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"GREEN FINANCE INSTRUMENTS: CHALLENGES AND RISKS"

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Firma dello studente

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Introduction

Due to the worsening situation regarding climate conditions, there has been a significant rise in the awareness of the social and environmental risks of human activities, as is visible in the attempt to shift from a profit-maximizing economic system that is primarily short term in nature, in favor of a more sustainable and environmentally oriented alternative.

Over the past decade, green bonds and green stocks have changed from being a specialized product to widely acceptable financial instruments in domestic capital markets. Such financing instruments are crucial in narrowing down the prevailing cost implications within stakeholders willing to finance the objectives of climate change in line with the 2016 Paris Agreement on Climate Change and the 2015 UN Sustainable Development Goals (SDGs).

The Climate Awareness Bond (CAB) issuance by the European Investment Bank (EIB) in November 2007 marked the birth of the green bond market. This prompted the significant development of the European market, which grew at an average of 50% per annum during the period 2015 to 2020. At present, the EU accounts for the majority, 51% of all the green bond market share worldwide.

The newly adopted EU Taxonomy Regulation (Reg 2020/852) and the EU Green Bond Standard (EUGBS) have similarly boosted the sustainable finance market in Europe (Cicchiello et al., 2022).

Yet various hurdles may hinder the very parent green bond from serving this purpose. However, many issues threaten the credibility and development of green instruments as an essential market tool. These concerns include the unexpected lack of green contractual protections for investors, the risk of greenwashing, the quality and transparency of reporting metrics, issuer confusion, and a perceived lack of pricing incentives for issuers.

Green banking and renewable financing are still two areas that need improvement over the current situation and further research into their complexities. A lot of information technology is behind the green economy: it is all about the processes, analyses, and interpretations of data to be green. The obstacles to overcome are numerous, but they can be managed because they are composed of structural, regulatory, administrative, financial, strategic, and sector-specific issues. A majority of these challenges share a relationship, and taking action to resolve one can bring about the reversal of others as well.

The work is structured as follows: Chapter I relates to the European framework created to support the issuance of green instruments and the development of green markets in the last decades. Chapter II reports the challenges in the development and diffusion of such green instruments in the market, and Chapter III reports the risks on the actual green financial

landscape, in particular, it addresses the topic of “greenwashing”. The last section, Chapter IV, presents some case studies of why and how green stocks outperform brown stocks in the industry.

By analyzing the contributions of the literature related to these topics, this thesis tries to present a broad overview of the most important green instruments, green bonds, and green stocks, the challenges and risks that such financial products faced, are facing and will face in the future in their path to sustain the goals set by the 2016 Paris Agreement.

Chapter I: The European Framework and the Development of Green Markets

Almost every country in the world committed to the Paris Agreement to put a stop to the increase in the global average temperatures. The critical threshold of non-return was set to 2 °C above pre-industrial levels, with the main goal to pursue the limit to 1.5 °C above pre-industrial levels. The treaty was adopted by 196 countries at the UN Climate Change Conference (COP21) in Paris, on 12 December 2015 (UNCC). To limit global warming to 1.5°C, greenhouse gas emissions must peak before 2025 at the latest and decline 43% by 2030. The European Union (EU) aims to be climate-neutral by 2050 with the expressed desire of "building a better future for all while leaving no one behind". The first intermediate target that the EU wants to reach is a reduction of 55% in net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. The objective falls into the European Green Deal and is a legally binding target thanks to the European Climate Law (European Commission). In the meantime, the United Nations adopted the 2030 Agenda, which defines 17 goals (Sustainable Development Goals), broken down into 169 Targets, to be achieved by 2030 (Linciano et al. 2022). The COVID-19 pandemic strengthened even more EU's plans to make its economy sustainable, as EUR 600 billion from the NextGenerationEU was channeled towards the Green Deal.

In the last years, the EU has tried to build a regulatory framework to support the green transformation of the European economy (Brühl, 2022). In this landscape, green financial instruments play a crucial role in the transition to a greener and sustainable economy. It is difficult to establish whether the actual level of transparency on Environmental, Social, and Governance (ESG) principles provided by the recent Sustainable Finance Strategy (SFS) is sufficient to move private capital into sustainable investments. The complexity of EU regulation has brought attention to a need to establish simplified green ratings for investors to facilitate the choice of the best green instrument on the market.

Sustainable finance refers to the process of taking ESG considerations into account when making investment decisions, whereas Brühl defines green finance as a subset of sustainable finance. Let's give an initial outlook on green instruments and markets to help us deepen the topic.

Green financial products could directly finance specific investment projects to achieve certain sustainability objectives, or they could provide general financing to companies whose business profile meets certain sustainability characteristics.

The green financial sector has been on the rise since the first green bond issuance of EUR 600 million called the "Climate Awareness Bond" by the European Investment Bank, in June 2007

(Ben Slimane et al., 2020). During these (almost) two decades, many more companies have excluded themselves from investing in problematic sectors with major environmental hazards, human rights issues, and lack of assurance of fair labor conditions. As we will see, institutional investors play an always more central role in the transition towards a greener market.

1.1 Regulatory framework in the European Union

Firstly, it is essential for investors that financial market participants disclose reliable and transparent information about the sustainability characteristics and effects of the financial products they offer. This will improve both the comparability of investment products and the information basis for portfolio decisions. By doing so, information asymmetries among financial market participants, advisors, and investors will be reduced. In the EU, thanks to the 2014/95/EU Directive, called the Non-Financial Reporting Directive (NFRD), European large companies (with more than 500 employees) need to publish information "related to environmental matters, social matters, treatment of employees, respect for human rights, anti-corruption, and bribery, diversity on company boards (in terms of age, gender, educational and professional background)" (Guagliano et al., 2022). Moreover, firms may deliver information on requests by other institutions like data providers, ESG rating agencies, etc.

The launch of the SFS and the very fast adoption of three fundamental pieces of legislation in 2018 (the EU benchmark regulation, the EU disclosure and financial advice regulation, and the EU taxonomy) gave concreteness to the EU ambitions on sustainability and to the European Green Deal.

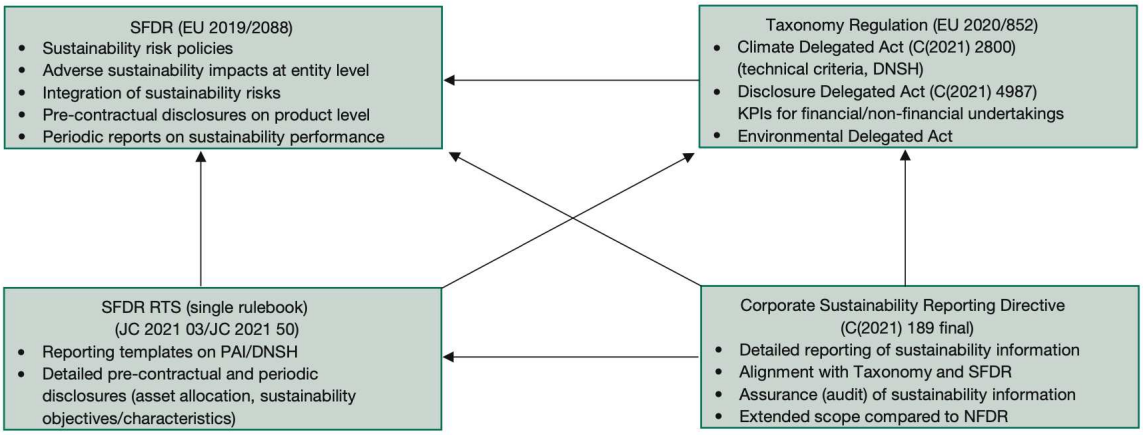
The EU worked also on external political initiatives, eight central banks (CB), with the leadership of the Banque de France and the Chair at De Nederlandsche Bank, launched the "Network for Greening the Financial System", with the initiative counting 105 members. In the meantime, the European Commission set up the International Platform for Sustainable Finance, with 44 authorities representing 55% of the world GDP and 55% of the greenhouse gas emissions all around the world. This platform allowed to treat sustainable finance as a global challenge.

A classification system (taxonomy), with science-based indicators and metrics, must be provided for characterizing financial products as more or less sustainable about one or more ESG criteria.

As mentioned before, the EU has developed an SFS, and a European Action Plan on Sustainable Finance, refined later by the Renewed Sustainable Finance Strategy and amended by the "April

Package" in 2021, which provides the regulatory framework for sustainable finance in the EU. These legislative components are strictly connected (as Figure 1 reports).

Figure 1. Sustainability reporting for corporates and financial institutions in the EU.



Notes: DNSH: do no significant harm; KPIs: key performance indicators; NFRD: Non-Financial Reporting Directive; PAI: Principal Adverse Impacts; RTS: Regulatory Technical Standards; SFDR: Sustainable Finance Disclosure Regulation.

Source: Brühl (2022).

The Sustainable Finance Disclosure Regulation (SFDR) provides the disclosure framework for sustainability information to be reported by financial market participants and advisors. With the SFDR, Financial Market Participants (FMPs), such as investment firms, alternative investment funds, venture capital funds, insurance companies, security brokers, pension funds, insurance firms, and banks offering portfolio management services, need to publish information about their policies on the integration of sustainability risks into their investment decision-making process. They have to disclose how they consider Principal Adverse Impacts (PAI) of investment decisions on sustainability factors. The FMPs also need to comply with pre-contractual and periodic disclosure requirements for each product they offer. The regulation, moreover, distinguishes between "light green" and "dark green" financial products, the difference stands with the firsts promoting only environmental or social characteristics, whether the latter pursuing specific sustainable investment objectives.

The SFDR is closely related to the Taxonomy Regulation (TR), established to provide a category for economic activities based on ESG criteria. The TR is supplemented by the Climate Delegated Act, specifying the technical screening criteria, and the Disclosure Regulation, which defines the Key Performance Indicators (KPIs). The corresponding Regulatory Technical Standards (RTS) provide detailed requirements in terms of methodology, indicators, metrics, and reporting templates. Being the SFDR and the TR interlinked, they were unified in a single rulebook, the SFDR RTS by the European Supervisory Authority (ESA).

Disclosure requirements for Article 9 SFDR ("dark green") state that issuers of such products need to disclose information about investment objectives, indicators used to measure the attainment of targets, and avoidance of Do No Significant Harm (DNSH). In addition, companies have to show planned minimum investments in sustainable activities and KPIs such as the minimum ratio of taxonomy-aligned investments. If a financial product pursues the reduction of CO2 emissions, it must be disclosed whether and how such emissions will be reduced in alignment with the Paris Agreement.

The TR distinguishes between six environmental objectives. An economic activity has to contribute to at least one of them to be categorized as sustainable. These sustainability objectives comprise "climate change mitigation" (the process of limiting the increase in the global average temperature to well below 2°C and pursuing efforts to limit it to 1.5°C above pre-industrial levels, as laid down in the Paris Agreement), and "climate change adaptation" (like flood protection).

Other objectives include the protection of water and maritime resources, the transition to a circular economy, the prevention of pollution, and the protection of biodiversity and ecosystems. An economic activity can only be classified as sustainable according to the Taxonomy Regulation, if:

- it contributes substantially to one or more environmentally sustainable objectives (Article 9 TR) and at the same time the activity does not cause a significant negative impact on the other sustainability objectives (do no significant harm (DNSH) principle) (Article 17 TR) and
- it is carried out in compliance with the minimum safeguards laid down in Article 18 TR and
- it complies with the technical screening criteria applicable to the respective activity.

If all TR-related criteria are met, the activity is said to be taxonomy-aligned; if the activity per se could be eligible under the TR but violates e.g. the technical screening criteria, the activity may be called taxonomy-eligible.

The Disclosure Delegated Act serves as a help to the TR regarding disclosure obligations; it requires increased transparency in non-financial statements. In particular, non-financial undertakings shall disclose the proportion of their turnover derived from products or services associated with economic activities that qualify as environmentally sustainable under Articles 3 and 9 TR. The proportion of their capital expenditures and their operating expenditures related to assets or processes associated with sustainable economic activities need to be reported accordingly.

To consider the potential adverse impacts of the economic activities financed by the respective financial product, financial market participants need to publish, for each product, a PAI statement. Regarding taxonomy-aligned activities, the strict criteria of DNSH must be applied. Adverse sustainability indicators associated with climate change mitigation could be the level of Greenhouse gasses (GHG) emissions, the carbon footprint, and the GHG intensity of investee companies. The supplier of a financial product promoting ESG criteria (Article 8 SFDR products) or even pursuing specific investment objectives (Article 9 SFDR products) therefore needs to disclose potential negative impacts on GHG emissions using these indicators. Another adverse sustainability indicator for climate change mitigation is the carbon footprint (CFP) of the financial product, which measures the GHG emissions in tCO2e per million euro of investment value.

As a part of the EU taxonomy, the Complementary Climate Delegated Act adds additional activities from the energy sector, in particular specific nuclear and gas energy activities. The Act applies from 1 January 2023. Specific disclosure requirements for businesses related to their activities in the gas and nuclear energy sectors are added (Celsia, 2022).

According to Brühl (2022), it is difficult to state if investors can understand all the information provided by the issuers of such financial products. Thus, it might be optimal to introduce a mandatory, easy to understand, and immediate indicator, referred to as "green rating". The rating would be based on a metric like the taxonomy-aligned turnover.

Table 1. Example of "green rating" of financial products

Rating score	A	B	C	D	E
Taxonomy ratio	100% - 80%	79.9% - 60%	59.9% - 40%	39.9% - 20%	19.9% - 0%

Source: Brühl (2022).

Then, it would be up to the regulator to state if a percentage above (for example) 50% will be enough to declare an instrument as "green" (see Table 1).

The European regulatory framework ensures a much higher level of transparency on ESG aspects of financial products and thus improves the information basis for investor decisions. This design, however, will create significant additional costs for collecting, evaluating, and reporting sustainability data. We know, for example, that the total spending for "ESG data" went from USD 617 million in 2019 to USD 750 million in 2020, with the EU accounting for 60% of the spending.

At the current state of the art, it remains questionable if the complex system of requirements affects investment decisions, especially those of retail investors.
Another issue is the high degree of heterogeneity within labeled funds across the EU because of the absence of an EU-wide ESG label. ESG fund labels exist in Austria, France, Germany, and Luxembourg but rely on different criteria. This situation raises consistency issues when funds are marketed at the international level.

1.2 Green financial markets and products

1.2.1 Green market evolution

Given that the definition of what is defined as "green" will be discussed in the next chapters, in the period 2007-2018, the annual issuance of green bonds grew from USD 0.8 billion to USD 167.3 billion (Glavas, 2020) (Dessertine, Migliorelli, 2019), with the market gaining traction over the last eight years thanks to the push of Central Banks and the signing of the Paris Agreement.
In terms of geographical impact, the United States, China, and the largest European countries have so far led the way in terms of new and overall issuance. Regarding of use of proceeds, in 2017 the distribution is as follows: 33% in renewable energy, 29% in low carbon buildings and energy efficiency, 15% in clean transport, 13% in sustainable water management, the rest in sustainable waste management, sustainable land use and forestry and climate change adaptation. These instruments, now, are seen as central to influencing the increased responsiveness of companies to ecological sustainability.
Due to the increasing concerns surrounding global environmental sustainability, investments attracted USD 12 trillion in 2018 alone. In the period 2014-2018, investments grew at an average rate of 16%, reaching a value equal to 14% of the world's GDP. (Gilchrist et al. 2021). Assets of funds with an ESG mandate have grown by 170% in the period 2015-2020 in the EU. The outstanding amount of euro-area green bonds has increased seven times over the same period (ECB, 2020). In Q2 2020, euro area investors held EUR 197 billion area green bonds. Banks are also increasing their own issuance of green bonds; in Q3 of 2020, new green bond issuance accounted for 13% of total euro area bank bond issuance, up from just 4% in Q1 of 2020. In line with the EU's goal of becoming the first Net-zero emission continent in the world, as of June 2021, Europe's green market bond issuance accounts for 60% of the global aggregate. It is possible to get an idea of how investors are shifting more and more towards sustainable investments in Figure 2. Whereas non-ESG investments in Exchange Traded Funds (ETFs)

remained particularly steady in the period going from early 2017 to March 2021 (in the middle of the pandemic), ESG investments in ETFs skyrocketed in the period following 2019. To get a numerical sense of this, the annual growth rate stands at +200% in 1H21 versus 27% for non-ESG ETFs. ETFs are becoming increasingly more common in the investment world for their peculiarities, the most known being the low expense ratios and costs of commission for passive instruments, furthermore they can be accessible for anyone, with a minimum investment required of just 1 dollar for many of them. It is a basket of securities that trades on an exchange, and they can contain stocks, commodities, bonds, currencies, industries/sectors, or a mix of all these.

Figure 2. Annual growth of EU-domiciled ESG vs non-ESG ETFs, in %.

Source: Linciano et al. (2021), pag. 31.

Offerings of EU ESG ETFs, jumped in 2020 to 90, exceeding for the first time the number of new non-ESG ETFs (62).

The green policy has brought a surge in two different green debt market instruments, green bonds, and green loans. Euro area financial institutions and households reduced their non-ESG holdings by 1-8% and increased the ESG ones by up to 10%. According to Gilchrist, green bonds are defined as: “a nascent fixed income asset class that are issued by governments, corporations and other institutions used to finance environmental and climate-friendly projects, such as renewable energy, recycling, and green infrastructure”, whether green loans: “bank lending/investments designed to support the transition to a net-zero carbon economy through

environmentally responsible projects and climate change mitigation". The first ever recorded green lending started in 2005.

Gilchrist's paper shows how green loans account for about 55% of total loans on average during the period 2010-2017. Geographically, the percentage of green loans is the highest in Spain, Italy, and Mexico in contrast to other countries. While Turkey, Chile, and South Africa have the lowest percentages.

The increased popularity of green financial instruments can be seen in Figure 2 and Figure 3: all the sections related to the instruments were born in the period 2015 onward, in line with what has been presented.

1.2.2 Green instruments

Figure 3. Major stock exchanges with dedicated sections for green or sustainable finance

Name of stock exchange	*Type of dedicated section*	*Launch date*
Oslo Stock Exchange	Green bonds	January 2015
Stockholm Stock Exchange	Sustainable bonds	June 2015
London Stock Exchange	Green bonds	July 2015
Mexico Stock Exchange	Green bonds	August 2016
Luxembourg Stock Exchange	Luxembourg Green Exchange	September 2016
Shanghai Stock Exchange	Green bonds	March 2016
Borsa Italiana	Green and social bonds	March 2017
Taipei Stock Exchange	Green bonds	May 2017
Johannesburg Stock Exchange	Green bonds	October 2017
Japan Exchange Group	Green and social bonds	January 2018

Source: Dessertine, P. Migliorelli. M. (2019), The Rise of Green Finance in Europe. Pag. 15.

