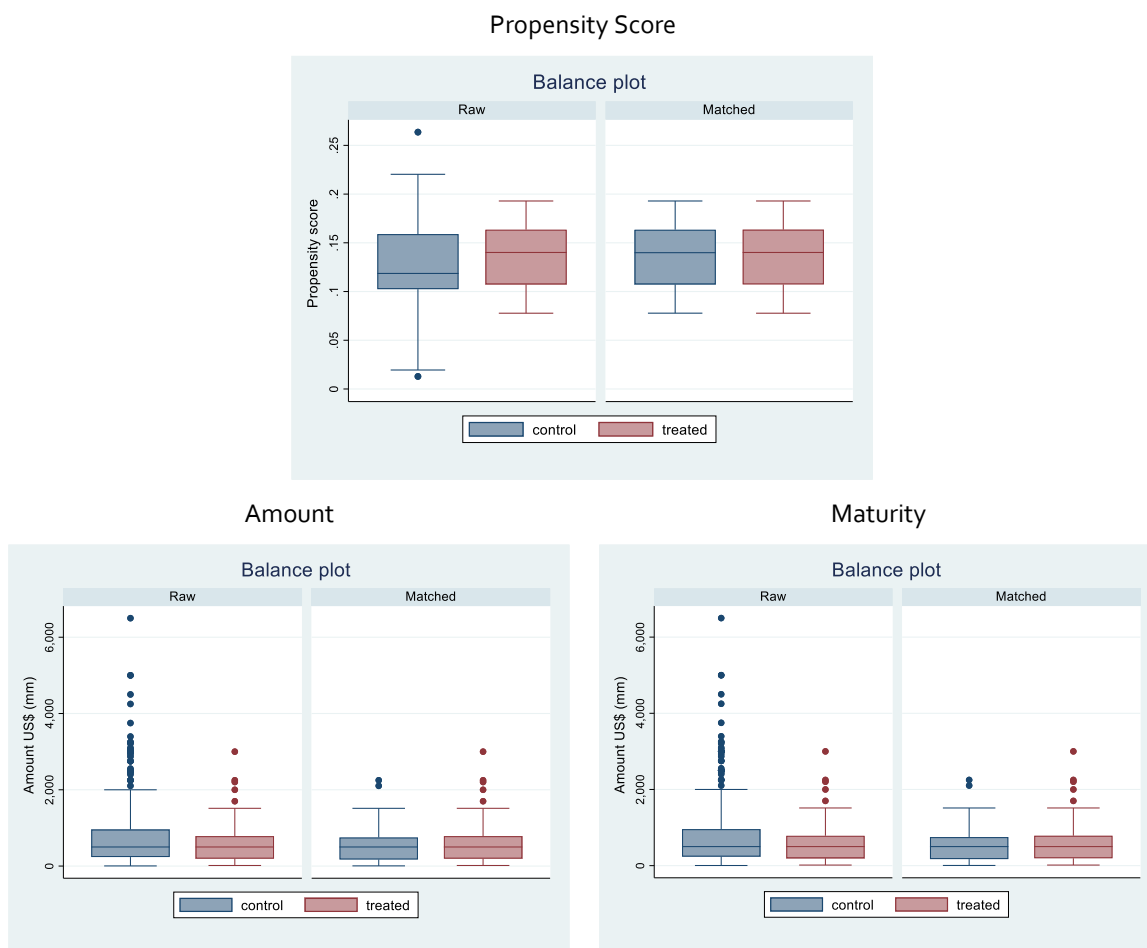
**Figure A1**  
Overlap, Logit linear estimation



Source: Elaborated by the authors based on ECLAC Washington Office Database.

In figure A2, we introduce three diagnostic box plots to check for balance, one for the propensity score and the rest for the amount and maturity confounding. The plot of the propensity score shows that matched samples for both groups (control and treated) are very similar in medians, percentiles (25<sup>th</sup> and 75<sup>th</sup>), and tails. An analogous result is offered in the plots of the amount and maturity; however, there are some differences in the outliers.

**Figure A2**  
**Balance-Box Plots, Logit linear estimation**



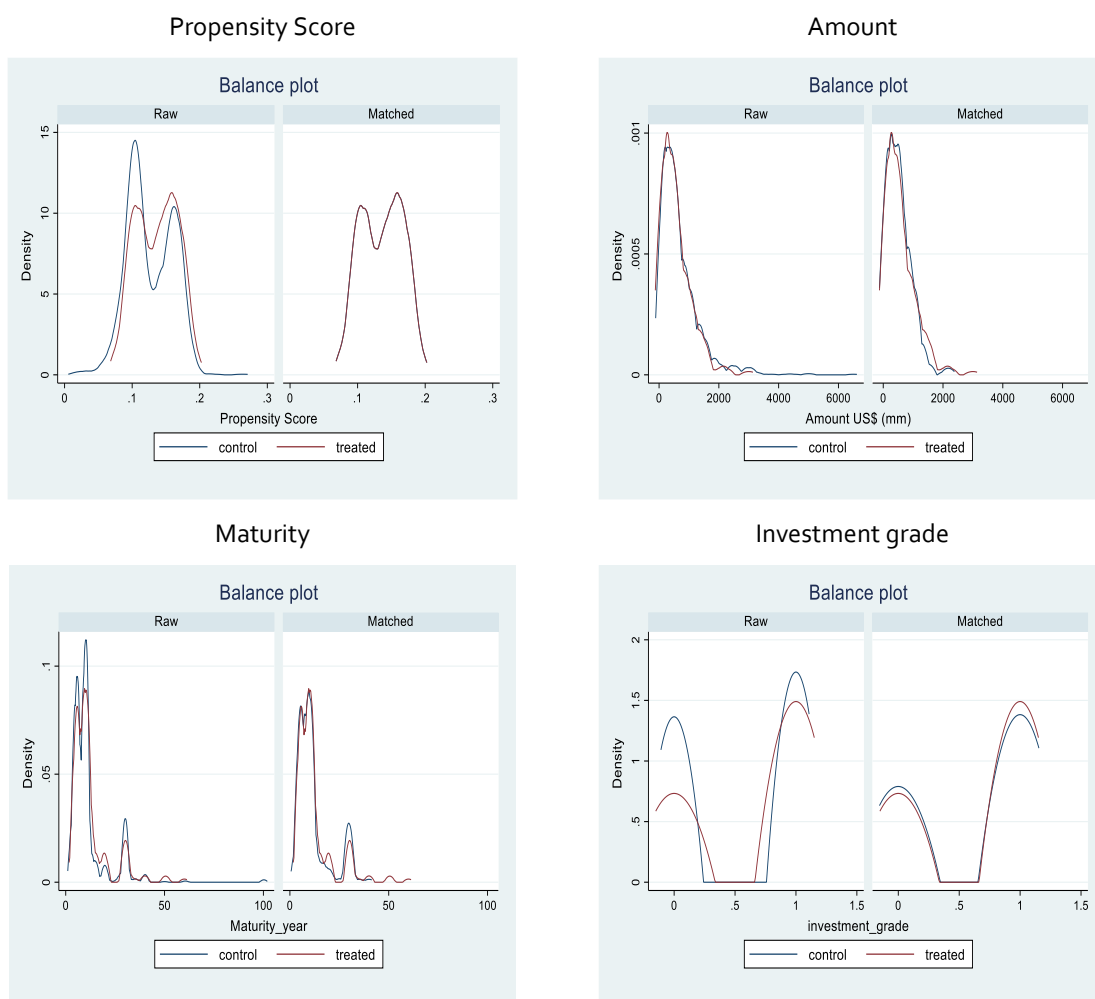
Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A3 introduces kernel density plots of the confounding variables for control and treatment groups as an additional check for the balance on confounding. Results show an acceptable balance of the matched groups.