Green bonds are debt instruments complying with the global certification standard operated by the global consortium of the Climate Bond Initiative (CBI), a branch of the International Capital Market Association (ICMA), and are considered the most important innovation in the green finance sector: they set the base for all the other financial products and services. These instruments are used to finance projects targeted at creating positive environmental impact. As previously mentioned, the issuance relates to sectors like renewable energy, management of natural resources in a sustainable way, energy efficiency, pollution control, and prevention. Use-of-proceeds refers to the information for investors on how money invested will be put to use. Bonds disclosing the use of proceeds are referred to as labelled green bonds and as of 2017, bonds aligned with the global climate agenda reached a staggering USD 221 billion. Before the issuance of the green bond, the issuer discloses the use of proceeds for the chosen type of green bond. Then, a framework of how the bond will be monitored is developed. A second opinion by

an independent entity on this framework is required: it can come from a think tank, investor-focused groups, or private or domestic ESG rating companies.

The largest buyers of these financial products remain institutional investors. Investors in such markets are called fixed-income investors and have been used for financing or refinancing infrastructure because they offer long-term maturities. Thus, they are perfect for institutional investors' liabilities (such as pension holders). In the meantime, bonds are quite stable instruments and predictable, when compared to equity, perfect for risk-averse investors who are looking for a low-risk and innovative opportunity (Weber, Saravade, 2019). To get a sense of the increasing importance of institutional investors in the green realm, we might take a brief example of what Warren Buffet did in 2015 by acquiring Axalta Coating Systems (ACS) (Barrons, 2021) (Shaydurova et al., 2018). Buffet, via his company, Berkshire Hathaway, purchased 10% of ACS, one of the world's largest producers of auto paints. The company had modest growth in the years preceding Buffet's operation but had excellent ESG ratings and reputation in terms of management quality. In mid-2017, Swiss Re, one of the largest reinsurance companies and institutional investors, stated that all of ACS USD 130 billion will be managed in accordance with ESG principles. For the reader's information, Berkshire Hathaway at the end of 2020 stake consisting of 23.4 million shares. Buffett's conglomerate sold 9.5 million in the first quarter and liquidated its remaining 13.9 million shares by June. Or, for example, the regional government of Île-de-France is issuing bonds to create "ecological corridors" to allow movements of wildlife between two natural areas that are disconnected because of roads and highways. Thus, there's an increasing appetite of institutional investors for green bonds in three ways according to Weber and Saravade: first of all, there's an uprising in stakeholder pressure to redirect investments into green products. Second, there is institutional pressure on institutional investors from their share and stakeholders regarding disclosure strategies on climate change risks and environmental and social awareness. Last, there's an increased risk of non-green long-term investments becoming more and more abandoned due to climate change.

Green bonds can fall into several categories, the most popular is the one that has been just described, the plain and simple corporate bond, or use-of-proceeds bond. The balance sheet of the company backs this kind of instrument. By contrast, project bonds are backed by the earnings of a single or multiple projects. The proceeds of these projects are paid out through an SPV.

If multiple of these projects are grouped, we experience the third type of green products, based on securitization, which is called green asset-backed securities (ABS). As for traditional securitization, green assets that are illiquid can be pooled into a special purpose vehicle (SPV)

and transformed into tradable securities. Green ABS are often included in the category of green bonds. The existing green ABSs present high heterogeneity. These products include solar ABS, electric automobile ABS, property-assessed ABS, residential and commercial mortgage-backed securities, and covered bonds. In 2019, green ABS accounted for around 17% of the entire green bond issuance market.

Another important driver of sustainable market development is the application of green indices reflecting the performances of securities of companies following ESG principles. Green indices act as an indicator of the performance of stocks in areas such as energy efficiency, renewable energy generation, pollution mitigation, and advanced materials, providing a benchmark for investors seeking to integrate environmental factors into their portfolios. A great variety of indices is present in the Standard & Poor's (S&P), which provides also a rating for bonds, Nasdaq, Dow Jones, MSCI, and FTSE index families. These families involve all-inclusive S&P Global Eco (forty of the largest publicly traded companies in six ecology traded industries), DJ Sustainability World (top 10% leading sustainability companies, across 2500), Nasdaq OMX Green Economy (tracking the performance of companies closely associated with a sustainable economic model), MSCI World ESG Universal, FTSE Environmental Market. Others are the Bloomberg Gender Equality Index; FTSE ESG Index Series; Solactive ISS ESG EU, Climate Benchmark Index Series, Solactive ISS Low Carbon Index Series, and Solactive ISS. ESG Screened Index Series; MSCI ESG Leaders Index, MSCI ESG Focus Index, MSCI. Climate Change Index; Refinitiv/S-Network ESG Best Practices Indices etc. ESG pan-European, such as the STOXX Europe ESG Leaders 50 Indices or the Dow Jones Sustainability Europe Index. These indices include companies with core businesses aimed at developing environmentally friendly techniques and those who are involved in different ecological initiatives and socially responsible reporting. The "green" economy index families also include regional, sector, and sub-sector, thematic indices. The last sub-group provides exposure to companies with the best results in specific fields, for example, in the reduction of carbon footprint.

1.3 The role of Multilateral Development Banks (MDB) in the market's expansion

Multilateral Development Banks (MDB) are major international financial institutions and organizations, such as the World Bank (WB), the European Bank for Reconstruction and Development (EBRD), and the Asian Development Bank (ADB). On one hand, they finance environmentally disruptive activities like coal power plants, on the other hand, they play an always more important role in the development of green markets. Financing both, however, it might be inefficient, because the effects of one investment could counter the benefits of the

opposites. In the first decade of 2000 and the first years of the next decade, all major MDBs, invested vast amounts of USD in fossil fuel projects. In 2010, for example, the WB invested USD 4.4 billion in fossil fuel projects in the developing world. Between 2006 and 2011, the EBRD increased its annual coal finance from EUD 82 million to USD 359 million. In India, the 4000-megawatt Tata Mundra coal-fired power station received USD 450 million in financing from both the World Bank Group's International Finance Corporation (IFC) and the ADB. The latter was for many years the third largest public international financier of coal-fired power plants, investing USD 3.9 billion in 21 projects, with a third of the investments in Latin America and the Caribbean not being green.

Things have changed in the last few years. According to the World Bank, climate financing by the world's six largest MDB increased to USD 35.2 billion in 2017, a 28% increase from the previous year. ABD, WB, and others began pledging major increases in climate finance as well. The World Bank stated that it wanted to increase climate finance to USD 29 billion (a 33% increase) by 2025 and the Inter-American Development Bank pledged to make climate finance 25–30% of total lending by that year. With a complete paradigm change, in 2019 25% of green bonds and climate bonds were issued by MDB.

A joint report by MDB published in 2022, stated that USD 60.9 billion of climate finances was provided for low-income and middle-income economies: USD 38.2 billion (63% of the total share) was for climate change mitigation and the rest for climate change adaptation. Mobilized private financing stood at USD 15.4 billion. (European Investment Bank, 2023). High-income economies received USD 38.8 billion in investments. Of this amount, USD 36.3 (94%) was for climate change mitigation, the rest for climate change adaptation. The amount of mobilized private finance stood at USD 39.1 billion. The European Investment Bank (EIB) reported that MDBs surpassed for the second year in a row the 2025 target set at the UN Secretary General's Climate Action Summit in 2019. The target was set to collect a total of USD 50 billion in climate finance for low-income and middle-income economies, at least USD 65 billion in climate finance globally, with an expected doubling in adaptation finance to USD 18 billion; and private mobilization of USD 40 billion. Compared to 2019 volumes, MDB 2022 climate finance for low and middle-income economies increased by 47% (USD 41.5 billion) and global MDB climate finance by 62% (USD 61.6 billion). Through its Climate Bank Roadmap, the EIB Group aims to support EURO 1 trillion of investment in climate action and environmental sustainability through 2021-2030. In the decade, the EIB wants to allocate investments in climate action and environmental sustainability to more than 50% of the EIB's annual lending by 2025, a target which, as mentioned before, has already been achieved.

MDB should take climate change issues and the green economy at heart in all their financing decisions. They should avoid financing projects that are harmful to the climate start boosting green product issuance and continue influencing financial regulators.

1.4 Sum-up

The past years have seen a dramatic increase in the attention and financial flows of green financial instruments, which is fueled by the necessity to combat climate change and secure sustainable development. The spectrum of instruments includes green bonds, green loans, sustainable investment funds, and green indices, among many others that help fund projects with environmental effects.

The increase in the variety and volume of these instruments is tied to the development of the regulatory framework, notably in the European Union. The EU has become a frontrunner in sustainable finance, implementing a set of remarkable policy initiatives to make the financial sector work for the environment. The European Green Deal is a significant lever of green finance in the EU, presenting a holistic plan to become carbon-neutral by 2050. The pursued major regulatory framework is the Taxonomy, which offers clear and identical criteria to disclose which economic activities can be labeled as environmentally friendly and thus favorable for financial support. Moreover, as the SFDR makes market participants make public the sustainability characteristics of their products it contributes to enhancing transparency. Subsequently, financial institutions tend to adopt ESG criteria in their investment strategies and consist of their portfolios with companies with sustainable activities and projects, thus driving capital into projects with ESG-compliant companies.

As the path for growth of green financial instruments and investments is set to mark the future faster, it will be driven by the ever-evolving regulations, heightened demand for sustainable options among investors, and the urgency in fighting against climate change. Retail investors, institutional investors, companies, and legislators are pushing hard to bolster the transition to greener investments.

The problems are still not solved, there might be a need for further harmonization of various standards, not-so-widespread data and its quality, and, of course, the credibility of green if proven to be not so.

Chapter II: Challenges in the Development of Green Instruments and Markets

In the previous chapter, we talked about how there was a shift in the adoption and development of green instruments and the relative markets in the past decade. However, the challenges that this world is facing are still relevant in some parts of it. Green practices, implemented by governments and supranational entities to stimulate sustainable development and reduce greenhouse gasses, need a broader green finance system that has faced several different responses on a multilevel of factors.

Green bonds offer several benefits for issuers, investors, and policymakers. For the former, green bonds align with long-term project maturities, lower debt financial expenses, and increase the firm's environmental footprints and financial performances. Investors, in the meantime, can increase their exposure to less volatile instruments, which can result in very appealing.

There is still a strong need to reinforce confidence in the green instruments market and have a better understanding of the characteristics and challenges attributed to these assets (Deschryver, 2020). The academics have focused on the macroeconomic conditions affecting the green market and its determinants, highlighting the link between national and supranational entities, firms, institutions, and policymakers.

In their report, Dorand and Tanner (2019), respectively partner and senior associate at Backer McKenzie, explicitly say "Green bonds are now in the mainstream. But the lack of contractual protections, as well as issues with reporting metrics and transparency, risk undermining the market and the broader sustainable finance project".

The finance industry is a key player in reaching global climate and biodiversity goals, as its contributions will channel the USD 1.5 trillion required for the transition to greener economies (Lopez Portillo Purata et al., 2022). Banks will be asked to decarbonize to reduce direct emissions from their operations while asking for an alignment towards the goals of the Paris Agreement in their loans and investments. To achieve this, they need to develop objectives to increase shares in sustainable portfolios, prioritize energy transition, reduce deforestation, and contribute to climate change adaptation.

Implementing Nature-based Solutions (NbS) can be an impactful strategy to support biodiversity and face actively climate crises. A cost-benefit analysis has shown that conserving peatlands in Indonesia generates a cost-benefit ratio of 19.1 against potential fire-induced damages: for every dollar invested in conservation, a return of 19 dollars was generated in avoided fire damage.

The help required by private institutions is substantial: it is estimated that the annual global budget required to safeguard the environment consists of USD 845 billion and there's a gap of

over USD 700 billion which cannot be funded with philanthropic and government funds alone (86% of the investments came from public financing, provided by national agencies). For example, of the 156 projects identified in Latin America regarding the provision of public services in the water (clean water and protection from flooding and droughts), sanitation, energy, and transportation, none of them were financed by private sector contributions.
This second chapter wants to address the problems that supranational entities, governments, and institutions are facing in the implementation of green finance systems and get a deeper look at what is hindering the transition to a more sustainable environment.

2.1 Green investment barriers

In 10 years, green bonds have gone from being a niche product to becoming mainstream on the international capital market landscape, being one of the fastest-growing segments.
Green bonds are now employed as a financing source for green renewable energy investments by sovereign companies, supranational companies, and brown corporations (those who harm the environment), all looking for a transition of some of their operations. These products have become crucial in helping to bridge the astonishing gap required to meet the targets set in the 2016 Paris Agreement. However, many concerns could undermine the evolution of green bonds. There's a surprising lack of green contractual protection for investors, the so-called Greenwashing, and the quality of metrics and transparency.
Recent trends point toward wider adoption of sustainable investing, yet some investors are still hesitant to include these strategies in their portfolios. Concerns about green investing can discourage and generate skepticism about these new instruments and companies that report on their ESG performances (King, 2024).
The greening of the economy mostly depends on the financial sector and several obstacles are met in implementing this new innovative system. Green banking and renewable finance still require extensive efforts given the complexity of collecting, processing, and understanding the data connected to the green system.
The infancy of the market and the lack of supply play a major role, as Deschryver and de Mariz report, there is a "chicken and egg" problem. The juvenile market doesn't offer enough data to investors to make a correct informed decision. Investors might look for the perfect transaction such as large deals, with straightforward allocation of the proceeds in simple green assets. Thus, the critical demand for quality, size, and type of project seems to be unmet. On the supply side, the characteristics and procedures of green bonds prevent many issuers from entering the

market. Many companies have limited amounts of renewable energy assets, with the bulk of the projects that are over by now.

The Green Bond Principles (GBP) require an issuer to use at least 95% of the proceeds to fund specific green projects, which poses a great challenge for the supply. With this logic, for a green bond to make financial sense for both sides of the market, a critical size must exist, which cannot happen below an estimate of USD 300 million. Unfortunately, this value can hardly be met by companies, governments, regions, and municipalities. The deficit of green assets has been emphasized also by ECB's President Christine Lagarde: "Green assets, while rapidly developing, are still a relatively limited asset class and a taxonomy of what constitutes a green asset is still in its infancy".

In countries relying massively on fossil fuels, it is harder to provide incentives to make investors shift from traditional to green investments. In addition to that, these countries generally fall into the category of markets under development, where bureaucratic capabilities are limited by poor regulatory structures. Also, political views and, therefore, laws, together with a lack of transparency, hinder green innovation.

There are still gaps between the international environmental agenda and the financial world since these issues are still not fully understood, despite efforts made by corporate environmental issues in the sector. These issues are strictly related to the fact that these so-called "NbS" are still seen as a relatively new concept even if presented in the early 2000s. The same happened with the topic of climate change: it became a topic of discussion in the 70s but was not treated as a vital issue in the global agenda until the 90s.

The barriers to sustainable investment are numerous but not insurmountable: they can be structural, regulatory, administrative, financial, strategic, and sector-specific.

We are observing an increasing effort on climate from the private sector, but as it has been presented in the South American case, it is still not enough.

Many of the obstacles to overcome are not independent of each other, and solving one of them could help in the solution of the others. A list of the principal factors will be reviewed.

Lack of clearly defined bond standards

There is no universally recognized legal and commercial definition of a green bond. However, the International Capital Market Association's (ICMA) Green Bond Principles try to state some common elements across many standards like the use of proceeds disclosure, redirection towards new or existing projects that have a positive impact on the environment or climate benefits, and an ongoing reporting on the use of proceeds and the provision of a second opinion

by an independent third party certifying the green aspects of the bond. But, the market has developed so much that no party involved in the business is obliged to follow any of these elements and none of the instruments confer actionable rights to the bondholder. At first, it might have been a way to encourage such a market, but with the market being more mature, problems have come to the surface. Use of proceeds, maintenance, second opinion review, and annual reporting are not often included as covenants in the "terms and conditions" of such bonds. The fact that there isn't a contractual stick that ensures a bond sold as green remains green for its lifetime creates a dilemma for bondholders and can undermine the credibility of this market. An example comes from the Mexico Airport green bonds case: Mexico City Airport Trust issued USD 6 billion of green bonds in 2016 and 2017 to finance the construction of a new airport, with the bond meeting ICMA GBP guidelines. There was a second-party opinion from Sustainalytics, and there was an ongoing evaluation from Moody's and S&P. In October 2018, the newly formed government decided to stop the construction of the already partially built airport and launched a buyback package, capped at USD 1.8 billion. After the news spread, Moody's lowered its assessment rating from GB5, the highest, to GB1, the lowest. S&P withdrew the evaluation report, and this caused an important loss for investors, for which they held bonds technically still labeled as green, but with a very different value in it. After a downrating of such bonds, not only investors would have incurred a loss if they decided to sell, but they were also holding a very different instrument in their portfolio than originally intended.
A more stringent definition of a green bond is given by the EU Technical Expert Group (TEG) on Sustainable Finance, which defines green bonds as "any type of listed or unlisted bond or any other capital market debt instrument issued by a European or international issuer, as long as three requirements are met: the issuer's 'Green Bond Framework' needs to explicitly affirm the alignment with the EU-Green Bond Standards (GBS); the proceeds will finance or re-finance Green Projects; and the alignment of the EU-Green Bond Standard is verified by an accredited External Verifier".
Green bond reporting is formed by two pillars, the first one is the pre-issuance use of proceeds disclosure used to sell the bond, and the second is the disclosed post-issuance ongoing reporting on the real use of proceeds. Unfortunately, the ICMA does not specify what is considered as green, leaving the analysis to the issuer, adviser, and second-opinion reviewers. This is rather opaque and can result in a discouraging factor for an investor, at this point, the use of proceeds will only match the issuer's investment guidelines.
Under green bond frameworks, issuers must commit to an internal audit of their use of proceeds, which a second-party opinion has to verify. Up to 12 months after the issuance of the bond, the

issuer must provide its verifiers with additional information supporting the correct allocation of the funds collected with the issuance.

A Climate Bond Initiative study of March 2019 found that only 68% of green bonds in their study benefited from regular ongoing post-issuance reporting, with only half of these reporting using impact metrics and allocation support. The issue is better illustrated in Table 2.

We can notice how the percentage increases for the total amount issued, meaning that the bigger issuers carry out ongoing post-issuance reporting, and they support it with impact metrics.

Table 2. Post-issuance reporting

Reporting scope		UoP reporting	Impact reporting	Both
Number of issuers	Reporting	251	194	172
	Non-reporting	116	173	195
	% reporting	68%	53%	47%
Number of bonds	Reporting	715	1,514	501
	Non-reporting	1,190	391	1,404
	% reporting	38%	79%	25%
Amount issued (USDbn)	Reporting	223	219	186
	Non-reporting	58	62	95
	% reporting	79%	78%	66%

Source: Doran, M. Tanner, J. (2019).

According to Mihálovits and Tapaszti (2018), a lack of defined standards leads to issues for investors and issuers since it becomes difficult to control for compliance. The absence of a common framework of guidelines leaves an important information gap that prevents investors from investing their capital. Several issuers of green bonds have developed their own green bond framework.

For example, an issuer might market a bond for a project thought to be green, and an investor, convinced that he bought a sustainable instrument, might discover that the product was different from what he expected, probably because of his different views on what is considered as green, like in the case of China, where the country includes clean utilization of coal as an eligible project category. China has issued RMB 7.4 billion, an equivalent of USD 1.1 billion in green

corporate bonds issued by 13 coal projects in the first 6 months of 2019. Clearly, this inclusion may be unacceptable for some participants in other countries like the EU, where its taxonomy excludes coal and nuclear as eligible sectors.

Therefore, this lack of standard might lead to complex screening solutions, which makes it expensive for both the issuer and the potential investor. Besides, the issuer might also face additional costs to issue green bonds via administrative requirements.

The difference in policies also comes at a country level: countries display very different green regulations, some of them show almost no legislation, and some of them show a very serious rigidity on the topic (EU).

Two policies form the much broader green policy, the fiscal policy (financial allocation and tax preferences), and the regulatory policy (administrative and legal matters), and both come in very different levels all around the world too. Policy is a crucial tool in implementing the drivers and facing the main issues in the development of the green bond market. Policies should focus on the trade-off between rigorous policymaking that prevents greenwashing (a topic that will be discussed in the next chapter) and the strengthening of the capital market. Many of the policies worldwide lack strategic regulation, creating the risk of short-termism, a big issue for green investments.

Governments showing weaknesses in administration, regulations, monitoring, direction, and uncertainty, along with scarce support in the commercialization of green projects, will hinder the efficiency and development of such markets.

Governments have the authority to create regulations that favor the development of green projects and political uncertainty makes it difficult for issuers and investors alike to strategize and make plans. Political difficulties have a negative impact on the visibility and risk appetite. Additionally, corruption limits investments, creates uncertainty, and increases costs; it represents a big barrier to overcome, and it also limits tax revenues.

Other limiting factors are non-solid and coherent legal basis, and non-strategic goals and objectives, like having a fixed timing about phasing out of fossil fuels, which is needed to bolster investor confidence. A too-strict regulatory environment, and administrative/bureaucratic barriers, result often in complex public spending procedures and length of the authorization process.

Green bonds perceived as complex, with high risks and low returns

This simple product is seen as complex to many issuers given the several criteria to be followed, the overlapping roles of some market players, and the confusing and always-increasing sets of rules, disclosure reporting guidelines, and standards to comply with. The number of stock exchanges, rating agencies, second-party opinions, reviewers, certifiers, and legislators that an issuer has to face is seen as a barrier. Therefore, many issuers feel confused and drained, particularly those who have to face the new framework of the EU and its Green Bond Standard. Green financing is also thought to be high-risk, mainly because it is based on projects. Financial institutions need to ensure that the financing can match the return on investment of each single project. Unfortunately, this characteristic of the green instrument itself (the fact that is linked to an asset), makes it perceived as risky. The perception, therefore, makes financial institutions and investors skeptical about the instrument, making it less desirable.

In addition to that, green instruments are considered as high risk due to the cost of green technologies, creating a "lethal" mix between the long period of time required by most of the projects and the fast pace in the development of such technologies, creating a risk of lower returns.

Besides, these kinds of investments are designed for the medium-long term, so the return takes time, plus they require big preparation and an important amount of capital at the beginning.

The myth of sustainable investments being less profitable with respect to traditional investments isn't often true: MSCI, the global leader in ESG research, displays global data since 2007 in developed and emerging markets and highlights how companies with higher ESG ratings outperform the lower-rated competitors. Furthermore, as the Principle of Sustainable Investing states, the convergence of factors (climate change, social attitudes, institutional governance, innovation) will positively impact the pricing of financial assets, the risk, and the ROI and will lead to a large reallocation of capital over the next decades. Those who are not investing enough in these principles could be unprepared in the next future when dramatic repricing of assets will happen.

Lack of transparency, data, and reporting

The lack of uniformity of principles and different views on ratings on green bonds is another key issue according to Mihálovits and Tapaszti. The researchers suggest that many times the institutions performing the rating and control participate also in the development of the green bond issuance framework, generating a conflict of interest. Verifiers and rating agencies also

pose structural barriers: asset managers fail to access the primary market for green products when verifiers take too long to allocate a rating. This is a big limit for passive investors who use green bond indexes, when there's a misalignment between the six-month review period and the immediate time period of the instruments themselves.

There is no transparency and public data on the performances and returns and there are also concerns over the disparity between ratings, resulting in a reduced credibility and a barrier: the market, therefore, results opaque.

Evaluating a company based on its ESG performance is a new practice and the controls, adopted in the traditional evaluation, don't exist yet. Without standardization and controls in place, data can be unclear and inconsistent. Self-reporting can cause malpractice among companies, the so-called cherry-picking on their ESG data, it means that companies show the data that benefit them the most, hiding some issues or malpractice. And even if companies aren't hiding important information, a lack of standards can make it difficult for investors to interpret in the best way possible a company's ESG performance. Let's point out, however, that big steps forward have been made towards transparency (still partially, because we still do not know the "real" quality of the data): in 2011, only 20% of S&P500 companies published ESG reports, 10 years later, in 2021, the number reached 96%. Companies like MSCI (from which derives one of the most popular indexes) and Sustainalytics, are making steps forward about disclosure transparency and ESG scoring evaluations. The Security and Exchange Commission (SEC) is following the EU Sustainable Finance Disclosure Regulation (SFDR) in order to enhance and standardize ESG disclosures for investors.

Defined standards accepted by the market, in line with the previous paragraph, might be the first big step towards a solution. Along with this, a clear separation of the entities performing credit rating and advisory might become handy.

A second lack of transparency regarding disclosure requirements exists. At the current state-of-art, market investors do not have enough information to price correctly climate change risks. In the meantime, companies do not know what and how they should report to market participants.

Lastly, since green bonds are structured to align with the Green Bond Principles of the ICMA, and the alignment is not mandatory, some companies might channel the proceeds to something not properly green. This practice is called Greenwashing, a term coined by the environmentalist Jay Westerveld in 1986 and is used when the resources collected from the issue of green bonds are spent on projects with negligible or negative effects on the environment. Greenwashing could discourage market participants from investing (Fernandez, 2023). However, this topic will be further deepened in the next chapter.

Lack of a clear quantification of the benefits coming from green instruments and incentives

In the context of green bonds and other similar green financial instruments, the traditional metrics, such as yield, spread, and duration, might not be sufficient. In this new environment other key factors must be included in the count, factors that cannot make lose sight of one goal: the environmental benefits.

Behavioral finance development in the last decades has shown us that investors aren't always economically rational and might prefer an instrument that might have a lower yield to maturity compared to a traditional one. Green projects are characterized for generating multiple co-benefits and positive externalities, plus they are effective in terms of costs and adaptation towards uncertainties associated with climate change. These positive externalities, however, are difficult to interpret as economic gains: it is difficult to quantify the economic impact of an avoided landslide or reduced flood risk. However, an interview made in December 2019 with 11 experts across issuers, investors, and intermediaries, displays 56% of convincing research and evidence towards the financial value added of green bonds, 33% think the contrary, and the remaining 11% do not know.

Studies show some disparity in price differences between green and similar traditional bonds. Some support a negative yield gap for ordinary bonds, and on the secondary market, research offers a wide range of results from no premium to up to -17 bps of premium. The Climate Bonds Initiative (CBI) results show how 72% of green bonds in 2018 achieved a higher subscription and spread compression than their vanilla equivalents after 24 hours, 62% were closer after four weeks. These results are explained because green bonds tend to be less volatile thanks to their orientation towards long-term projects and the relative investors display a stronger propensity to a buy-and-hold strategy and more diversified strategies.

Going back to the topic of investors' preferences, a framework where the volume of reduction or avoidance of harmful substance emission (like how many tons of CO2 emission can be avoided) is a pretty good example of how the quantification can become more uniform, along with the more traditional benchmarks of course. Having a more direct benchmark can increase the demand for green instruments, a lowering of upfront costs in collecting information, and a general, more efficient, allocation of capital.

An example has been reported in Table 3. It is noticeable that two of the climate-related instruments return a fairly high yield (6% in the case of Continental Wind and 5.75% in the case of Topaz Solar Farms, obviously taking into account the long maturity).

To have a sense of the comparison with traditional bond yields, the average 15-year Italian Treasury Bond BBB rated yield floats at 4.18% at May 10, 2024 (TradingEconomics), the 15-

year High-Quality Market (HQM) Corporate Bond Spot Rate floats around at 5.61% the same day (it includes AAA, AA, A companies), or AA+ Market Yield on U.S. Treasury Securities at 20-Year Constant Maturity at 4.70% (FRED).

Topaz Solar Farm is a 550-megawatt photovoltaic power station in California and it's one of the biggest solar farms in the world: the project cost USD 2.5 billion and is made of 9 million modules. It is interesting to report that one of the construction companies is owned by Berkshire Hathaway, Warren Buffet's company (in line with what Chapter I stated regarding Buffet's vision on green instruments and projects).

Table 3. Traditional and environmental metrics (CO2 reduction, decrease projected on face value of 1 million) of seven green bonds.

Name	Coupon	Maturity	Moody's	S&F	CO_2 Study by	CO_2 Offset/ USD million Bond	Method
Continental Wind	6,000%	Feb-33	Baa3	BBB–	Carbon Count	1037	Wind
Sthm. Cal. Public	4,00%	Jul-19	Aa3	AA–	Carbon Count	392	Wind
Solary City Series LMC	1,80%	Dec-26		BBB+	Carbon Count	161	Solar
Topaz Solar Farms	5,75%	Sep-39	Baa2	BBB+	Carbon Count	198	Solar
HASI Sustainable	2,79%	Dec-19			Carbon Count	522	Energy Efficieny
HASI Sustainable	1,28%	Oct-34			Carbon Count	390	Solar/Wind
KfW	0,38%	Jul-19	Aaa	AAA	ZSW	885	Wind/Solar
KfW	1,75%	Oct-19	Aaa	AAA	ZSW	885	Wind/Solar

Source: Mihálovits and Tapaszti (2018).

A second example where a traditional investment indicator, such as the Internal Rate of Return (IRR) is adapted to include social and environmental benefits, can be retrieved from an Indonesian case. The study has been conducted to analyze the economic viability of forest restoration to maintain and improve water yield. When these benefits and avoided costs are accounted for a period of 30 years, the IRR returned a staggering 74.8% compared to the -4.8% of the traditional calculation.

However, this lack of clear returns for investors is perceived more like a social responsibility or a philanthropic act, instead of investments that could generate cash flow. A big mistake companies are making is comparing these investment strategies with short-term alternatives,

which are more popular, require less knowledge, probably get faster (but lower) results, and have been previously implemented.

Even if green investments may seem more costly, it has been proven that their benefits overcome maintenance and implementation costs. For instance, coastal ecosystem restoration has been identified as a 2-5 times cheaper strategy to provide coastal protection from breakwaters or levees.

Let's remember, also, that the issue of green bonds is more expensive than that of conventional ones due to administrative costs, which are another barrier. In addition, consultants, third party accreditation, and "green level certification", play a significant role too. These costs can reach USD 100,000, and escalate when tracking, monitoring, and reporting. A solution to this barrier comes from regulation authorities that could, for example, absorb part of these costs, lowering, therefore, the barriers to entering the green market. Singapore gives us an example, the Singapore Monetary Authority refunds 100% of the costs of issuing up to a total of 100,000 Singapore dollars (around EUR 68000) if the bond meets such criteria: it must be issued in Singapore, quoted there, it has a face value of at least 200 million Singapore dollars (EUR 140 million) and with a minimum maturity of 3 years.

Missing infrastructures, Financial Institutions and Enterprises Incapability

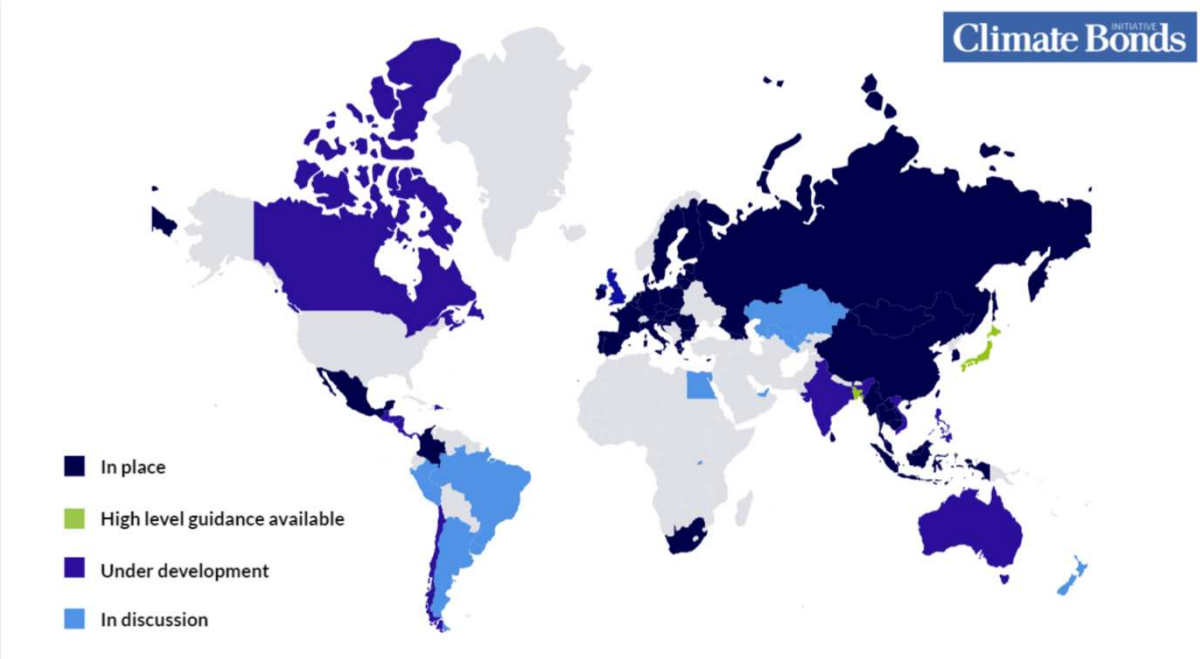
The World Bank in a report has estimated how low and middle-income countries will need investments for around USD 2 trillion per year, or 6%, on average, of their GDP for the period 2015-2030 to meet the infrastructure related sustainable development goals. Unfortunately, with the pandemic and the great instability of these years around the world, the resources left to meet these goals are scarce. The UN states that USD 90 trillion is needed in climate investments by 2030 to achieve sustainability goals.

According to Mustaffa et al. (2021), one of the main barriers to the development of green markets is the weak capability of financial institutions to keep up with the pace of the increasing demand for assets. Green financing is much more technical compared to the conventional side and most financial institutions, like central banks (especially in non-primarily developed economies), fail in being comfortable to work with these assets due to the complexity of structures and operations. Mustaffa's paper cites India as an example and reports that at least five to ten years are needed for the country to adapt to the new landscape.

These financial institutions are still not able to face these operations capabilities due to the lack of human capital that is competent enough to make green financing smooth in the process.

Moreover, institutions fail to correctly process enough information about green financing, they fail to understand the taxonomy regulation (for example the one adopted in the EU), and the terminology, showing a big underdevelopment and missing expertise in this field. Let's recall that the EU taxonomy is a series of sustainable economic activities that will help implement the European Green Deal. The taxonomy sets a common ground and a clear definition for users like companies, investors, and policymakers (Dan, 2021). Figure 4 provides an infographic representation of Taxonomy regulation across the world.

Figure 4. Taxonomy projects across the world



Source: Climate Bonds Initiative

In 2012, the CBI launched its voluntary guidelines in the form of a taxonomy and related Certification scheme. In 2015, the People's Bank of China Green Finance Task Force recommended the adoption of the "Green Bonds Endorsed Project Catalogue". Supported by rigorous regulation, the Chinese green bond market grew rapidly.

In 2016, the EU followed with its Taxonomy after backing the recommendations given by the EU High-level Expert Group on SF. Bank Negara Malaysia, Malaysia's Central Bank, published a taxonomy regulation focused on climate change mitigation and adaptation. Regulations not yet final are underway in Russia, South Africa, and South Korea and are under development in Canada, Chile, Colombia, and the UK. These are some examples of taxonomy regulations around the world, with many more on their way in the following years.

The institutions' incapability has also another negative effect: private users find it difficult to obtain resources to fund the projects for two reasons, one being the capital constraints that banks

are facing to shift money to finance such projects because of central banks' regulations, and the second because of the perception that conventional financing is safer and more rewardable than green financing.

As highlighted by the report on Green Finance published in 2016 by G20 members, the lack of clarity on green activities and products is still an obstacle. This barrier, united with financial problems (like high levels of subsidies for the production and consumption of fossil fuels), poses structural hurdles, and the lack of standardized frameworks leads to a mispricing of the bonds.

Not only, Cheung et al. (2022) in their paper, describe what are the main challenges for Australian companies and institutions in cooperating with the green market. As reported by the authors, the current misalignment between banks' private interests and the development of ESG objectives represents a clear "credit market failure". This statement is backed by the USD 3.8 trillion investments in fossil fuels by sixty of the top private banks since the signing of the Paris Agreement. They also report that correct credit default predictions improve by approximately 7.7% when sustainability criteria are added to conventional credit risk indicators.