Finally, table A2 shows two additional indicators (standardized differences and variance ratio) that also help to check the balance (a perfectly balanced covariate has a standardized difference of zero and a variance ratio of one). The matched sample reflects an acceptable balance for the investment grade and the standardized maturity difference; however, the amount and maturity are not well-matched according to the variance ratio.

Summing up, the linear Logit estimation shows a statistically significant *greenium*, but there are some concerns regarding the balance accuracy from the variance ratio. We follow this estimate with an alternative Probit linear propensity score function.

**Figure A3**  
**Overlap–Density of probability of treatment level, Logit linear estimation**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

**Table A2**  
**Balance–Logit linear estimation**

Variable	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	0.1199	0.5634	1.4938
Maturity	0.0631	0.0615	0.9202	1.2939
Investment grade	0.2291	0.0715	0.9009	0.9548

Source: Authors' calculations based on ECLAC Washington Office Database.

## b) Probit linear estimation

The next step was to estimate the propensity scores using a Probit linear propensity score function as an alternative to the Logit linear estimation. The estimated ATT, presented in table A3, shows —again— the presence of statistically significant *greenium*, in this case of 55 bps, slightly below the previous estimation.

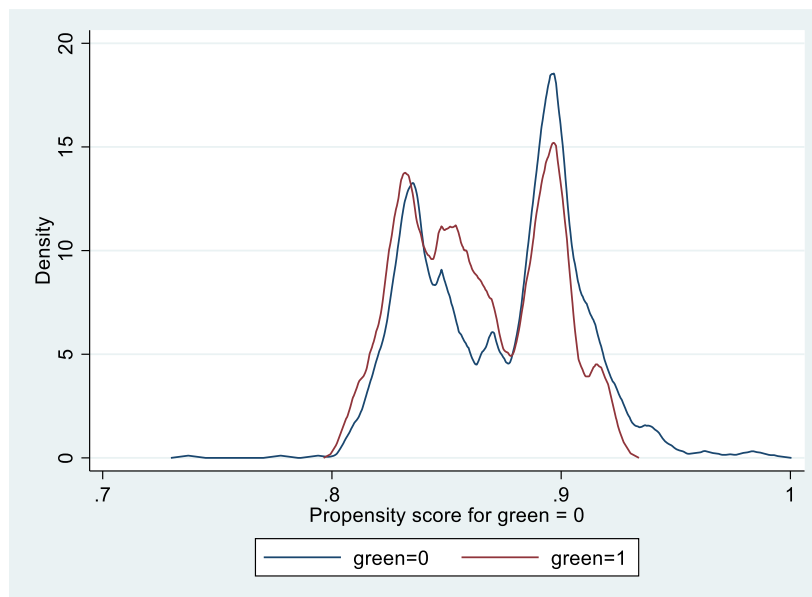
**Table A3**  
**PSM-Probit linear estimation**  
*Average Treatment Effect on the Treated*

	<i>Values</i>
ATT	-0.0055***
Std. Error	0.0025
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database. Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

Figure A4 shows an acceptable overlap between the treatment and control groups.

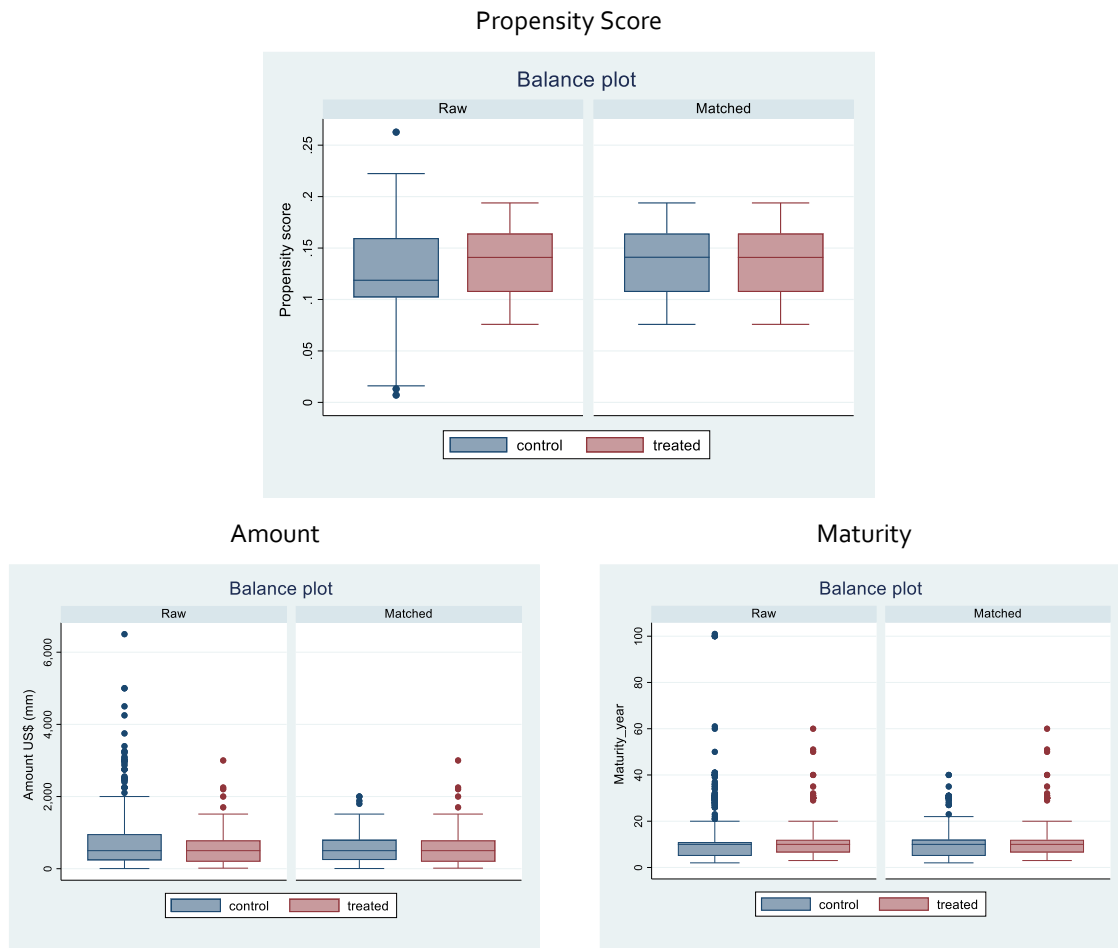
**Figure A4**  
**Overlap, Probit linear estimation**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A5 presents the diagnostic box plots, showing that both groups have a well-matched balance.

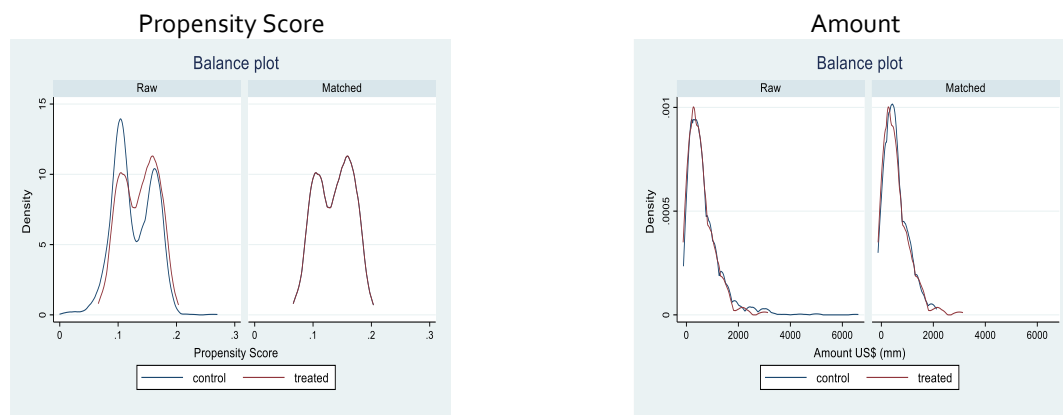
**Figure A5**  
**Balance-Box Plots, Probit linear estimation**



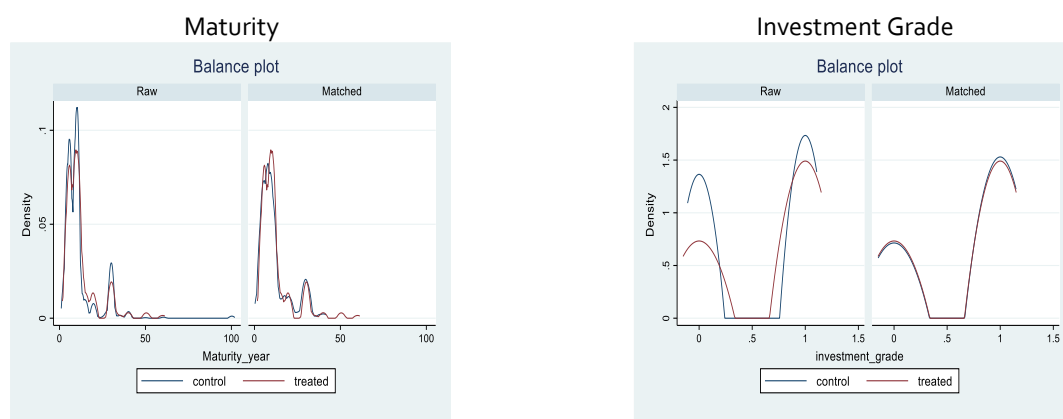
Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A6 introduces kernel density plots that reflect an acceptable balance of the propensity score and the confounding.

**Figure A6**  
**Overlap-Density of probability of treatment level, Probit linear estimation**







Source: Elaborated by the authors based on ECLAC Washington Office Database.

For its part, table A4 shows an acceptable fit of the matched data according to the standardized differences and some concerns with the variance ratio of the amount and maturity confounding.

**Table A4**  
Balance-Probit linear estimation

Variable	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	-0.0054	0.5634	1.2606
Maturity	0.0631	0.0450	0.9202	1.2116
Investment grade	0.2291	-0.0242	0.9009	1.0185

Source: Authors' calculations based on ECLAC Washington Office Database.

Overall, the ATT based on estimates of propensity scores using a linear Probit estimation shows a statistically significant *greenium* as in the logistic estimation. However, again, there are some concerns about the balance according to the variance ratio. For this reason, richer interactions in the propensity score functions are introduced in the following estimations.

**c) Logit polynomic estimation**

Due to balance concerns of the Logit linear estimation according to the variance ratio of the amount and maturity confounding, we proceed to include polynomic relations in the Logit propensity score estimation in this section. According to the new estimates in table A5, the ATT shows a *greenium* of 59 basis points, which is statistically significant.

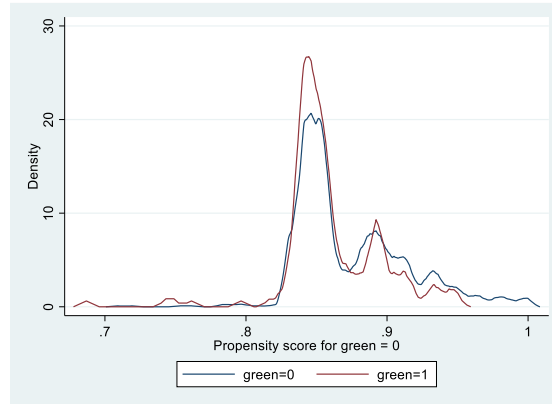
**Table A5**  
PSM-Logit polynomic estimation  
Average Treatment Effect on the Treated

	Values
ATT	-0.0059***
Std. Error	0.0024
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database. Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

The overlap graphical analysis presented in figure A7 reflects an acceptable intersection of the propensity scores of both groups.