Structural barriers have a key role in the development of green financing: many European economies are characterized by high proportions of small and medium enterprises (SMEs). In Italy, for instance, 95% of companies have fewer than 9 employees, and SMEs contribute 66.9% of the total value added in the non-financial economy. The average contribution of SMEs in their respective economies stands at 56.4% in the EU (ICF, 2021). SMEs are highly dependent on bank loans and have low innovative capacity. They have also less capacity to access innovative financing, issue bonds, seek private investment, or apply for state aid and subsidies. In simple terms, SMEs have high financial constraints and financial literacy problems. Moreover, these companies fail to attract institutional investors because of their lack of visibility, credit rating, size, and liquidity constraints. Projects on energy efficiency, waste, and biogas often rely on equity investment in favor of debt as the costs of setting up the project are too high. SMEs are also more pessimistic about the regulatory environment, economic environment, and the availability of internal financing.

What has been just said is reported also in Chien et al. paper of 2021. The researchers state that the absence of technical skills is one of the main barriers to green product creation, putting a big stop to green innovation initiatives of firms. In their study on SMEs in the United Arab Emirates (UAE), they find multiple criticalities in the development of such markets. The other factors hindering green success are technological scarcity in a very dynamic green technological market: enterprises, so as financial institutions, fail to keep up with the astonishing pace.

The impact of climate change on the economy can be enormous: Tragedy of the Horizon, a

Climate Minsky Moment and Green Swan Events find that climate change can increase the probability banking crisis between 26 and 248%, causing a possible fiscal burden in saving the institutions of 5-15% of GDP per year. The effects can be exponentially worse due to a spillover in other institutions, partners, and customers.

2.2 Green barriers in the Italian case

Barriers to Greening Finance tend to be economy-wide, impacting both investors and issuers. One of these hurdles includes Italy's regional divisions in the economy: Lombardy is the business core of the country, it's the fourth largest region in the EU for GDP (2.78% of the total GDP) with 800,000 companies and 40% of firms working in the renewable field located in this region. The gap between regions is considerable, 12% of the population in Lombardy was at risk of poverty in 2019, meanwhile in Sicily and Campania the same risk was over 40%. Southern regions face lower education levels and higher unemployment rates; its companies have a four times higher risk of defaulting with respect to northern counterparts. Meridional firms account for 68.6% of the European Structural and Investment Fund in the country, showing, therefore, a much higher instability and need for resources.

Education, legislation, political uncertainty, and corruption are other important barriers. The predominance of SMEs, as mentioned before, is to be kept in consideration when thinking about the reduced capacity to issue bonds or equity instruments.

As noted by CONSOB (Commissione Nazionale per le Società e la Borsa), the Italian supervision authority on financial markets, SMEs tend to suffer from the so-called "size bias": big companies tend to have more financial capabilities and therefore can allocate more money towards green practices and get higher sustainability ratings (which do not necessarily mean a greener commitment).

EU policies and regulations like the Markets in Financial Instruments Directive (MiFID II) and the SFDR designed to increase transparency, may result in an added burden for such companies and may limit investments. For example, the 2020 European Investment Bank (EIB) survey in Italy shows that labor market regulations are thought to be the leading barrier to investment by market participants.

Access to finance limits Italian investment activity, companies over-rely on loans from banks, which are risk averse and are limited by high non-performing loans (NPLs) ratios on their balance sheets. Thus, the Italian financial system is bank-centric: less than 16% of financial intermediaries are independent of banking groups, only 46% of companies access equity

financing (against 53% of the euro area) and 60% rely on bank lending (against 40% of the euro area).

The 2020 World Bank's Doing Business survey reports a "getting credit" of 45/100, Italy's lowest scoring topic, placing the country at the 58th position out of 190 economies, confirming the difficulty for Italian companies to access credit. The recent COVID pandemic has worsened the situation even further and therefore, the European Commission (EC) recommended in 2020 an effective implementation of liquidity provision schemes and the use of grants and incentives, peculiarly for innovative firms (those who are more strictly related to ESG values).

Banks' misallocation of credit towards traditional sectors and less productive firms poses another big barrier; the lack of risk appetite impacts innovative sectors and the issuance of innovative instruments.

The Organization for Economic Co-operation and Development (OECD) talks about the phenomenon of the so-called "Zombie Companies", underperforming firms that in competitive markets would have gone bankrupt, but that are being held alive because of a resource misallocation by banks. This condition not only stops new entrants from entering the market but also prevents competitive, new firms from accessing capital.

The Italian landscape displays a serious level of financial education, which is another important obstacle because it limits understanding of financing options and exacerbates investors' risk aversion. The Financing Fit for Paris assessment displayed a 2/10 score for consumer education on green finance for Italy and this low financial literacy creates an overly cautious behavior, putting a halt to the willingness to invest in innovation. This illiteracy creates barriers such as information asymmetry, which distorts the perception of risk among stakeholders. Even if retail investors are well aware of sustainable investments (69% of Italians with assets above EUR 50,000 know), only 7% invest in sustainable and responsible instruments.

This issue exists also on the other side of the market: Borsa Italiana (BI), Italy's only Stock market exchange, recognizes a lack of expertise among issuers and is trying, along with the Ministry of Economy and Finance (MEF), to increase the certification industry to boost the number of experts.

Fortunately, not everything is lost, steps forward have been implemented during the last few years. In 2019, the Bank of Italy integrated ESG investments of euro area shares into its EUR 8 billion equity investment portfolio policy and the bank is considering extending the criteria to corporate bond investments. Instruments are excluded if they do not comply with UN Global Compact principles, favoring those with higher ESG ratings. Moreover, the Bank of Italy is a member of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) and plans to disclose the performances of its ESG portfolio.

Cassa Depositi e Prestiti (CDP), the Italian state's investment bank, has a strong focus on sustainability; two-thirds of its portfolio is channeled to the competitive industry and circular economy, and the remaining third is directed to renewables, energy efficiency, and smart networks. The bank finances itself primarily through postal savings and bonds.

Intesa Sanpaolo, Italy's second largest bank after Unicredit, follows the UN principles for Sustainable Banking, issues green bonds, and has a leading position in sustainable investments in the country with a market share of 25%. BPER Banca, the 6th largest Italian bank, follows its Sustainability Goals, including ESG monitoring, a sustainability rating project for 200 issuers, and a goal of increasing its ESG portfolio by 20%.

But probably, the most important effort has been made by BI, with its Green Social and Sustainability Bonds, the exchange has provided issuers and investors with the Green Bond Segment, a platform to ease exchanges of sustainable instruments since 2017. Also, BI is part of the Sustainable Stock Exchanges Initiative, supported by the UN.

The institution has 135 ESG-listed bonds for a total of EUR 162 billion from 37 issuers in 19 currencies. 53% of these bonds can be classified as Green, 9% as Social and 38% as Sustainable. 52% of the bonds were issued by supranationals, 29% by Corporations, 9% by banks, 8% by governments and 2% by insurance companies.

CDP has issued EUR 4.2 billion of ESG bonds and the turnover of these assets has reached EUR 640 million. In 2020, 71 newly listed ESG ETFs on the ETFplus market, summing up to a total of 190 and EUR 12.4 billion of assets under management. Of these ETFs, 72% are in the category of equity, 27% of bonds, and 1% other. The inflows reached a new high in December 2020 of EUR 1 billion and a turnover of EUR 7 billion in the whole year, a 250% increase with respect to 2019.

Since 2014, EUR 24.2 billion of green bonds have been issued in Italy, with the market remaining modest until 2019. After displaying a boom, similar to ETFs, in 2020 the issuance market halted given the global pandemic; things started to change again in March 2021 with the boost given by the EUR 8.5 billion sovereign issuance.

Enel, the largest Italian manufacturer, and distributor of electricity and gas, with the Italian state as major shareholder, has been leading the issuance since 2017. The company has issued EUR 8 billion in green bonds in the period 2017-2021, of which four green loans and seventeen sustainability-linked loans. The capital collected from these bonds has been channeled primarily to new renewable power projects (49%), smart networks and infrastructures (16%), clean mobility (9%), and energy efficiency in industry and building (5% each).

Concluding, Figure 5 summarizes the key barriers identified in this section, with some of the extra aspects not fully described in these previous paragraphs. The figure, collected in ICF's

paper applies a Red, Amber, Green (RAG) methodology to explain each barrier's relevance to each investor group. In the rows are described the main barriers, whereas in the columns we can find the investors. The types are divided into three sub-groups: institutional investors, financial investors (FIs), and foreign direct investors (FDI). Barriers like the predominance of SMEs, lack of policy coherency, and administrative barriers affect almost if not all, types of investors. Amber cells represent the out-of-scope of the proposed solutions made by ICF.

Figure 5. Key barriers to sustainable finance flow in Italy, with RAG rating indicating the main barriers to each investor type.

Barriers	Investor Type							
	Institutional				FIs			
	Asset Managers	Insurance	Pension Funds	Private/ Family Office	Commercial Banks	Banking Foundations	CDP	FDI
Structural								
Predominance of SMEs								
Regional differences								
Verifiers/ rating agency speed								
Political uncertainty								
Policy and Regulatory								
Lack of policy coherency								
Lack of strategic clarity and alignment								
Administrative barriers								
Restrictions to competition								
Capital increase regulation								
EU regulation								
Financial								
Level of NPLs								
Underdeveloped securitisation								
Lack of PPPs								
Misalignment between issuers and investors								
Skills, knowledge and information								
Lack of financial education								
Demographics								
Risk aversion								
Lack of issuer expertise								
Access to information								

Note: Amber cells signify each barrier's relevance to each investor group. Those shaded red are beyond the scope of this project's proposed solutions.

Source. ICF (2021). *Sustainable finance and investments for the transition to a green economy*.

2.3 Possible solutions to knock down these barriers

It is now urgent to act and address the Paris Agreement limits on global warming, no more additional time can be wasted, and much more has to be done to ensure the success of green investments as a way to finance ESG projects.

First of all, the sector could align to develop internationally uniform and recognized standards for the classification of green projects or better integrate the existing standards like the "Green Bond Principle" and the "Climate Bond Initiative", both of them discussed in this chapter. With specific standards, that would consider the peculiar features of each sector, the green instruments certification path could definitely speed up, it would become simpler and cheaper. The green compliance of a particular project can be more exhaustive with the inclusion of more scientific methods, for example with the accountability of favorable impacts on the environment that can be quantified with relative precision. These frameworks could rely on the help of external, independent experts, that can develop a quantitative scale of assessment that shows the environmental scope of projects financed by the instrument. In most green projects, this could be captured in the volume of reduction or avoidance of harmful substance emission, and this tool would easily allow to compare single instruments as well. Integrating the annual level of how many tons of CO2 emission can be avoided for a million-dollar investment can be a plausible example. If the environmental impact of the project is presented to the investor as a decision factor, there would be higher transparency, thus a probably higher demand for green investment products, more efficient investments, and lower financing costs. Incorporating the green use of proceeds and/or reporting provisions into terms and conditions of the bonds could be supportive too to make a reasonable decision for investors.

High standards must be adopted for disclosure regulation and reporting, and policymakers must facilitate how issuers disclose and report information on their streams of revenue of green activities and assets, and the use of proceeds of all green bonds issued. Legislators should accompany institutional investors and asset managers who distribute sustainable instruments, explaining if and how they align with green classifications and guidelines and how they should disclose the related instruments. The EU taxonomy represents an important tool to reach the goals of large diffusion and the TEG's document of the Union skims away some of the risks borne by issuers and investors.

Henceforth, reporting should be standardized, and issuers must reinforce the measurement of the environmental impact of green bonds. Introducing a less tolerant and mandatory reporting regulation to small-medium firms and/or small size bonds would encourage them to integrate

climate change and mitigation schemes into their business models and to adapt their strategies. Costs would eventually drop if all companies would follow the same level of transparency.
To sum up, switching abstract benefits with more tangible results could help investors towards more efficient investments.
Secondly, governments and supranational entities need to step up in order to bolster issuers' and investors' confidence. More economic benefits are needed for issuers of green instruments that generate long-term social and natural positive externalities. Tax benefits would be a strong support, together with subsidies for the costs of obtaining the green label. On the other hand, incentives for investors, like exemption from taxes on interests, could be an excellent idea too. Some stand against tax incentivization since some bonds, labeled as green, do not have any actionable contractual ensuring right that the proceeds will be channeled towards the announced project. Thus, taxpayers may risk ending up subsidizing a simple vanilla bond. According to Doran and Tanner, the argument is easily superable by providing such incentives only to those with clear actionable legal terms or, for example, to those instruments that at maturity clearly can give evidence of the real proceeds. This would have a win-win effect in bolstering the green bond market and supporting public objectives in line with the Paris Agreement.
Governments and financial institutions could also solve the perception of green instruments being as high risk by developing Green Credit Guarantee Schemes. These schemes would provide a government guarantee to help investors or borrowers cover their debt obligation in case of default. The scheme could also operate for a de-risking operation, meaning that a portion of the risk is transferred to another party.
Going forward with the issues, let's recall the Mexican airport case, a possible solution to a case like that, which hinders investors' confidence, is to develop a framework that would make the payment of a penalty obligatory. For example, after the green bond's default, the issuer could be obliged to repurchase the product, making him rethink more of its actions (also because repurchasing a vast amount of issued instrument could threaten its solvency).
A less stringent solution, which could help in not "scaring" the companies into entering the market, could be making the issuing companies just lose their tax benefits.
The research discussed about the issue of green bonds being more expensive than the traditional ones because of administration costs, consultant costs, external accreditation, and services. The financial authority could absorb some of these expenses, therefore decreasing the barriers to entry into the green bond market.
Informing market participants is key for an efficient market and at the current state-of-art, investors do not have enough information for pricing correctly climate change related risks. In the meantime, issuers don't know what and how they should report on such instruments. Being

a relatively new market for most, financial institutions are suggested to run more publicity to raise awareness among the industry. Banks could operate by providing additional awareness campaigns and marketing commercials.

Governments, both central and local, need to support sustainable finance education across the public and private sectors so that it becomes mainstream on a day-to-day basis in management and financial practices. Improving financial literacy will allow the general public and retail investors to boost informed investment decisions, with the additional support of advisors if needed. To achieve this goal, decision makers should engage with sectoral associations to connect financial institutions to companies, especially SMEs, and aim at compulsory sustainable finance training and qualifications and investing in insurance advisors and public servants managing public programs. Recalling the Italian case, in Italy this would make a considerable difference given the fact that the country shows one of the lowest numbers in financial literacy and presents an underinsured market.

Ultimately, investments should be facilitated in emerging economies: in most emerging markets, where green instruments are less popular, guarantees and de-risking measures need to be put in place to sustain the expansion of the market. As it has been discussed, the key barrier in such economies is the lack of appropriate institutional capability in terms of knowledge and in terms of infrastructure, resulting in no or small size issuance and high transaction costs. Steps forward have been made by the Amundi Planet Emerging Green One (EGO) fund in collaboration with the International Finance Corporation (IFC); they are offering some solutions by capturing emerging market debt premium while reducing the risk with a first-loss buffer and high portfolio diversification. A first-loss buffer is a financial mechanism used to reduce the risk for senior investors. It acts as a layer against initial losses, the buffer absorbs the underlying asset losses up to a certain threshold. The presence of a first-loss buffer enhances the credit quality of the senior tranches, making them more attractive to risk-averse investors.

This kind of green bond fund, which targets non-financial issuers in emerging markets, shows the potential of this instrument.

Haro et al. (2019) presented some solutions in their paperwork on the Inter-American Development Bank (IDB) and one of them was to use covered bonds to support investors on the claim of the issuer. A covered bond is a collateralized debt instrument against a pool of a covered class of assets in case of default. It provides the investor with recourse against the issuer and the collateral (called also additional cover or dual recourse). Unlike an asset-backed security, in the covered bond, both the debt and the underlying asset remain on the issuer's balance, therefore, the risk isn't transferred from the issuer to the investor. This dual structure makes these bonds less risky and allows for superior credit ratings. Lower risks mean lower

risk premiums, which can fit perfectly for some kind of investment strategies (it allows some institutions, which wouldn't be allowed because of capital requirements, to invest in these instruments).

Moreover, the authors suggest that this kind of bond can help build smaller underlying assets and develop pipelines of small-scale projects that are usually found in sectors such as agriculture, SME energy efficiency, and housing. Covered bonds are also required to follow specific regulations and laws to protect bondholders: some of these regulations include authorized issuing institutions, eligibility of assets, reporting, and disclosure. One of the obligations of the issuer is to replace any NPL or pre-paid debt in the pool, allowing the legal framework basically to have as the primary function the safeguard of investors from potential credit events. The regulations shall govern that the enforceability of the contract regarding a credit event is not questioned by any court, and similarly, no court may question the segregation of the collateral asset pool. An increase in green financing of banks and investors has already started thanks to the boost in covered bonds activity, as mentioned by the S&P too: "The emergence of green covered bonds highlights the growing prominence of green finance in the traditional area of covered bonds and offers an alternative mechanism for banks to contribute to financing global climate commitments."

By implementing these strategies, the market of green instruments, and especially of green bonds, can be strengthened, leading to increased issuance and investments in sustainable projects that contribute to environmental and social goals.

2.4 Sum-up

Green bonds are those issued to finance environmentally sustainable projects and hence can play an important role in global climate change efforts. Despite promising to be of great help, green bonds face several problems that limit their wide use. This research presents the advantages of green bonds, the problems they face, and some potential solutions to facilitate their issuance.

There are so many benefits to green bonds. For the issuers, for example, these include alignment with the long-term maturity of those projects, which results in reduced financial expenses and improved environmental and financial performance. Investors love this because it usually has lower volatility compared to a traditional finance instrument and becomes perfect for portfolio diversification. Policymakers also like green bonds because it is a critical tool that channels a lot of funding to sustainable projects that are geared toward achieving global climate goals.

There are significant challenges that the green bond market faces, however. The lack of standardized reporting metrics and transparency is a major issue, it reduces investor confidence and raises the risk of greenwashing, creating a situation where the money is not used, as stated, for environmental projects. Inconsistent reporting and vague definitions of green bonds make it difficult for investors to actually verify the true environmental impact of investments.

Another critical aspect is the high cost and technical barriers related to the issuance of green bonds. Such a process is costly compared to traditional bonds because of the administrative requirements involved, external accreditation, and consultancy fees. Technical complications in the matter of green financing make the instruments even more unattractive for full market participation by financial institutions.

What drives such obstacles varies from one part of the world to another. For example, regional economic imbalances make the pace of uptake of green finance very different across Italy, with the more economically advanced northern regions, such as Lombardy, way ahead of the less developed south. Even regulations like, for instance, MiFID II and the SFDR, that offer greater transparency, introduce new burdens that can scare investors away from the market.