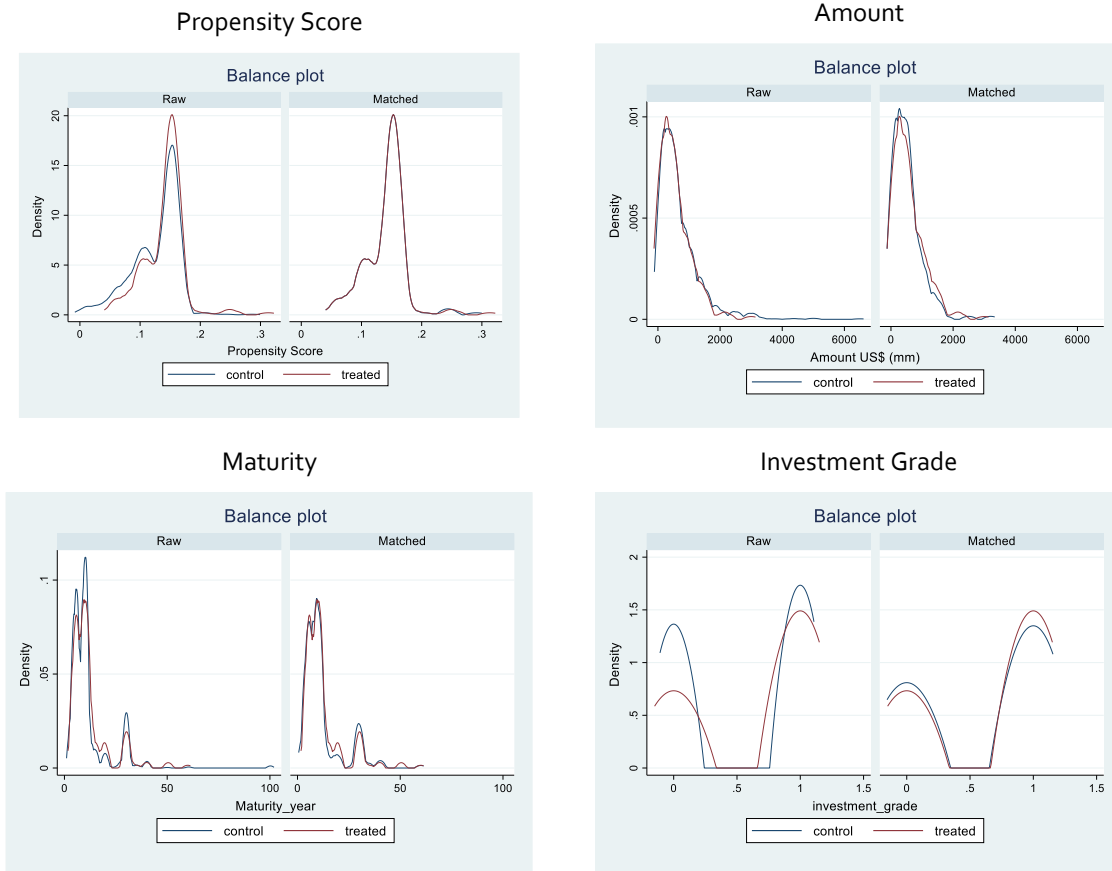
**Figure A7**  
Overlap, Logit polynomial estimation



Source: Elaborated by the authors based on ECLAC Washington Office Database.

In figure A8, the kernel density plots reflect an acceptable balance of the propensity score and the confounding.

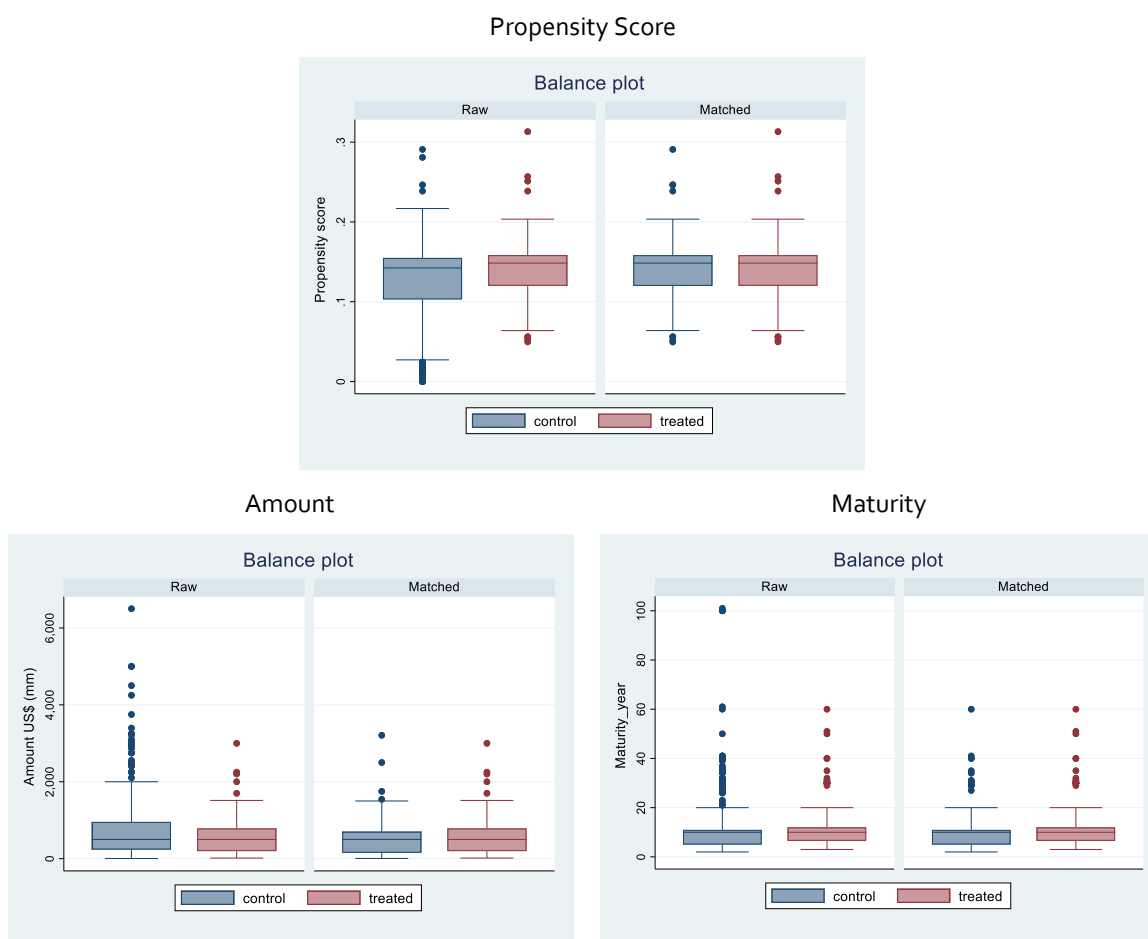
**Figure A8**  
Overlap–Density of probability of treatment level, Logit polynomial estimation  
*Diagnostic - Kernel Density Plots*



Source: Elaborated by the authors based on ECLAC Washington Office Database.

The balance box plots, presented in figure A9, appear to be good for the propensity score and the amount: the medians, tails, and percentiles (25<sup>th</sup> and 75<sup>th</sup>) look similar, but there are some differences in the outliers and the matched values of the maturity confounding.

**Figure A9**  
Balance-Box Plots, Logit polynomial estimation



Source: Elaborated by the authors based on ECLAC Washington Office Database.

Table A6 introduces the standardized difference and variance ratio as measures of the covariate balance. According to these indicators, the confounding variables have a good balance.