Perceived complexity and risk are also impediments to the adoption of green bonds. They are perceived as complex and risk-intensive investments due to strict green certification criteria, the involvement of multiple market players, and dynamically changing rules.

The long-term nature of the green project coupled with rapid technological changes is another reason investors are kept in the dark regarding returns, which fronts green bonds as unattractive investments.

In addition, the market of green bonds is still in the development phase, and the supply currently is very inadequate to meet investors' demand. As a result, it has developed into the "chicken and egg" problem, where a lack of supply of green bonds deters investments, leading to a slow growth in new green projects.

These issues, however, can be overcome by certain steps that shall facilitate the issuance of green bonds. Standardized frameworks need to go a long way to ensure transparency and investor confidence.

Clearly defined and properly documented guidelines on reporting, certification, and use of proceeds will reduce risks that may arise from greenwashing and can ease the assessment of actual environmental impact for an investor. The standardization process can reduce costs and complexity, allowing more issuers into the green bond market.

Looking ahead, concerted efforts towards harmonization of regulatory frameworks across regions can offer a more harmonized set of parameters for the issuance of Green Bonds on a cross-border basis, thereby improving investments and liquidity in the market.

Educational initiatives by issuers and investors may well demystify green bonds and bring their benefits to light. Improved understanding and awareness can help alter perceptions of green bonds from those of riskier, opaque instruments to those of feasible, desirable investment opportunities.

Subsidies, tax incentives, and public-private partnerships can promote green projects, thus increasing the supply of green assets, which in the early stages result in scarcity, constraining the growth of the market for green bonds.

Some challenges can be solved by concerted efforts and strategic interventions that can ensure the achievement of the full potential for green bonds, the most important instrument for financing the transition to a sustainable, low-carbon economy.

Chapter III: Risks in Green Finance

The research, in the previous chapters, faced the increasing awareness about human activities on the environment and how investors are searching for instruments marketed as environmentally friendly. With an uprising demand for such products, companies responded by incorporating green market strategies into advertising campaigns to push their new eco-friendly products. However, some companies have been discovered to be engaging in the so-called “greenwashing”, a term coined in the 1980s. This practice consists of misleading consumers and investors about the environmental benefits of a given product or instrument. The problem, as we will find out, is that dark-green companies are also misbehaving (Lagoarde-Ségot, 2023). The International Organization of Securities Commission's 2021 "Asset Management Report" describes greenwashing as "the practice of misrepresenting sustainability-related practices or the sustainability-related features of investment products".

Greenwashing leads investors to make uninformed financial decisions, believing that they are making environmentally responsible choices when they are not. Greenwashing can also lead to mistrust of future companies’ environmental commitments. Typically, firms use strategies to deceive investors and consumers by using vague language, such as eco-friendly, green, and natural, or by making misleading claims without providing concrete evidence or certification to support these claims. They also engage in selective disclosure (or “cherry-picking”). The tactics and techniques that are used are different and sometimes sophisticated, making it difficult for consumers and investors to understand if the efforts are real. Another technique is using irrelevant, catchy claims or false labels to impress the public.

A survey of 1,300 advertisements across Italian print media revealed that 84% of companies were found to be potentially greenwashing according to ISO 14001 standards. The number of brands that sought to build up an image based on environmental sustainability increased by 33% in one year. The words that were related to greenwashing were the terms "environment" which was on the rise by twenty-one percent from 2018, "plastic" was up 73%, "recycling" was up 66%, and the word "planet" was up 80% (Forum per la Finanza Sostenibile, 2022).

As opposed to greenwashing, another concept that exists is referred to as “green-blushing” where companies refrain from exaggerating their efforts and provide little or no information regarding the sustainability of their products, actions, or claims. Most green-blushers do not care about marketing their products concerning ESG issues. Organizations adopting this attitude mostly avoid explaining their sustainability strategies and records in detail, even to their staff, but rather prefer vague statements. They also tend to think that investors, for instance, suppliers

or customers, care little about sustainability and do not expect them to concern themselves with ESG issues.

According to Galletta (2024), many banks have been found to engage in greenwashing: they would claim to be environmentally responsible whilst continuing to fund damaging projects.

Unfortunately, such a practice undermines the credibility of the green market and hinders the transition to a low-carbon emission economy. If investors lose faith in the claims made by the companies, they may become reluctant to invest in sustainable instruments.

The relationship between technological innovations and green finance is crucial: digital finance solutions can increase transparency and consumer protection, stopping greenwashing practices.

Eventually, greenwashing can lead to an inefficient allocation of resources because money is shifted away from projects that could make a real difference for the environment (Dempere et al., 2024).

In this chapter, we'll go through a series of greenwashing activities related mainly to the financial industry and some solutions to address this issue.

3.1 Greenwashing cases

Lagoarde-Ségot (2023) states that there is increasing evidence of generalized greenwashing practices in the financial system. He reports that nearly half of dark-green funds, so those who should be channeling all their money towards sustainable investments, invest in fossil or aviation-related assets and that 0.5% of global assets under management align with the Paris Agreement. Another example comes from JP Morgan Chase (JPMC), one of the leading investment banks worldwide. In 2023, the Rainforest Action Network (RAN) reported that the bank was the largest financier of fossil fuels in the world whilst claiming to be a leader in sustainable finance. JPMC has provided over USD 434 billion in financing to fossil fuel companies since the Paris Agreement in 2016 (RAN, 2023), obviously going against its public claims on commitment to support climate change mitigation. Along with JPMC, Citibank and Bank of America have been criticized too for promoting green investment opportunities while lending big amounts of money to polluting industries.

It seems clear how top corporate executives of the financial landscape consider ESG ratings as another causal variable, or as an opportunity, in their goal for short-term financial gains rather than a way to contrast the social and ecological crisis.

In the same way, sustainable finance policies lead to an extension of financial markets via commodification and financialization of the environment rather than accumulating capital for eco-friendly purposes.

There has been an increase in greenwashing accusations against several large corporations across the EU. After the oil and gas sector, the one that has taken second place in terms of greenwashing is the financial sector, which is even higher than the food and beverage sector (Baker McKenzie, 2024).

Research findings indicate that the topic of greenwashing has gained significant attention, with an increased number of studies in recent years, particularly from 2020, with 2021 being the peak year with six publications. Results of Galletta's paper (2023) show, for example, the contrast that is happening inside financial institutions. From one side, banks have emphasized sustainable policies and their efforts on environmental objectives, pushed by the pressure made by business groups, regulators, and legislators, especially in developed nations, to meet ESG targets. Moreover, they are trying to show to the outside the commitment towards sustainable finance. But on the other hand, they've been discovered to still be financing damaging projects with the money collected from their investors.

Dempere (2024) tries to scrutinize the consequences of greenwashing by giving an overall look at the damages made to the environment by the false claims and how they can hinder efforts toward green practices, as highlighted by Goal 12 of the United Nations SDGs.

This phenomenon raised attention because corporate social responsibility (CSR) has gained importance in both the business and academic world.

Most banks claim that CSR has a positive effect on the communities where they are acting and on their brand image, so it's seen as a win-win scenario. Banks also state that social and environmental reporting has enhanced profitability, especially in the long run.

Outside the financial sphere, real-life examples are common. For instance, Volkswagen, the famous automobile colossus, admitted to have cheated on emissions of the vehicles. The scandal happened when the Germans were pushing in their marketing campaign with their sustainable statements. Therefore, Volkswagen had to pay billions of dollars in fines and lawsuits.

Other examples of this phenomenon come from fashion brands like H&M, Zara, and Uniqlo. In the same way, the former British Petroleum (BP), rebranded as Beyond Petroleum, added solar panels to its gas stations. What is curious is that the company spends more than 95% of its annual budget on gas and oil. Royal Dutch Shell has faced similar critics because of the claims of their commitment to global net-zero programs while continuing to explore oil and gas opportunities and investing just 1% of the budget on renewable energy.

Thus, active contrast to greenwashing could be beneficial to banks; they may be seen as more appealing to investors and customers, potentially bringing in more profits and market shares.

But, if investors start perceiving deceptive claims from the institution, the risk is that they might flee and disengage from the firm.

In the food & beverage sector, Nestlé announced in 2019 that it would switch to 100% recyclable or reusable packaging by 2025. However, the company never stated clear targets and, together with Coca-Cola and PepsiCo, was named the world's top plastic polluter.

To support the green transition that banks are required to, they must prioritize sustainability, and transparency, and guarantee alignment with their claims.

Bank greenwashing unravels common patterns and practices among these institutions. The presence of such deceptive activity creates a need for stricter and more robust regulation, oversight, and guidelines. About that, Deschryver and De Mariz (2020) argue that green bonds can potentially channel capital toward eco-friendly projects while reducing the risk of greenwashing with a proper specific reference framework but are also one of the simplest ways for firms to engage in greenwashing.

What Galletta's (2023) report points out is there seems to be a correlation between subsidy shocks and greenwashing strategies. The study has been conducted in China over the period 2011-2021. Findings show that when subsidies are set to expire, there is a higher chance for companies to engage in greenwashing practices compared to those whose subsidies still have a longer lifespan.

The Jirau Dam construction project on the Madeira River, in the Brazilian Amazon, is regarded as a prime case of greenwashing, particularly for the context in which it is found: the industry of massive hydropower development. Concerning Brazil's commitment to renewable energy and her hydro resources, the dam was focused on providing clean energy to mitigate carbon emissions. Hydropower energy is often defined as a form of renewable energy, which helps boot the environmental credentials of this project and gained its remarkable support.

Skeptical viewpoints and advocacy groups with issues against the project, however, have drawn serious allegations of greenwashing against the Jirau Dam project. First, since its so-called "green" purpose, the dam has rectified the environmental destruction, such as forest loss, loss of flora and fauna, and alteration of aquatic living organisms' habitat.

Dams have also received criticism over the methane emissions associated with their use. While hydropower is often referred to as low-carbon energy source, in-the-jungle dams like Jirau met develop fairly a bit of methane gas which is a dangerous gas. This is because of organic matter rotting beneath the water. This detracts from the credibility of the claims made by the project to cut down carbon emissions and questions the green credentials of the venture. Not only that, but the story also embeds a serious case of corruption in the Brazilian administration. In March 2007, the Brazilian environmental agency Ibama rejected the application for the licensing of

two dams due to weaknesses in their environmental impact assessments. In this respect, President Lula Da Silva rebuked Ibama after possessing it into living and appointed its new head the same leader who had previously signed the licenses. Under this leadership, however, licenses were issued for the construction of the Santo Antonio dam in 2008 and the Jirau dam in 2009, even when there were protests.

Considering that Emílio Odebrecht, head of Brazil's largest construction company, claimed he was present at a meeting with President Lula in 2008 on the issue, it is clear the President was involved in the strategy. Lula was said to have assured that something would be done before he left the office. It was claimed as well that in 2010, a sum of R$1 million (which was about €500,000 back then) was allegedly funneled to Rousseff's campaign by Jirau through the issuance of Green Bonds by previously known GDF Suez (Cauchois, 2024).

In addition, various companies participating in the project GDF Suez, a French utility company (now Engie), correspondingly promoted the dam as a model project aimed at pursuing their sustainability targets. However, such claims are looked at as a way of window-dressing their activities for the purposes to enhance their environmental sustainability when in fact the project was ecologically and socially destructive.

In addition, the local communities, as well as the indigenous people who settled around the dam, were also put out of their homes, resulting in changes in their earnings and lifestyle practices. Considering these remarkable social consequences, however, the framing of the project as being environmentally and socially clean persisted.

3.2 Contrast to Greenwashing

3.2.1 Policies and Recommendations

Regulatory bodies have a significant role in preventing greenwashing as an established standard for companies. They need to sustain the promotion of transparency and act when companies are accountable for wrong practices. The first measure should be, once again, the establishment of clear and stringent standards for environmental claims. Such standards must provide a benchmark against companies' green practices and claims, making it way more difficult to make false or unclear statements. The EU Taxonomy regulation, again, is the first clear attempt to create a strong regulation and, therefore, to prevent greenwashing in the finance industry. The taxonomy fixes performance thresholds for activities to qualify as environmentally sustainable. Just a reminder of what's been explained in more detail in the previous chapters.

Regulatory bodies should also be imposing penalties for such misconduct; accountability must include fines, sanctions, and legal response. In the EU, for example, policies against greenwashing are regulated by the Unfair Commercial Practices Directive (UCPD), which disallows misleading and aggressive commercial practices. The UCPD acts in strict connection with Taxonomy regulation.

The Spanish Fundación Ecología y Desarrollo, or ECODES (Ecology and Development Foundation), offers a climate change assessment model to enable banks, fund managers, investment advisers, insurance companies, and managers of the public sector in charge of economic planning and development to correctly assess risks and opportunities of credits and portfolios.

In 2021, the Danish Ombudsman, who is a law graduate and is elected by the Danish Parliament, the Folketing, and investigates complaints about the public administration (Folketingets Ombudsmand), published a handbook designed to aid businesses in conveying their environmentally-friendly targets and accomplishments effectively and in a manner which would be understood with ease by consumers. The report specifies that only the Life Cycle Assessment (LCA) of products can yield data that supports any strong and credible sustainability claims.

In the US, the Federal Trade Commission (FTC) first started to fight greenwashing with its first guidelines in 1992, updating them in 2012. Unfortunately, these green guides aren't legally binding. However, the FTC can act against companies that engage in deceptive practices, greenwashing included.

In the last ten years, self-regulatory efforts seeking to create voluntary market norms within the green finance sector have increased. Such efforts can be identified in three broad categories: sustainable and responsible business activities, efforts connected with disclosure, and sustainable investing initiatives targeting disclosures, behavior of companies and metrics (Rizzello, 2022).

In terms of sustainable business practices, the best known and widely practiced is the UN Global Compact, which is a framework for businesses that seek to meet their responsibilities of sustainability and responsible conduct. Among the investment frameworks available, the Principles for Responsible Investment (PRI) is the most widely adopted by investors intending to factor Environmental, Social, and Governance (ESG) issues in their investment decisions. Nevertheless, developing a one-size-fits-all standard on green investment continues to be an uphill task due to contextual disparities, which is expected since different countries have different economic and geographical conditions.

Regarding environmental performance, investment in the green finance market has necessitated the integrity of measurement and presentation of climate-related risks. Over the years, the demand for sustainable development reporting has gone up, as has the demand for more complex accounting and reporting standards consistent with the cause. This has raised issues of the trustworthiness of the said information. Therefore, in addressing the challenges posed by greenwashing, the adoption of existing disclosure frameworks such as, but not limited to, the Sustainability Accounting Standards Board (SASB), the Task Force on Climate-Related Financial Disclosures (TCFD), the Global Reporting Initiative (GRI), and the World Business Council for Sustainable Development (WBCSD) is highly recommended.

Standardized reporting has seemed to ease some of these worries; however, the pull to create a standard that cuts across proves futile because of the local differences in the global green economy ambitions and dynamics.

Moreover, other pivotal players in fighting greenwashing are institutions and non-governmental organizations (NGOs). Their help can come in the form of education, research, and development of standards and certifications. For instance, the International Organization for Standardization (ISO) has developed standards like the ISO 14020 that create environmental labels and guidelines.

NGOs, alternatively, provide more action, they typically raise awareness about greenwashing and ask for more stringent regulation. For instance, Greenpeace has exposed cases of greenwashing and has been pushing to increase transparency among companies.

Rainforest Action Network (RAN), another NGO, has exposed institutions of the financial sector engaging in this practice. They periodically analyze the situation on greenwashing in the industry, and in their 2023 article, they report how, as mentioned before, JP Morgan Chase financed more than USD 400 billion to the fossil fuel sector since the Paris Agreement of 2016. Additionally, JPMC is one of the biggest financiers of fossil fuel expansion. Instead of pushing for a complete transition to renewable energy investments, they came up with an “energy mix target”, a combination of zero-emission investments with very polluting investments. According to RAN, these new metrics will make it impossible to track correctly the year-to-year progress.

One of JPMC’s clients, Callon Petroleum, was fined USD 1.3 million in July 2023 by the US Environmental Protection Agency (EPA) for emitting the equivalent of methane to power more than 7,000 homes for one year. Since 2016, JPMC has provided Callon with almost USD 4 billion.

Moreover, the bank is supporting methane liquefaction facilities in the US Gulf and is the only bank to participate in the Final Investment Decision for the Rio Grande LNG project in Brownsville, Texas, where local and Indigenous communities are being pushed away.

Another way of verifying the environmental claims of a company is to get help from independent, third-party certifications and eco-labels. One of the most important benefits of third-party certifications and eco-labels is that they can reduce the information asymmetry between companies and consumers or investors. These organizations can provide reliable and easy-to-access information about a firm's environmental activity. Thus, investors can make more informed decisions and discourage companies from greenwashing.

Baldi and Pandimiglio (2022) make recommendations for investors, rating agencies, and policymakers to address the risk of greenwashing. They recommend to investors who want to minimize the exposure to greenwashing to underwrite public sector Green Bonds (GBs) issued by the local governments and corporate GBs issued by firms in the services sector. By doing so, investors are incentivized to acquire public GBs since the project underneath might have a beneficial impact on the target territory and community. Moreover, investors should buy only bonds with an ESG rating; this reduces the information asymmetry between the issuer and the investor.

On the other hand, rating agencies should improve their ESG rating models to be able to better detect and quantify the greenwashing risk embedded in GBs issued by States, Supranational entities, and GBs issued by firms.

At last, they, as the other authors, sustain that policymakers should increase the care and efforts to detect greenwashing practices and enforce new regulations.

3.2.2 Modern technologies to contrast greenwashing

To fully comprehend if a company is engaging in greenwashing, an assessment on sustainability reporting is due. The technological advance in the field of Artificial Intelligence is helping to analyze more rapidly and more accurately large volumes of data, like those contained in sustainability reports. Along with AI, Machine Learning (ML) helps regulators and certifiers to analyze firms' sustainability reporting disclosures, measure the readability of such documents, and corporate alignments with the UN SDGs. To give a brief explanation of what ML is, it uses algorithms to recognize patterns, make decisions, and imitate human manners in learning and solving problems.