**Table A6**  
Balance-Logit polynomial estimation

Variables	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	0.1175	0.5634	1.1792
Amount^2	-0.1837	0.0950	0.2004	1.0236
Maturity	0.0631	0.0299	0.9202	1.0019
Maturity^2	0.0107	0.0157	0.4834	1.1878
Investment grade	0.2291	0.0950	0.9009	0.9427

Source: Authors' calculations based on ECLAC Washington Office Database.

In this section, propensity scores were estimated with a Logit function with polynomial terms. According to the box plots, a statistically significant *greenium* was found, with some concerns about the balance of the maturity confounding. In the next section, the propensity scores are estimated with a Probit function with polynomial terms.

#### d) Probit polynomial estimation

In this section, we repeat the polynomial estimation of the propensity scores using a Probit function. As shown in table A7, the estimated ATT reflects a statistically significant *greenium* of 58 bps.

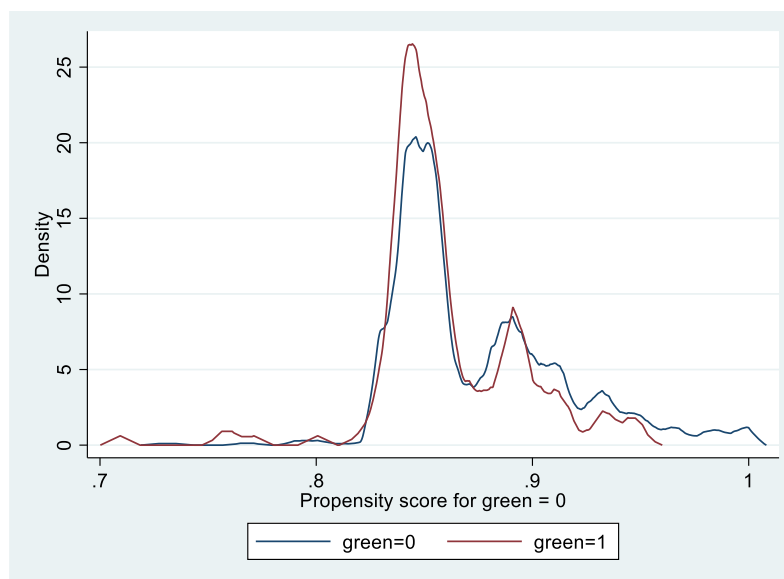
**Table A7**  
**PSM-Probit polynomial estimation**  
*Average Treatment Effect on the Treated*

	<i>Values</i>
ATT	-0.0058***
Std. Error	0.0021
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database.  
Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

Figure A10 shows an acceptable overlap of the propensity scores of the treatment and control groups.

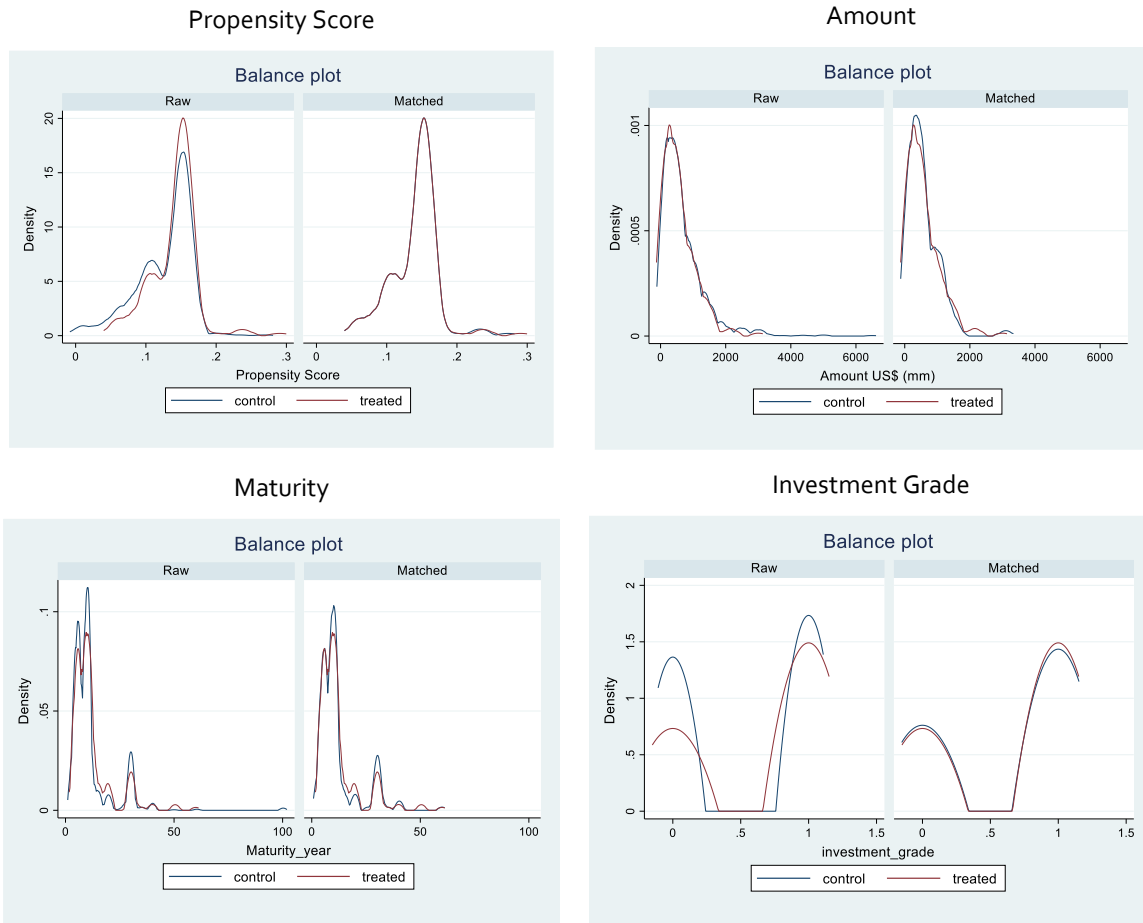
**Figure A10**  
**Overlap, Probit polynomial estimation**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

The kernel density plots—shown in figure A11—reflect an acceptable balance of the propensity score and the confounding.