Research on this topic has spiked recently, and, for example, Vergara and Agudo (2021) highlight two fintech initiatives for the detection of greenwashing and bring suggestions to

improve the discernment of the activity and similar malpractices. The term fintech applies to the improvement, development, and automation of financial services through modern technology and digital innovations. It uses certain programs and applications to assist organizations, investors, and individuals in controlling their finances. Fintech customers are usually provided with pleasant, effective, clear, self-service products and services. More precisely, fintech's new features nevertheless encompass all new technologies, applications, processes economics, for the creation and distribution of financial services, many of which are completely online. Such services generally include several independent entities working together, provided that at least one of such entities would typically be a separately licensed bank or insurance company, among others. Such provided services include the provision of concerns such as robo-advisory for the management of investments, credit assessment, trading of financial assets, cryptocurrencies, e-transfers, payment gateways, creative funding, P2P systems, and mobile wallets.

Fintech brings about some of the following benefits to users. It empowers users with more control over their finances, allows decisions to be made quickly, and allows for payments to be made almost instantly. Anyway, all these quick and easy processes have a price, as they may compromise data security. Due to the existing situation in the financial market, the greatest concern is removing any barriers to growth while safeguarding consumers and investors.

Thanks to the introduction of this new technology, any business transactions can be carried out from the comfort of one's location at any point in time with minimal restrictions to any of the parties concerned. Firms adopting fintech have come up with advanced mechanisms of reaching out to clients and investors beyond physical branches through mobile applications containing banking services, thereby offering more dynamic and effective services while cutting down on time and money spent through physical visits. Doing this makes financial services more reachable, cheaper, and quicker, which is a revolutionary way of delivering conventional services and a catalyst for the evolution of the financial sector into the digital age.

Deeper research about green investments and the environment surrounding such topics is key to understanding a never-ending increasing evolution and attention. For example, 66% of global consumers (73% if we talk about millennials) are willing to pay more for eco-friendly products, and investors are increasingly willing to include in their financial investment decisions not only traditional criteria but also non-financial attributes like environmental impact.

AI and big data analytics are used to collect and process information on companies and their behavior. RepRisk uses AI and its analysts to transform, in twenty languages, big data into research and metrics, returning information about the ESG activity of listed and non-listed firms. Sustainalytics uses big data and AI to push to include ESG parameters to make more

informed investment decisions. Your SRI uses financial and ESG data to automatically assess a fund's ESG score and its carbon footprint. Other similar examples come from APG and Ecochain; the latter, for example, creates digital carbon certificates using the life cycle of companies and their footprint.

An interesting example comes from Clarity AI, a Fintech company founded in 2017. The platform considers itself a "societal impact rating agency and tech company offering a software solution for investors to optimize the societal and environmental impact of their investment portfolios". Through this digital platform, investors can manage the social impact of their portfolios thanks to the platform usage of big data and machine learning technologies evaluating the sustainability and environmental impact of more than 30,000 companies and 198 countries, 187 local governments, and more than 200,000, on 1,000 indicators.

Clarity AI focuses on quantifying the success and integration of women in technology within organizations. Investors also face difficulties when trying to measure the effect their investments have made due to the unavailability of quality information, leaving one with unclear and labor-intensive and expensive conclusions.

3.3 Sum-up

This chapter focuses on the benefits of green finance but also highlights the major risks posed by greenwashing. It demonstrates that even with the growing knowledge about the effects of business on the environment and a rise in the production of investment products that are green, ethical, and sustainable, firms continue using falsified information in their operations to seem greener than they are. There is no faith in green finance when it comes to greenwashing, that is, the practice of making false or exaggerated claims about the environmental attributes of products, services, and investments. It is often exacerbated by vague or unsubstantiated statements, partial reporting, and misleading badges. A survey conducted in Italy in 2022 showed a considerable amount of the advertisements published in the Italian media included elements of greenwashing.

A classic example is the case of JP Morgan Chase (JPMC), which has described itself as a champion of sustainable finance, meanwhile, it has been the biggest backer of fossil fuel investments, having spent USD 434 billion on such activities since 2016. Other large institutions such as Citibank and Bank of America have also been accused of doing the same. This trend has progressed to include industries other than just financial ones: corporations such as Volkswagen, H&M, Zara and BP have been accused of false advertising regarding environmental policy as well.

The chapter recognizes “green-blushing,” when businesses tend to understate, overlook or downplay achievements related to sustainability, further expanding the reader’s understanding of inappropriate green behavior. Greenwashing and green-blushing are detrimental not only to decreasing the companies’ standing with the stakeholders but also to the attempts to construct low-carbon economy as they shift investments from truly green initiatives.

To mitigate these risks, there is a need for more regulations and more transparency. But, due to the advent of new technological innovations such as artificial intelligence (AI) and machine learning (ML), they are becoming key procedures in enhancing transparency and combating greenwashing. AI can look through and make sense of large volumes of sustainability-related data while fintech solutions would facilitate the creation of infrastructure to effectively curb greenwashing. In the end, this chapter explains that to address the issues of greenwashing and people’s confidence in green finance cleansing, there is a need for strict rules, independent third parties, and advanced technologies.

Chapter IV: Do Green Stocks Outperform Traditional Stocks?

Over the years, many researchers have been trying to answer the question of whether green instruments provide better returns for investors. When analyzing this kind of phenomenon, a broad scope of variables is needed. For example, one factor to take into consideration is how a company's financial position may be affected by a possible change in climate regulation and the perception that the public has on the issue. Companies may be more or less exposed to possible changes in the environment, think of a company that sells ski or snowboarding equipment, what happens if, in ten or twenty years, the weather changes and, in many places, it becomes impossible to practice winter sports?

Companies may become less profitable due to changes in climate-change policies, like an increase in carbon taxes might reduce their profitability, or climate regulations that promote decarbonization might drastically reduce the value of the assets. Investors, therefore, might start requiring a higher premium for the risk they are facing, making the situation even heavier for brown companies due to an increase in the cost of capital (Bauer et al., 2022).

On the other hand, green firms' instruments display higher alphas, or excess returns, which is the ability to beat the market and reduce riskiness. In this way, the BNP Paribas report of 2019 shows how ESG investing has a dual appeal in financial gain and social mission, which can be summarized as "doing well by doing good."

Theoretical models have tried to explain for years the factors affecting green and brown stock's performance; the empirical field has made slow progress, returning contradictory results, sometimes showing that green stocks have lower returns, confirming the existence of a carbon premium. This is because, theoretically, brown stocks, which are more exposed to climate risks, should carry a larger risk premium and, therefore, have larger expected returns. Based on a model created by Pastor, Stambaugh, and Taylor in 2021, predictions suggest that, indeed, green assets have lower expected returns than brown because investors have green tastes and because greener assets better hedge climate risks.

By contrast, several studies have documented substantially positive returns for portfolios that go long in green stocks and short in brown stocks. For example, Ardia et al. (2022) and Pastor et al. (2022) provide support for the view that a rise in climate concerns has led to higher realized green stock returns.

But why has the literature returned such opposed results? The response lies in three different factors. First, the greenness of firms can be measured in different ways: some consider the levels of CO2 emissions, others the emission intensity, or the growth rate of emissions or build scores. Second, there's a problem with the time periods taken into account, some use a time period

from 2005 to 2017, others use the 2012-2020 period, and the data are collected mostly by US publicly-traded firms. And last, the main issue is the methodology used by the different authors. Some use regression analysis, and others manage portfolio sorts and their returns using standard asset pricing methods.

This chapter will review the contributions to the literature regarding the performances of green stocks with respect to the brown counterparts. The contributions that will be analyzed are provided by Bauer et al. (2022), Pastor et al. (2022), and Ardia et al. (2022) and all three are related to the performances of green stocks in the last decade over brown stocks, especially in the developed economies, the factors of such phenomenon, with a particular focus on the news about climate change and their role in driving the demand for green stocks. This last chapter will try to blend the three publications together and provide a summarized point of view of the topics covered in them. The analysis will start reviewing the contribution of Bauer et al. (2022).

4.1 Data collection and methodology

Firm-level accounting, equity return, and carbon emissions are collected from Refinitiv: the first is collected from Refinitiv's Worldscope database, the second is collected from Datastream, and the carbon emissions are from the Asset4/ESG database.

Bauer et al. (2022) document the performance over time of portfolios of firms based on emission data and an 18-month publication lag. The study begins from the US and then estimates green and brown portfolio returns for all G7 countries, which are the United States, Canada, France, Germany, Italy, Japan, and the United Kingdom. The choice of choosing these countries is made because they have the best coverage on emissions.

The data is then compared with those of the other cited papers, along with the different methodologies (they will be mentioned again).

The greenness is measured using reported scope 1 and scope 2 CO_2 emissions and emission intensities (ratio of the level of emissions and total revenues in the same year) to avoid possible contaminations by third-party scores. Scope 1 covers emissions from sources that an organization owns or controls directly, for example, from burning fuel in our fleet of vehicles (National Grid). Scope 2 refers to the emissions that a company causes indirectly and come from where the energy it purchases and uses is produced. Therefore, the analysis considers only companies with actually disclosed emissions, and even if it reduces the sample, this choice boosts the reliability of the emissions data.

Table 4. Summary statistics for the G7 countries. January 2010-December 2021

	Mean	Median	25th	75th	Obs.
Scope 1	2,921,550	66,653	9,008	526,035	12,674
Scope 2	561,833	97,130	21,327	402,473	12,458
Scope 1 + 2 level	3,425,962	222,858	42,860	1,193,117	12,851
Scope 1 + 2 intensity	0.31	0.03	0.00	0.12	12,820
Market cap	8,036	1,375	329	4,976	50,636

Summary statistics: mean, median, 25th and 75th quantile, and number of observations. Emissions are measured in tons of CO2; emission intensity is tons of CO2/thousands of USD in firms' revenues and market cap in millions of USD.

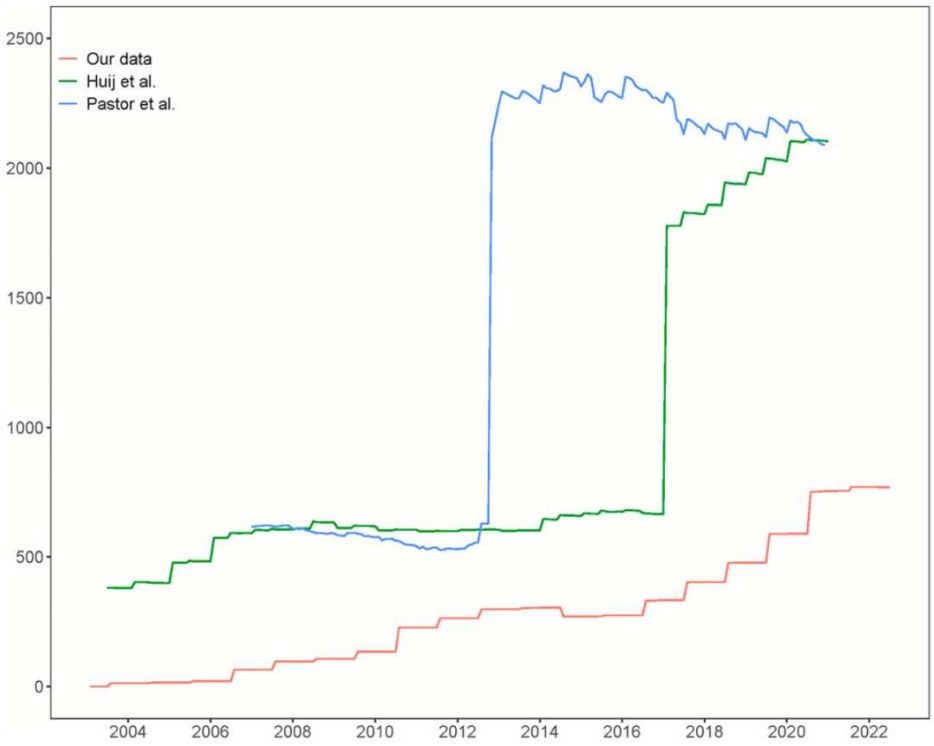
Source: Bauer et al. (2022)

As a result, the emissions data are very right-skewed, as mean emissions exceed not only median emissions but even the third quartile.

They use monthly return data; specifically, they consider the total return index in USD for each stock to try to simulate an investor that continually reinvests dividends. For value-weighted portfolio returns, they use monthly observations of market caps.

To have a sense of increasing awareness towards emissions, the number of firms included in the analyses (recall that only the ones disclosing their emission reports are considered) are reported in Figure 6.

Figure 6. Monthly number of firms with reported emissions data from Refinitiv (18-month publication lag).



In the other publications, the number of companies is greater since they include third-party certification on their emissions.
Source: Bauer et al. (2022)

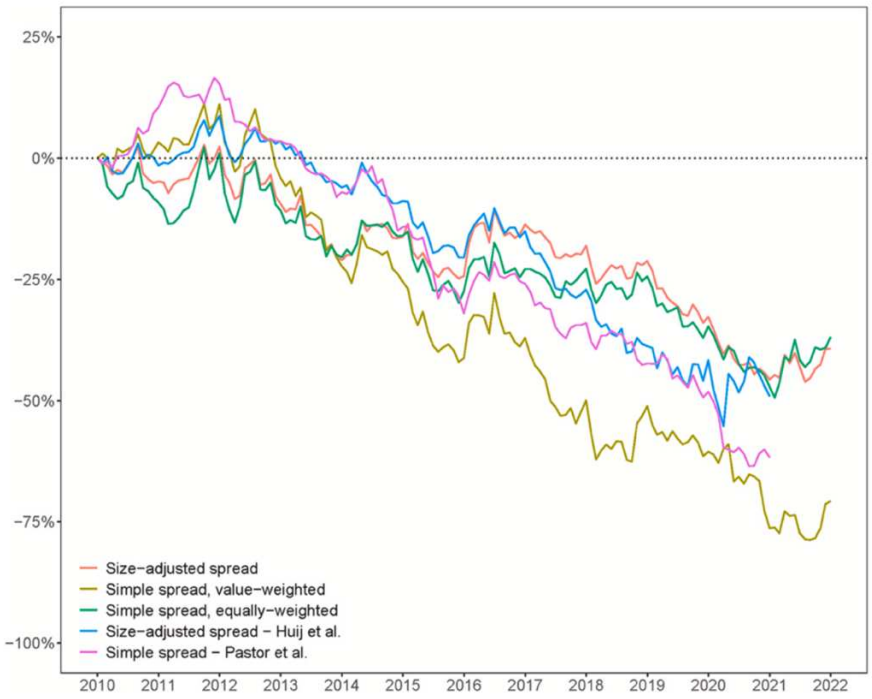
To clarify the 18-month lag, it means that returns from month t are matched to emissions from month t-18. The other publications, for example, don't lag their emissions.
The authors use three different methods for constructing green and brown portfolios. The first one is a "size-adjusted spread," which uses a two-way sort of market cap and emissions (by level and intensity).
Companies are divided into groups by market value and are given a classification based on their carbon emissions into "low/green," "medium," and "high/brown," based on the 30^{th} and 70^{th} percentile of the emission variable. The green portfolio return is the equal-weighted average of the returns for the small and large green portfolios and is analogous to the brown portfolio. The size-adjusted spread is the difference between the brown and green portfolio returns.
The second and third portfolio methods apply a "simple spread" methodology: stocks are sorted into quintiles based on their reported emissions level or intensity and the average return for each quintile portfolio. The methodology simply is the difference between the quintile portfolio returns with the highest and lowest emissions. In the second method, the simple spread is calculated using value-weighted returns within each quintile, whereas, in the third method, equally-weighted portfolio returns are computed, which downweighs very large companies within each portfolio that tend to outweigh the others in the value-weighted returns. In this way, the third measure controls for firm size.
Eventually, panel regressions are performed to check if the different results for the empirical methodologies can be reconciled.

4.2 Results

The findings are very interesting; research reports that over the period 2010-2021, green stocks had higher average returns compared to brown stocks, with the outperformance being steady and persistent over the period and cumulative returns up to 70% higher than brown portfolios.
Using emission intensity as a proxy for greenness, green stocks outperform in six of the G7 countries, with a range from 23% for Canada to 110% for France. The only exception is Italy, where brown stock returns have been higher on average.
In the US, for example, Figure 7 shows results for portfolios using the different methods cited in the previous paragraph based on total emissions. Cumulative log returns for different brown–

green (BMG) spread portfolios, based on the levels of CO2 emissions for the three different methods: size-adjusted spread (i), simple spread value-weighted (ii), and simple spread equally weighted (iii).

Figure 7. Brown vs green performance in the US. Based on total emissions.



Source: Bauer et al. (2022)

Figure 8. Brown vs green performance in the US. Based on emission intensity.

Source: Bauer et al. (2022)

For all the methods, green portfolios have outperformed brown portfolios since 2012, with some reversals in early 2016. Still, the cumulative return of BMG portfolios over the sample is about – 50% for (i) and (iii) and -75% for (ii). The average monthly returns in the US are displayed in Table 5.

Table 5. Average monthly returns in the United States. Sample period January 2010-December 2021

Factor/Portfolio	brown	green	BMG
Panel A: Level of emissions			
Size-adjusted spread	1.15	1.40	−0.25
	(3.17)	(3.45)	(−1.30)
Simple spread, value-weighted	1.02	1.47	−0.45
	(3.27)	(3.63)	(−1.84)
Simple spread, equally-weighted	1.15	1.37	−0.22
	(2.93)	(3.06)	(−1.00)
Panel C: Emission intensity			
Size-adjusted spread	1.04	1.37	−0.33
	(2.68)	(3.27)	(−1.70)
Simple spread, value-weighted	0.79	1.45	−0.65
	(2.11)	(3.38)	(−2.37)
Simple spread, equally-weighted	1.24	1.43	−0.18
	(2.65)	(3.25)	(−0.75)

In parentheses, the t-statistics are based on heteroskedasticity-robust (White) standard errors.
Source: Bauer et al. (2022)

It's interesting to point out how the use of emission intensity generates even larger gains for the green portfolio with respect to the brown. For example, (i) and (ii) have cumulative returns 13% and 32% lower at the end of the sample than when using emission levels. The mean spread return is always negative, ranging from -0.65% to -0.18% per month.
One key aspect to understand is whether higher returns of green portfolios reflect higher risk, and, of course, the Sharpe ratio has been investigated. To recall:

Formula 1.

$$\text{Sharpe Ratio} = \frac{E[R_p] - R_f}{\sigma_p}$$

Where:

1) $E[R_p]$ is the expected return of the portfolio.
2) R_f is the risk-free rate.
3) σ_p is the standard deviation of the portfolio's returns, which represents the risk or volatility.

A higher Sharpe Ratio indicates better risk-adjusted performance. It suggests that the investment provides a higher return per unit of risk. Table 6 provides broad results in this sense.

Table 6. Portfolio returns and Sharpe ratios for the US and G7.

	Quintiles					BMG	Market
	1 (green)	2	3	4	5 (brown)		
Panel A: U.S., level of emissions							
Mean return	1.47	1.26	1.32	1.31	1.02	−0.45	1.27
	(3.63)	(3.27)	(3.60)	(3.87)	(3.27)	(−1.84)	(3.69)
Volatility	4.86	4.66	4.41	4.07	3.75	2.92	4.13
Sharpe ratio	0.29	0.26	0.29	0.31	0.26	−0.17	0.30
Panel B: U.S., emission intensity							
Mean return	1.45	1.31	1.17	1.04	0.79	−0.65	1.27
	(3.38)	(4.08)	(3.96)	(3.05)	(2.11)	(−2.37)	(3.69)
Volatility	5.16	3.86	3.57	4.10	4.53	3.33	4.13
Sharpe ratio	0.27	0.33	0.32	0.24	0.17	−0.21	0.30
Panel C: G7 avg., level of emissions							
Mean return	0.80	0.91	0.82	0.75	0.59	−0.20	1.05
	(1.84)	(2.21)	(1.98)	(1.83)	(1.54)	(−1.20)	(3.07)
Volatility	5.22	4.97	4.96	4.93	4.66	2.05	4.11
Sharpe ratio	0.15	0.18	0.16	0.14	0.12	−0.12	0.25
Panel D: G7 avg., emission intensity							
Mean return	0.80	0.86	0.74	0.71	0.48	−0.33	1.05
	(1.71)	(2.10)	(2.01)	(1.86)	(1.16)	(−1.60)	(3.07)
Volatility	5.66	4.93	4.45	4.61	4.93	2.48	4.11
Sharpe ratio	0.14	0.17	0.16	0.15	0.09	−0.15	0.25

Average monthly returns, t-statistics, volatilities, Sharpe ratios.

Source: Bauer et al. (2022)

For emission intensity, there is a monotone decrease in mean returns going from the green portfolio and rightwards, where less green portfolios stand.

Findings provide that brown portfolios are slightly less volatile all over the analyzed countries, but the differences in average returns are larger than the differential volatility. Therefore, green stocks show a higher Sharpe ratio. While the green portfolio has a slightly larger volatility than the brown portfolio, the Sharpe ratio of the green portfolio is 0.27, whereas that of the brown portfolio is 0.17. The same pattern is weaker on emission levels, and average returns are no longer dropping monotonically.

Eventually, the market portfolio displays a higher Sharpe ratio than each single quintile portfolio due to better diversification and, thus, reduction in risk.

From the panel regression, green stocks still outperform brown stocks, even though the differences narrow down with respect to the portfolio methods.

In the United States, there has been a better performance of green portfolios over the last decade using all different measures of greenness as well as different portfolio construction techniques. Moreover, green and brown stocks for G7 countries, which account for half of the global net wealth, represent a good mixed environment to support the robustness of US evidence.

In the analysis of G7 data, only the single-spread value-weighted technique is applied to construct portfolio returns. Figure 9 provides results for brown vs green performance in the G7 countries for total emissions and emission intensity.

Figure 9. Brown vs green performance in the G7 countries, total emissions and emission intensity. January 2010-June 2022

Cumulative log returns for value-weighted, simple BMG spreads.

Source: Bauer et al. (2022)

Together with the G7 cumulative log returns for individual countries, the figure also includes an average among all countries, which is represented by the black line. The global average return is computed as the average of the country-specific spread returns.

Using total emission levels, green stocks provided 30% higher returns than brown ones in the sample period. The pattern is similar to the US results but with a lower magnitude.

A country like France, for instance, shows great cumulative BMG returns, -115%. Countries like the US, UK, and Canada display cumulative returns from -80% to -30%. Germany and Japan showed performant green stocks until COVID-19, then BMG returns shrank to zero. The worst-performing country is Italy, with a BMG of 45%.

Taking emission intensity as a proxy, there's even a larger outperformance of green stocks, with results ranging from -40% to -110%. France still displays the best outperformance; Germany shows a -80% (recall that was close to 0 with emission levels as a proxy). To analyze, more specifically, the results of G7 countries, Table 7 displays the results.

Table 7. Average monthly returns in the G7 countries.

	Level of emissions			Emission intensity		
Factor/Portfolio	brown	green	BMG	brown	green	BMG
Canada	0.65	0.89	−0.24	0.46	0.84	−0.38
	(1.38)	(1.98)	(−0.93)	(0.93)	(1.86)	(−1.25)
France	0.31	1.06	−0.75	0.40	1.12	−0.71
	(0.64)	(1.91)	(−2.45)	(0.82)	(1.91)	(−2.43)
Germany	0.49	0.45	0.04	0.09	0.56	−0.47
	(0.85)	(0.96)	(0.11)	(0.16)	(1.05)	(−1.34)
Italy	0.64	0.15	0.49	0.68	0.35	0.33
	(1.16)	(0.19)	(0.99)	(1.18)	(0.44)	(0.71)
Japan	0.61	0.58	0.03	0.42	0.66	−0.24
	(1.84)	(1.50)	(0.14)	(1.15)	(1.53)	(−0.83)
United Kingdom	0.44	0.98	−0.54	0.47	0.65	−0.18
	(1.15)	(2.05)	(−1.91)	(0.96)	(1.19)	(−0.52)
United States	1.02	1.47	−0.45	0.79	1.45	−0.65
	(3.27)	(3.63)	(−1.84)	(2.11)	(3.38)	(−2.37)
G7 average	0.59	0.80	−0.20	0.48	0.80	−0.33
	(1.54)	(1.84)	(−1.20)	(1.16)	(1.71)	(−1.60)

In parentheses, the t-statistics are based on heteroskedasticity-robust (White) standard errors. Sample period: January 2010 to December 2021.

Source: Bauer et al. (2022)

To summarize, the results show that the green outperformance displayed by the US is strongly supported by G7 countries, in particular when emission intensity is used as a proxy.

All these outcomes clash with the carbon premium hypothesis that green stocks should have lower expected returns than brown stocks.

The average realized returns are taken as good proxies for expected returns, which is a common assumption in empirical asset pricing. Findings show the inconsistency of such premiums. Different papers display a positive relationship between emissions and financial returns. To understand which is the correct result, estimated mean returns for BMG spread portfolios with estimated panel regression that are similar to the portfolio are considered narrowed for the US data. To perform the analysis correctly, additional variables are added to the specification, like controls and fixed effects.

First of all, the mean returns of the simple spread BMG spreads with equally-weighted portfolios in panels A and C of Table 5, with mean spread returns of -0.22 and -0.18. An indicator variable, $D_{it,}$ is defined. The variable takes value +1 if the stock *I* in month *t* belongs to the brownest fifth of stocks and, -1 if it's in the greenest fifth, 0 if in between. A cross-sectional regression of stock returns in month *t*, D_{it} would yield the spread return in month *t*, and the time series of the regression coefficients would reproduce the mean spread return.

Table 8. Panel regressions based on brown-green allocations (US data). January 2010-December 2021

	Level of emissions			Emission intensity		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	1.537***			1.535***		
	(0.05)			(0.05)		
Brown-green indicator	−0.130*	−0.146	−0.046	−0.062	−0.315***	−0.194*
	(0.07)	(0.10)	(0.11)	(0.08)	(0.10)	(0.11)
Book-to-market		0.240	0.218		0.191	0.190
		(0.21)	(0.22)		(0.21)	(0.22)
Sales growth		0.000	0.000		0.000	0.000
		(0.00)	(0.00)		(0.00)	(0.00)
Log(PPEGT)		0.050	0.199***		0.102*	0.235***
		(0.06)	(0.07)		(0.06)	(0.07)
Leverage		0.014	0.006		0.007	0.003
		(0.02)	(0.02)		(0.02)	(0.02)
$r(t-1)$		−0.036***	−0.036***		−0.035***	−0.036***
		(0.01)	(0.01)		(0.01)	(0.01)
Log(market cap)		−0.201***	−0.347***		−0.270***	−0.383***
		(0.06)	(0.08)		(0.07)	(0.08)
$r(t-12, t-2)$		−0.003*	−0.003*		−0.003	−0.003*
		(0.00)	(0.00)		(0.00)	(0.00)
ROE		0.053	0.012		0.048	0.011
		(0.24)	(0.24)		(0.23)	(0.24)
Investment-to-assets		−0.238	−0.147		−0.222	−0.148
		(0.30)	(0.30)		(0.30)	(0.30)
Number of observations	47418	47418	47418	47400	47400	47400
R^2	0.00	0.27	0.27	0.00	0.27	0.27
Time fixed effects	No	Yes	Yes	No	Yes	Yes
Industry fixed effects	No	No	Yes	No	No	Yes

Panel regressions for monthly stock returns on an indicator variable ("Brown-green"), D_{it}. Returns are linked with an 18-month emission lag. Controls are book-to-market, sales growth, log property plant and equipment, leverage, past 1-month return, log market cap of the previous month, cumulative past returns from *t-12* to *t-2*, return on equity (ROE), and investment-to-assets. Standard errors in parentheses. ***, **, and * indicate statistical significance at the 1 %, 5 %, and 10 % level, respectively.

Source: Bauer et al. (2022)

The estimated coefficients are negative, thus in line with the estimate of Table 5. However, they are half as big as the portfolio-based estimates. This is probably due to the number of observations for each month that differs in the panel regression, causing the weights to change from month to month. Meanwhile, in the portfolio methods, the weights are equally distributed. Therefore, when the number of observations is higher, there is a higher weight for months with less green outperformance.

Later, two changes are made in the regression: fixed effect and firm-specific controls are added, the controls are specified in the bottom of Table 8. The estimates for the specifications are in columns (2) and (5). The coefficients are larger, in absolute value than in OLS regression without controls, and results in column 5 are statistically significant at the 1% level.

Industry fixed effects are added to account for differences in greenness among industries, and adding them lowers the absolute magnitude of the coefficient of the D_{it} indicator. The

coefficient remains negative, but it is slightly significant for emission intensity and statistically not different from zero for the level of emissions.
Results show, once again, green stocks outperforming brown stocks, in contrast with the positive carbon premium theory.
The main difference in this panel regression with respect to the previous literature is the reliance on an indicator variable that measures if a specific stock is brown or green relative to its peers. Previous works, on the other hand, have used the level of emissions or the intensity as a key variable in the regression. The presented approach is considered better because it tracks the green performance at that particular point in time. The approach, therefore, is more realistic from the view of an investor who has to decide among firms. With such indicators, firm size and characteristics become less important and, therefore, are much less strongly correlated.

4.3 Additional literature

Two very important contributions to this topic have been made in recent years of green instruments surge by the already cited Pastor et al. (2022) and Ardia et al. (2022). These two publications will be analyzed to try to deepen and rattle off the topic.
The first publication analyzes why green returns have spiked, particularly in years of uprising environmental concern, with green stocks outperforming brown stocks. The paper watches the expected returns ex-ante, using the implied cost of capital and ex-post, using the realized returns after shocks from climate concerns and earnings. Pastor, Stambaugh, and Taylor built their model, called henceforth PST, which predicts that brown assets have greater expected returns because of investors' green tastes and that green assets are better at hedging. PST also says, however, that green assets can realize higher expected returns when an investor's green demand shifts unexpectedly. Paragraph 4.3.1 will explain the model.
Ardia's contribution strengthens the first publication using data from S&P 500 companies constructing a daily Media Climate Change Concerns index (MCCC). Their results display an increase in green stock prices following climate change concerns, whereas prices of brown stocks tend to decrease.

4.3.1 PST model

As stated in the previous paragraph, the focus of the publication is to try to understand what drives the investor's demand for green assets and how this affects green returns. First of all, if investors' demand increases, also green asset prices will follow. Second, the demand for green

products can strengthen due to environmental regulation. In the opposite way, brown stock demand can decrease, causing the green stocks to outperform the brown ones.

The main focus is on the US stock market, and this time, environmental ratings from MSCI, the top global provider of ESG ratings, are considered. The sample starts in November 2012, where data coverage becomes robust, and over the period, the value-weighted portfolio of stocks in the top third of greenness performed better than the bottom third by 174%. The return spread, or the GMB, has a monthly Sharpe ratio of 0.33, above the stock market's Sharpe during the bull period. According to the model, the right outperformance shouldn't lead to high expected returns going forward because the results reflect an unprecedented increase in environmental concerns. Shocks to climate concerns (like great extreme events, rallies, and protests) exhibit a significant positive relation to GMB.

The strong support by agents is demonstrated in the German "twin" bonds. In 2020, the German government issued green bonds, along with identical non-green bonds. Even if the green instrument of the ten-year yield appeared lower compared to the non-green counterpart, it was much more successful. This shows that the investors are willingly accepting a "greenium" and thus have lower expected returns to align with environmental concerns. The same equity greenium, calculated ex-ante comparing the implied cost of capital, has been demonstrated and widens when concerns about the environment increase. Since 2012, the greenium has widened four times (in contrast to what Bauer et al. suggest).

As mentioned before, the environmental ratings are collected from MSCI, which employs 200 analysts, AI, machine learning, and natural language processing. The MSCI variables "Environmental pillar score" (*E_score*) and "Environmental pillar weight" (*E_weight*) are used. *E_score* is a number ranging from 0 to 10 and measures the company's weighted average score across 13 environmental issues related to climate change (e.g., pollution, waste). *E_weight,* on the other hand, measures the importance of environmental issues relative to social and governance issues. It ranges from 0 to 100 and is typically constant among firms in the same industry. The greenness score of firm *i* at the beginning of month *t* is:

Formula 2.

$$G_{i,t-1} = -(10 - E_score_{i,t-1}) \times E_weight_{i,t-1}/100$$

Source: Pastor et al. (2022)

$E_score_{i,t-1}$ and $E_weight_{i,t-1}$ are from the company *i*'s most recent MSCI ratings date before month *t*, looking back no more than 12 months. The quantity $10 - E_score_{i,t-1}$ measures how far the company is from a perfect environment score of 10. The product $(10 - E_score_{i,t-1}) \times E_weight_{i,t-1}$ measures how brown the firm is. The minus before the equation converts the measure of brownness to greenness.

The environmental score used in the analysis is given by Formula 3.

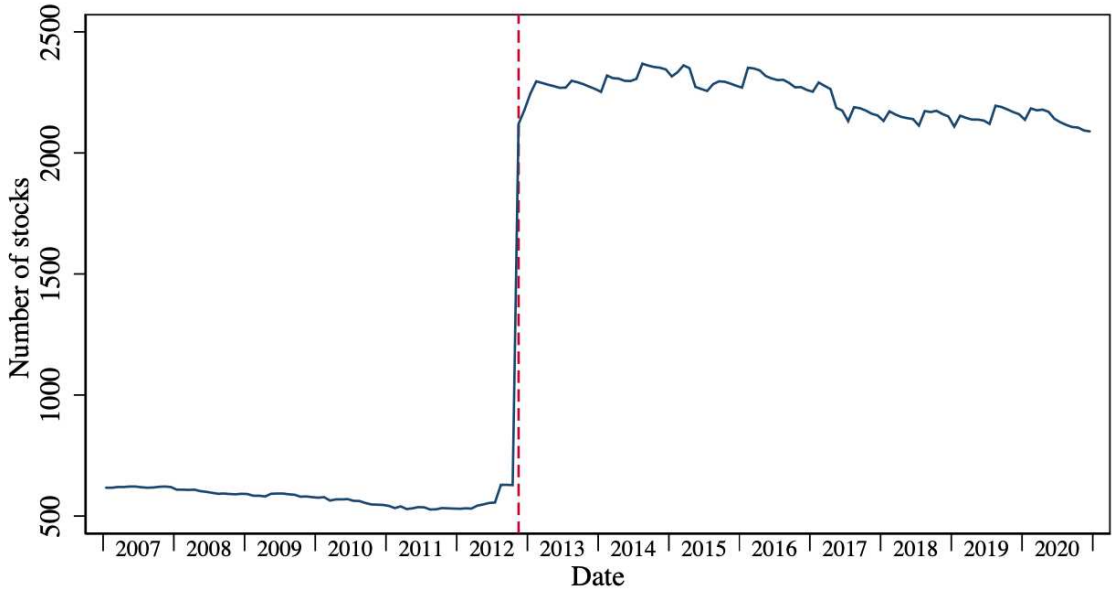
Formula 3.

$$g_{i,t} = G_{i,t} - Gavg_t$$

Source: Pastor et al. (2022)

Where $Gavg_t$ is the value-weighted average. $G_{i,t}$ of all firms *i.* Therefore, the variable $g_{i,t}$ measures the company's greenness relative to the market portfolio. The sample starts in November 2012, when MSCI coverage on environmental scores skyrockets (Figure 10), to December 2020.

Figure 10. MSCI coverage.



The dashed red line is November 2012. Coverage expanded in October 2012.

Source: Pastor et al. (2022)

To understand what the greener and browner industries are, Table 9 provides the answer. The lowest-ranked industries are chemicals, oil and gas exploration and production, steel and

mining, followed closely by paper and forest products, and marine transport. Across all the 64 provided industries, only 20 displayed a positive $g_{i,t}$ at the end of 2019. Remember that $g_{i,t}$ represents the environmental score.

Table 9. Industries ranked by environmental scores.