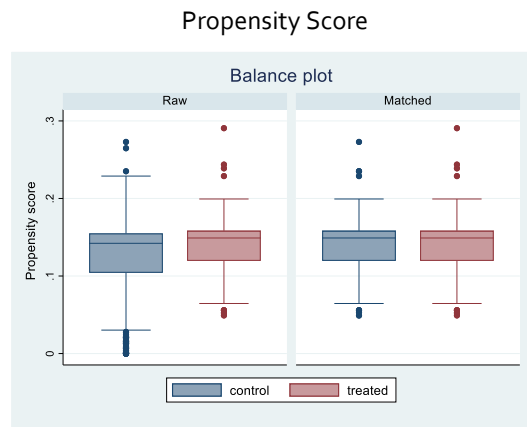
**Figure A11**  
**Overlap–Density of probability of treatment level, Probit polynomial estimation**

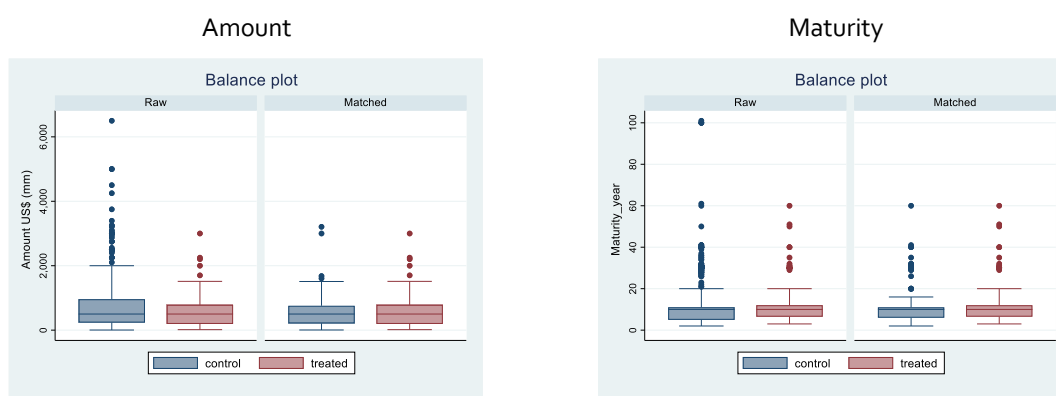


Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A12 introduces the box plots for this estimation. According to the plots, there is an acceptable balance on the matched data. However, some issues persist with the outliers and the maturity confounding.

**Figure A12**  
**Balance–Box Plots, Probit polynomial estimation**





Source: Elaborated by the authors based on ECLAC Washington Office Database.

Table A8 shows a good balance of the matched confounding according to the standardized differences and the variance ratio.

**Table A8**  
Balance-Probit polynomial estimation

Variables	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	0.0089	0.5634	1.0748
Amount^2	-0.1837	0.0203	0.2004	0.8310
Maturity	0.0631	0.0060	0.9202	1.0179
Maturity^2	0.0107	0.0067	0.4834	1.1875
Investment grade	0.2291	0.0359	0.9009	0.9756

Source: Authors' calculations based on ECLAC Washington Office Database.

In sum, and according to the ATT, estimating the propensity scores by a Probit function with polynomial terms shows a statistically significant *greenium*. However, the box plots raise some concerns regarding the maturity confounding. In the following two sections, we introduce estimates with additional interaction terms to improve the balance.

### e) Logit polynomial estimation with augmented interaction terms

In this section, we estimated the propensity scores using a Logit polynomial function with more interaction terms than in section c, aiming to improve the balance. According to the new estimates in table A9, the ATT shows a *greenium* of 63 bps, which is statistically significant.

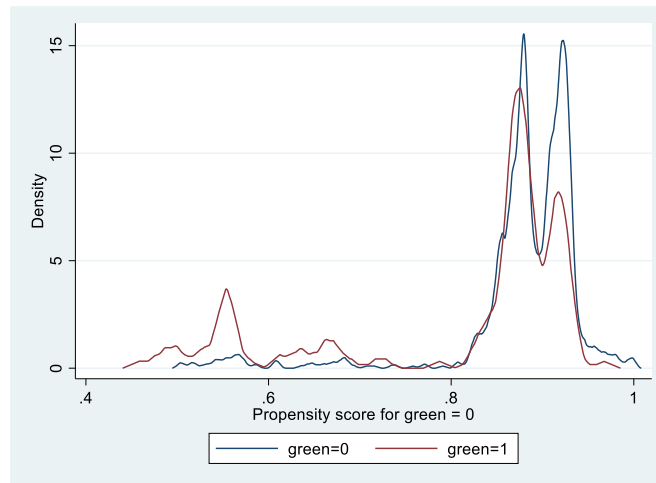
**Table A9**  
PSM-Logit polynomial estimation with augmented interaction terms  
Average Treatment Effect on the Treated

	Values
ATT	-0.0063**
Std. Error	0.0026
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database. Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

Figure A13 shows an acceptable overlap of the propensity scores of the treatment and control groups.

**Figure A13**  
**Overlap, Logit polynomial estimation with augmented interaction terms**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

The density plots, shown in figure A14, reflect a sound balance of the propensity score and the confounding.

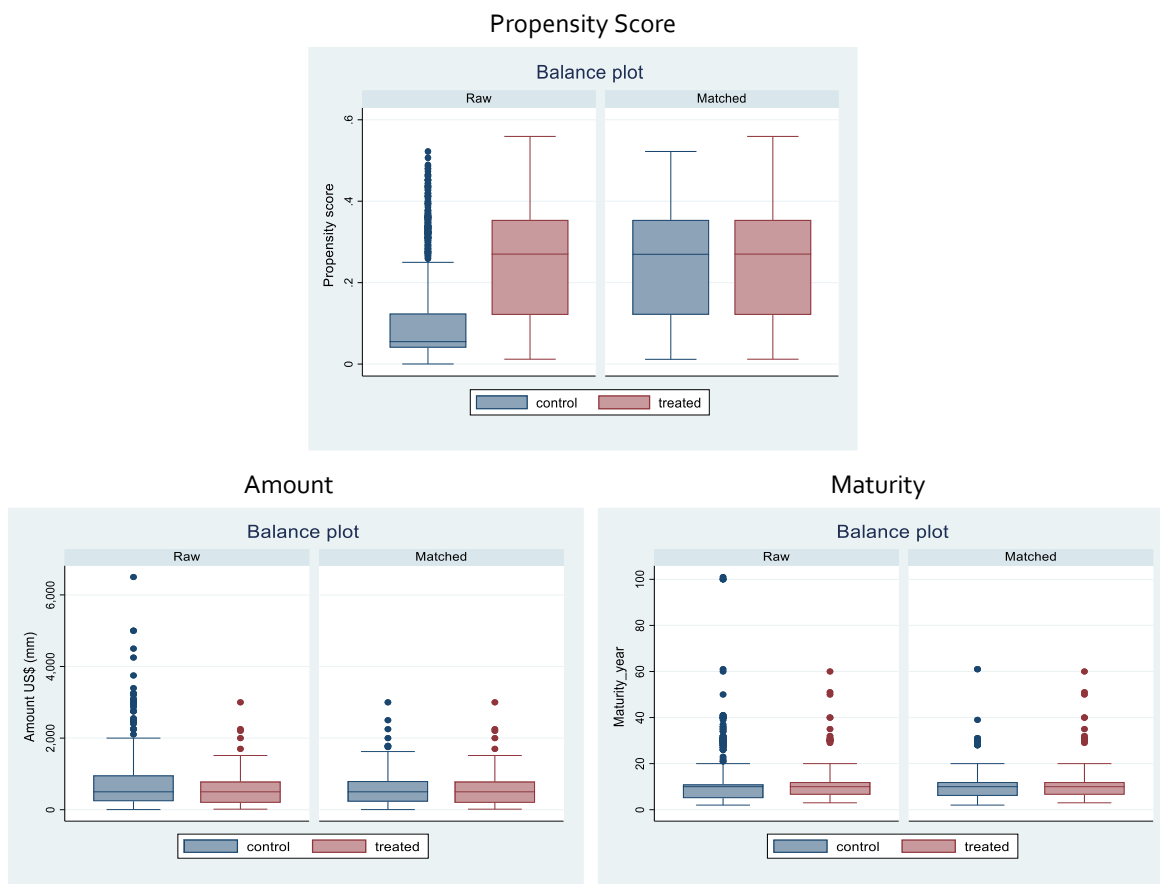
**Figure A14**  
**Overlap–Density of probability of treatment level, Logit polynomial estimation with augmented interaction terms**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A15 introduces the box plots for this estimation. There is an acceptable balance of the matched data. In particular, the maturity confounding now has a better balance than previous estimations.

**Figure A15**  
**Balance–Box Plots, Logit polynomial estimation with augmented interaction terms**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

Table A10 presents the standardized differences and the variance ratio of selected interactions. The statistics show a better balance of matched confounding than previous results.

**Table A10**  
**Balance–Logit polynomial estimation with augmented interaction terms**

Variables	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	-0.0330	0.5634	0.9829
Amount^2	-0.1837	-0.0218	0.2004	0.8968
Maturity	0.0631	-0.0481	0.9202	0.9344
Maturity^2	0.1007	-0.0377	0.4834	0.9250
Investment grade	0.2291	0.0950	0.9009	0.9427

Source: Authors' calculations based on ECLAC Washington Office Database.

Summarizing, in this section, we applied an augmented polynomial Logit function whose estimates show a statistically significant *greenium* with a better balance of the matched confounding than previous estimates. In the next section, we again apply an augmented polynomial function, in this case with a Probit specification.



**f) Probit polynomial estimation with augmented interaction terms**

Finally, we introduce a similar model to the previous section but estimate the propensity scores using a Probit polynomial function with augmented interaction terms. In table A11, the estimation results show an ATT with a statistically significant *greenium* of 55 bps.

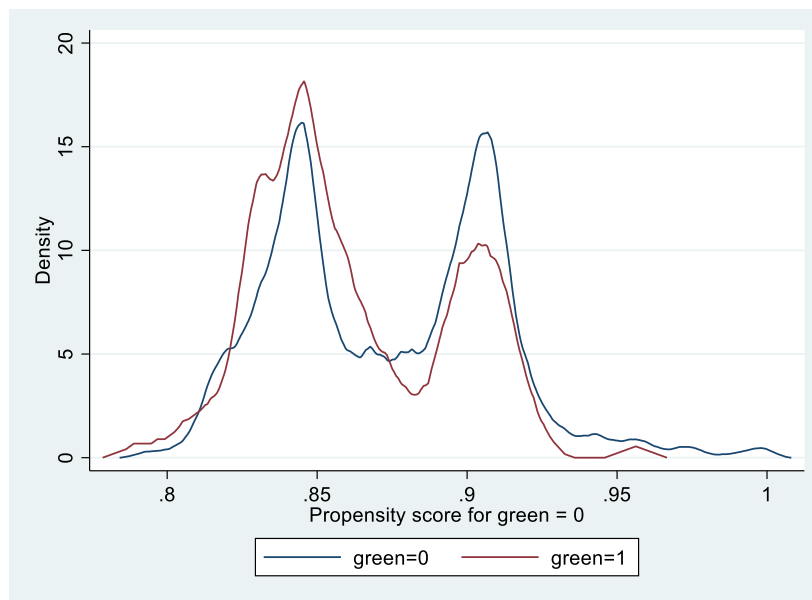
**Table A11**  
**PSM-Probit polynomial estimation with augmented interaction terms**  
*Average Treatment Effect on the Treated*

	<i>Values</i>
ATT	-0.0055*
Std. Error	0.0025
# treated	176
# untreated	1 201

Source: Authors' calculations based on ECLAC Washington Office Database. Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

The overlap plotted in figure A16 shows a good fit of the propensity scores of the treatment and control groups.

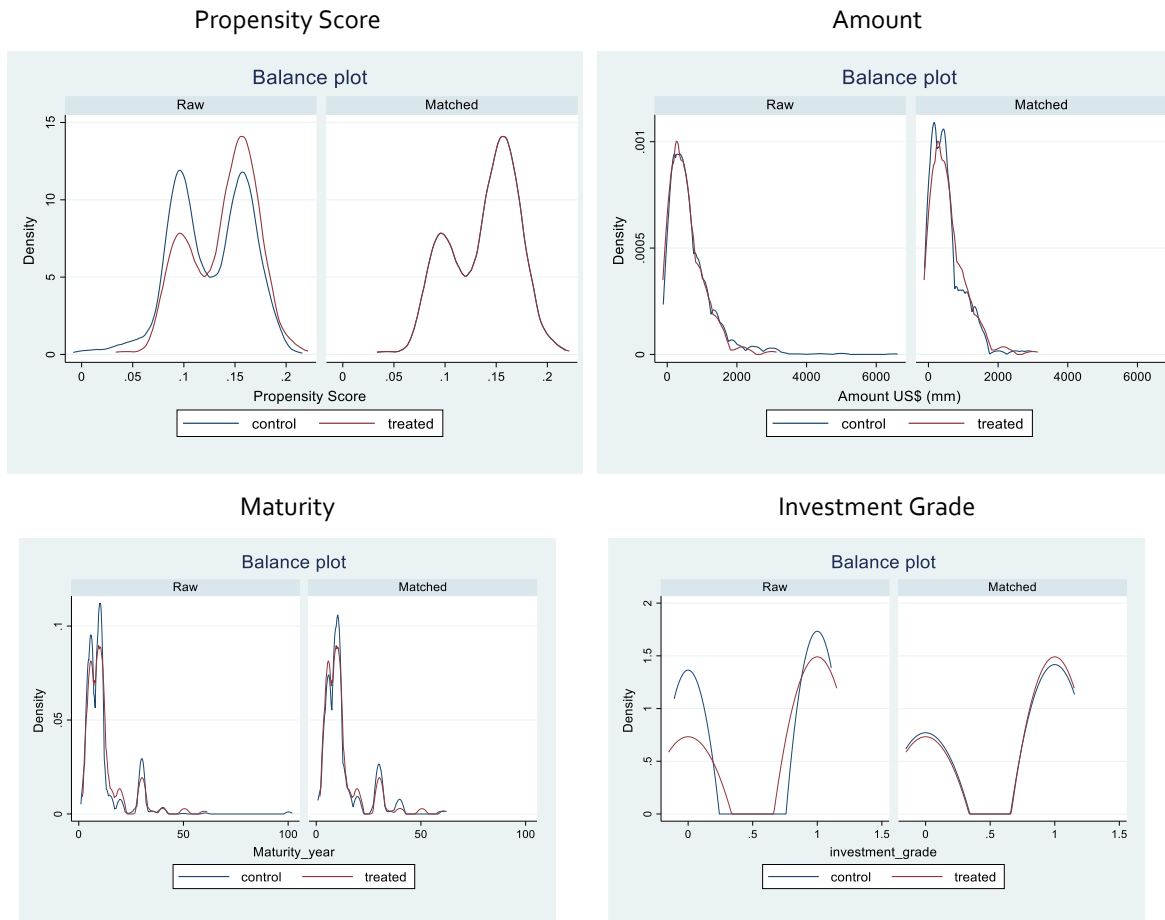
**Figure A16**  
**Overlap, Probit polynomial estimation with augmented interaction terms**



Source: Elaborated by the authors based on ECLAC Washington Office Database.

Figure A17 introduces the kernel density plots, which reflect an acceptable balance of the propensity score and the confounding variables.

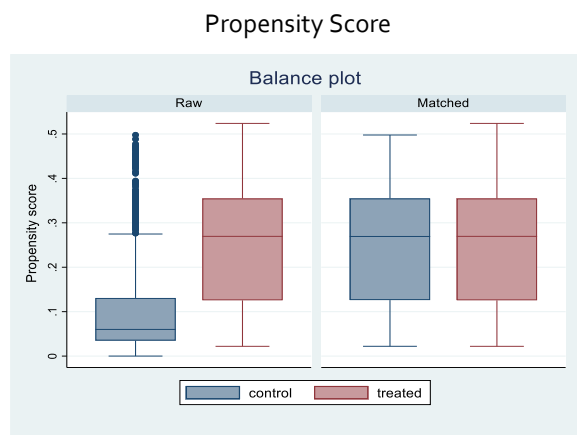
**Figure A17**  
**Overlap–Density of probability of treatment level, Probit polynomial estimation with augmented interaction terms**

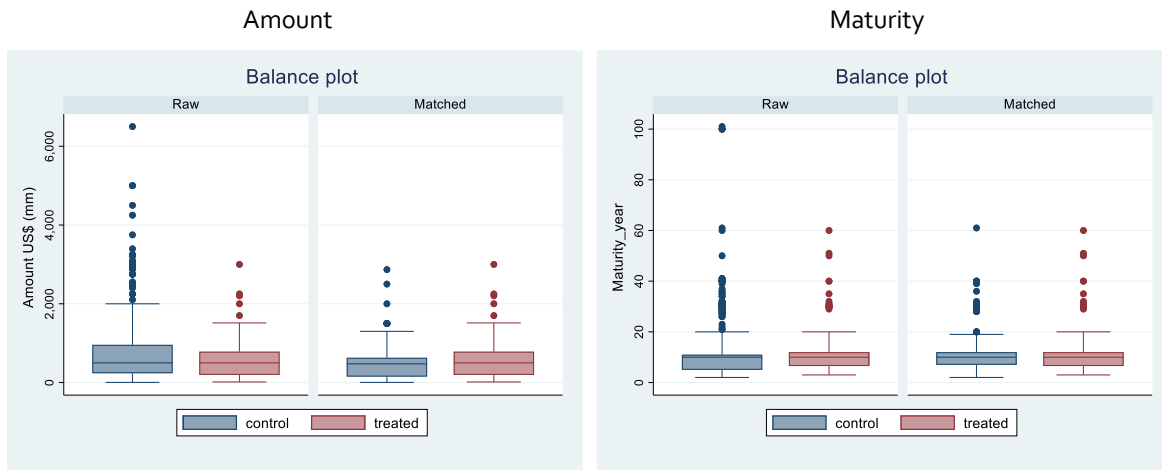


Source: Elaborated by the authors based on ECLAC Washington Office Database.

According to the box plots introduced in figure A18, the balance on the matched data is better than previous Probit estimations.

**Figure A18**  
**Balance–Box Plots, Probit polynomial estimation with augmented interaction terms**





Source: Elaborated by the authors based on ECLAC Washington Office Database.

Finally, table A12 shows the standardized differences and the variance ratio estimates, presenting a better balance of the matched confounding than previous Probit results.

**Table A12**  
**Balance-Probit polynomial estimation with augmented interaction terms**

Variables	Standardized differences		Variance ratio	
	Raw	Matched	Raw	Matched
Amount	-0.1868	0.1061	0.5634	1.0858
Amount^2	-0.1837	0.0752	0.2004	1.1498
Maturity	0.0631	-0.0467	0.9202	0.9627
Maturity^2	0.0107	-0.0320	0.4834	1.0768
Investment grade	0.2291	0.0478	0.9009	0.9683

Source: Authors' calculations based on ECLAC Washington Office Database.

Summing up, in this section, we estimate the ATT, which showed a statistically significant *greenium*, with a Probit function with augmented polynomial terms instead of the original Probit polynomial estimation. The result shows a better balance than before.

## Annex 2: Estimations with different matching neighbors

As a robustness check, we estimate the propensity scores and the ATT using the same Logit and Probit specifications of the augmented polynomial estimations with three and five matching neighbors. The results show statistically significant *greenium* close enough to those presented in the main body.

Tables A13 and A14 show the ATT for the Logit and Probit functions, respectively.

**Table A13**  
PSM–Logit polynomial estimation with augmented interactions and matching neighbors  
*Average Treatment Effect on the Treated*

	Neighbors matching (NN=3)	Neighbors matching (NN=5)
ATT	-0.0054**	-0.0055***
Std. Error	0.0022	0.0021
# treated	176	176
# untreated	1 201	1 201

Source: Authors' calculations based on ECLAC Washington Office Database.

Note: ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model. Neighbor matching set to one. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.

**Table A14**  
PSM–Probit polynomial estimation with augmented interactions and matching neighbors  
*Average Treatment Effect on the Treated*

	Neighbors matching (NN=3)	Neighbors matching (NN=5)
ATT	-0.0060**	-0.0056**
Std. Error	0.0027	0.0023
# treated	176	176
# untreated	1 201	1 201

Source: Authors' calculations based on ECLAC Washington Office Database.

Note: Columns refer to the different matching neighbors. ATT is the Average Treatment Effect on the Treated. # treated (# untreated) is the number of treated (control) units. The propensity score is based on a Probit model reported in Table X. (\*\*\*) (\*\*) (\*) indicates significance at the (1%) (5%) (10%) level. A common probability support of the treated and control units is enforced to ensure the common support region.



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