Rank	MSCI Industry	Avg. g	Rank	MSCI Industry	Avg. g
1	Asset Management & Custody Banks	0.87	33	Textiles, Apparel & Luxury Goods	-0.50
2	Professional Services	0.85	34	Auto Components	-0.51
3	Telecommunication Services	0.84	35	Property & Casualty Insurance	-0.51
4	Consumer Finance	0.84	36	Casinos & Gaming	-0.54
5	Health Care Equipment & Supplies	0.84	37	Real Estate Development	-0.55
6	Health Care Providers & Services	0.83	38	Semiconductors	-0.66
7	Life & Health Insurance	0.76	39	Electrical Equipment	-0.75
8	Interactive Media & Services	0.74	40	Construction & Farm Machinery	-0.76
9	Diversified Financials	0.73	41	Tobacco	-0.89
10	Media & Entertainment	0.70	42	Trading Companies & Distributors	-0.99
11	Diversified Consumer Services	0.61	43	Industrial Machinery	-1.04
12	Biotechnology	0.57	44	Containers & Packaging	-1.09
13	Pharmaceuticals	0.49	45	Energy Equipment & Services	-1.16
14	Multi-Line Insurance & Brokerage	0.40	46	Real Estate Management & Services	-1.20
15	Investment Banking & Brokerage	0.39	47	Airlines	-1.21
16	Banks	0.35	48	Hotels & Travel	-1.57
17	Restaurants	0.31	49	Building Products	-1.62
18	Construction & Engineering	0.13	50	Utilities	-1.90
19	Aerospace & Defense	0.10	51	Integrated Oil & Gas	-2.01
20	Commercial Services & Supplies	0.07	52	Food Products	-2.02
21	Air Freight & Logistics	-0.06	53	Beverages	-2.04
22	Household Durables	-0.12	54	Metals and Mining, Precious	-2.19
23	Software & Services	-0.13	55	Oil & Gas Refining, Marketing	-2.52
24	Electronic Equipment, Instruments	-0.17	56	Construction Materials	-2.56
25	Leisure Products	-0.17	57	Specialty Chemicals	-2.82
26	Automobiles	-0.22	58	Marine Transport	-2.83
27	Retail - Food & Staples	-0.25	59	Paper & Forest Products	-2.93
28	Retail - Consumer Discretionary	-0.27	60	Metals and Mining, Non-Precious	-2.95
29	Road & Rail Transport	-0.30	61	Steel	-2.96
30	Household & Personal Products	-0.30	62	Oil & Gas Exploration & Production	-3.01
31	Industrial Conglomerates	-0.36	63	Diversified Chemicals	-3.21
32	Technology Hardware, Storage	-0.39	64	Commodity Chemicals	-3.78

Average g is the environmental score averaged across firms within each MSCI industry at the end of 2019.

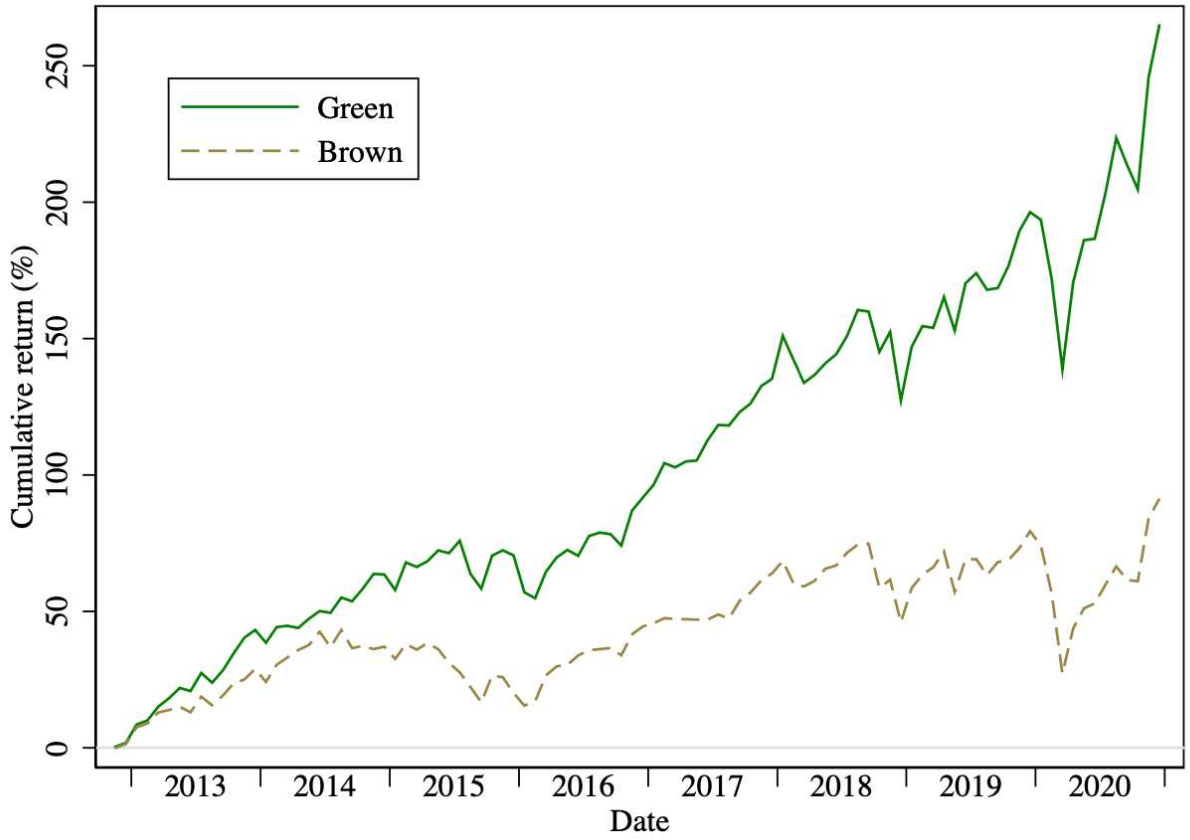
Source: Pastor et al. (2022)

Similarly to what Bauer et al. (2022) results show, green stocks strongly outperformed brown during the sample period, as shown in Figure 11. The values of the green and brown lines at the end of 2020 are 264.9 and 91.3, implying green stocks outperformed brown by 264.9 − 91.3 = 174 percentage points over this period. The monthly return difference, denoted by GMB (green-minus-brown), averaged 65 bps per month. The monthly Sharpe ratio of GMB is 0.33, larger than the market portfolio's Sharpe ratio of 0.30 over the same period.

To comprehend if the equity greenium is real, which is captured by the difference in expected returns on green versus brown returns (the GMB spread), an estimation is needed because expected returns aren't directly observable. To do so, an ex-ante approach and an ex-post method are performed. The first method estimates every stock's expected return as its implied cost of capital (ICC), which is the discount rate of its present value of expected future cash

flows. The second approach, on the other hand, estimates the GMB return as the average ex-post return given unexpected shocks. Climate-concern shocks and earnings-news shocks are used when pursuing the second approach.

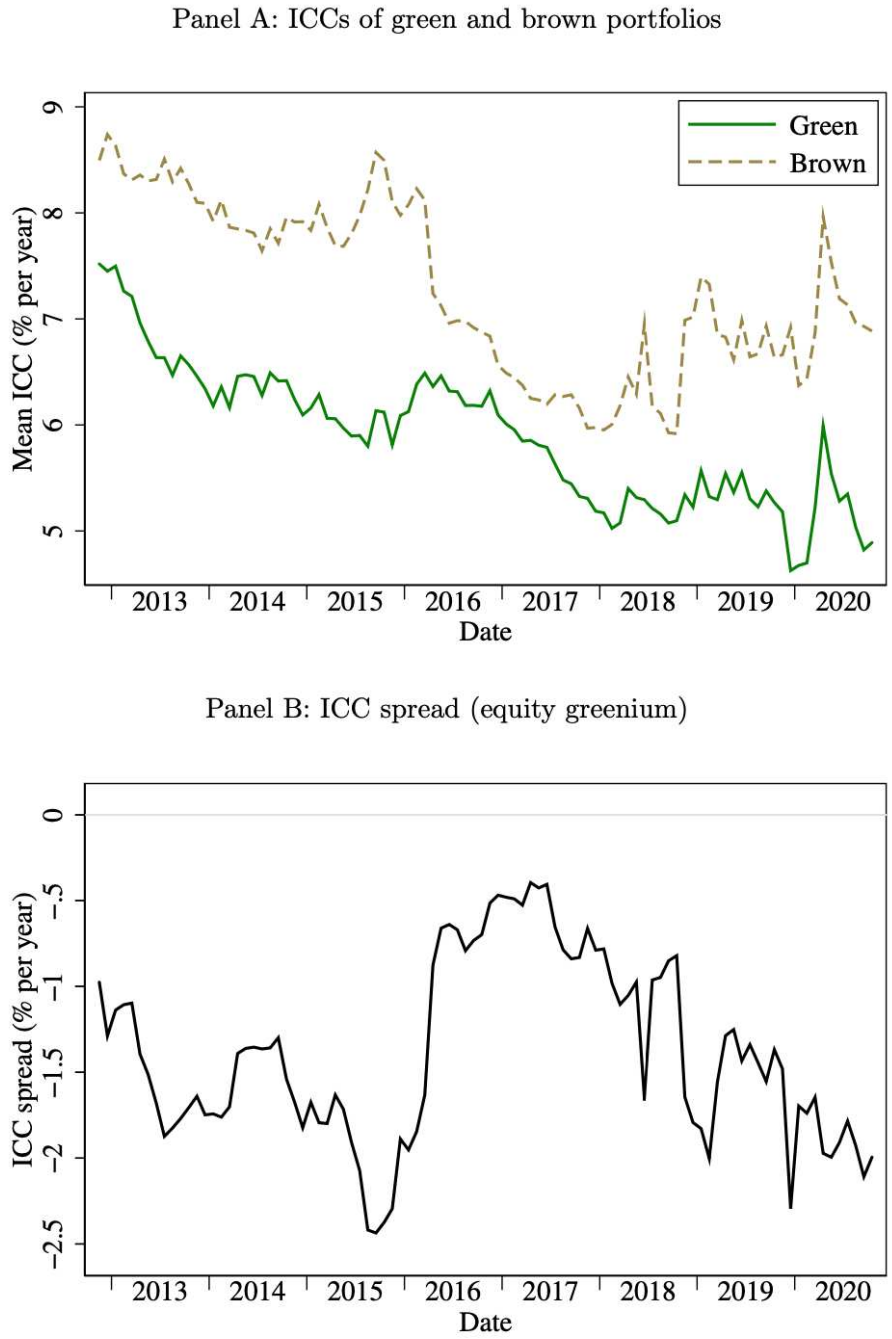
Figure 11. Returns on value-weighted green and brown portfolios. Cumulative returns.



Source: Pastor et al. (2022)

The first approach computes ICC for each stock month. Figure 12 shows the results of the ICC. During the sample period, the green portfolio's ICC declines from 7.6% to 4.9% per year, and the brown portfolio's ICC drops from 8.8% to 6.8%. It's important to note that the green portfolio's ICC is constantly below brown's ICC, indicative of a consistent equity greenium (lower expected returns on green stocks over brown stocks). Panel B plots the differences in ICC between green and brown stocks. The difference ranges from -0.4% to -2.4%, with an average of -1.4% per year. To support even more the results, a panel regression with month fixed effects is performed. The regression returns a highly significant negative estimate (t = -11.90). That's not it, the ICC of GMB declined from -1.2% to -1.9% per year during the sample period, with a decline much steeper in the last four years. The result displays an increased demand from investors for green assets.

Figure 12. ICC



Source: Pastor et al. (2022)

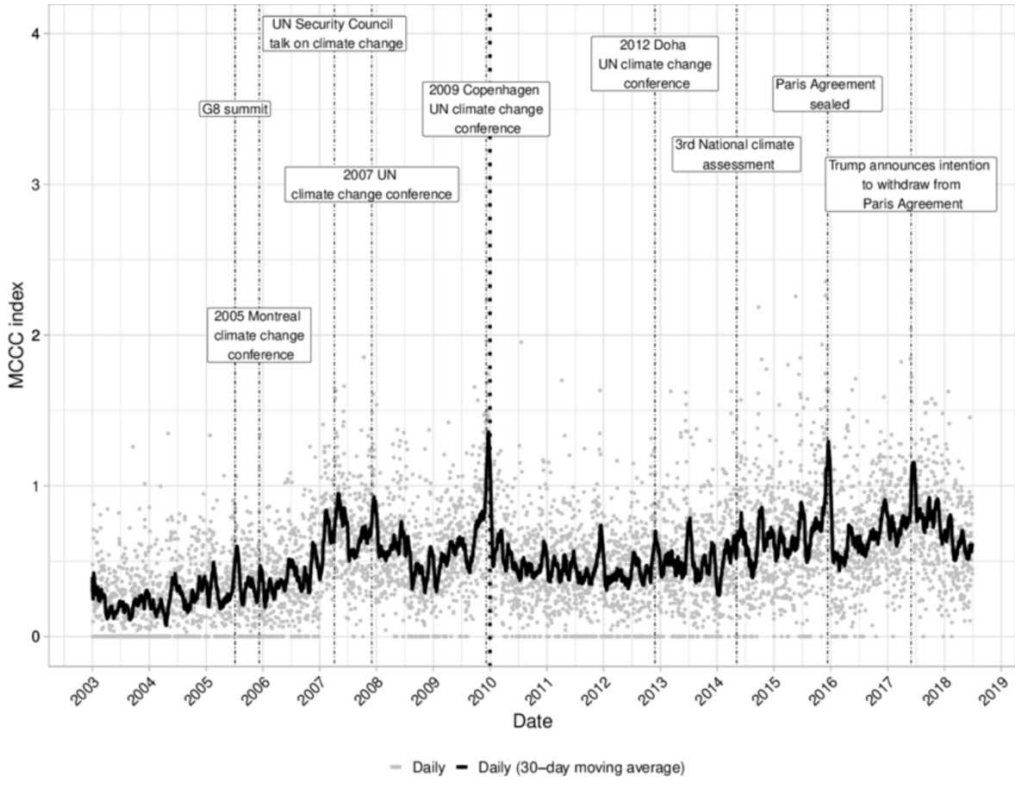
The second approach to estimating the greenium addresses the problem of inferring an asset's unconditional expected return, $\mu = E\{rt\}$, using ex-post data. The publication uses a variable *xt,* that is correlated with the return and for which $E\{xt\} = 0$.

xt represents an unexpected change in climate concerns and is a vector of shocks having two sources. The first one is climate concerns, which will play a key role in pushing the demand for green instruments and assets. To measure these concerns about climate change, the Media Climate Change Concerns index (MCCC) is used. The index is built by collecting data from the

eight most popular US newspapers. The index gathers the number of climate news stories each day. For each news article about climate change, Ardia et al. (2022) compute a "concern" valuation that interacts with two variables: a fraction of total words related to risk and the difference between negative and positive words. They then sum the measure to the newspaper-day level by adding the concern values across stories. Afterward, they aggregate to the day level by averaging across newspapers after adjusting for heterogeneity across newspapers. At last, they take the square root of this daily measure to avoid giving too much weight to concern if many articles write about an environmental issue. In a simpler way, if one article increases the level of concern, twenty articles don't increase the concern by twenty times.

The values of shocks to climate concerns are computed as prediction errors from an AR (1) applied to the MCCC index. To compute the prediction error in time *t*, the AR (1) uses the 36 months of MCCC data prior to *t* until *t* -1. Figure 13 provides a clear example of how the index moved during the sample period.

Figure 13. MCCC index. Sample period 2003-mid 2018.



Source: Ardia et al. (2022)

The second source is earnings news expectations. Two measures of earnings news are included in *xt:* the first one is based on the idea that a large quantity of earnings news happens on earning-related announcement days. There are two types of such announcements: those of quarterly earnings and those that come voluntarily for future guidance on future earnings. Stock returns

are computed in excess of the market during the three-trading-day windows centered on announcement days.

The second measure captures news about long-term earnings. The news can arrive gradually, in between quarters, and data are generally retrieved from the analysts' forecasts on each company's earnings growth rate.

Putting together the variables, the results from the regressions of GMB return on *xt* are displayed in the first two columns of Table 10.

Table 10. Sources of GMB performance. November 2012-June 2018.

	Dependent variable			
Independent variable	GMB return		GMB alpha	
Δ Climate concerns (same month)	4.08	3.75	3.95	3.44
	(2.70)	(2.69)	(2.79)	(2.70)
Δ Climate concerns (prev. month)	2.98	2.86	2.64	2.33
	(1.86)	(1.77)	(1.97)	(1.82)
Earnings announcement returns		0.77		0.63
		(2.64)		(2.31)
Δ Earnings forecasts		6.93		14.16
		(0.44)		(0.96)
Constant	0.05	-0.04	-0.10	-0.15
	(0.20)	(-0.15)	(-0.41)	(-0.66)
Observations	68	68	68	68
R^2	0.14	0.25	0.14	0.26

Alphas are estimated in a time-regression of GMB. Each month's alpha is set equal to the expression's intercept plus residual. Returns are in % per month. "Δ Climate concerns" is the prediction error calculated from the AR (1) models applied to the MCCC index. T-stats in parentheses.

Source: Pastor et al. (2022)

The first column gives the GMB return without the earnings variable included in *xt*, and the second column with the earnings variable included. When earnings are included, the R-squared goes from 0.14 to 0.25. The same-month climate shock, ΔCt, and the earnings announcement return are both significant with their expected positive signs (t-statistics: 2.69 and 2.64). The positive ΔCt coefficient supports the prediction that an increase in climate concerns is good for green stockholders. The previous month's climate shock, $\Delta Ct-1$, suggests that green stock

prices still respond in delay to climate concerns, even if in a weaker way. In this particular point, the stock size plays a key role. Table 11 shows results from six time-series regressions of monthly portfolio percent returns on ΔC.

Table 11. Stock size and the response to climate news. November 2011-June 2018.

	ΔC (same month)			ΔC (prev. month)		
Portfolio	Small	Large	Lg.−Sm.	Small	Large	Lg.−Sm.
GMB	2.83	3.91	1.08	7.49	2.79	-4.70
	(1.23)	(2.46)	(0.56)	(2.99)	(1.74)	(-2.35)
Green	0.03	2.27	2.24	-0.14	0.62	0.75
	(0.01)	(3.19)	(0.75)	(-0.06)	(0.83)	(0.28)
Brown	-1.81	-1.39	0.42	-8.49	-2.35	6.14
	(-0.61)	(-1.26)	(0.15)	(-2.71)	(-2.10)	(2.29)

Source: Pastor et al. (2022)

The first row shows results for two value-weighted GMB portfolios, the second for two green portfolios, and the third for two brown portfolios. For each row, one portfolio of small-cap stocks (market capitalization between USD 300 million and USD 2 billion) and one of large-cap stocks (market capitalization above USD 10 billion) is formed. Lg. – Sm. is simply the difference between large-caps and small-caps coefficients. Green and brown portfolios' returns are market adjusted, meaning each stock's alpha is subtracted the stock's market beta (volatility) times market excess return. It's noticeable how ΔC is significant for large-cap GMB portfolios (t = 2.46) in the same month but not for the previous month (t = 1.46). Whereas small-cap GMB, same month ΔC is insignificant (t = 1.23), but the previous month is strongly significant (t = 2.99). Even if shocks have effects on both small-cap and large-cap, results suggest that the reaction is more delayed for small-cap stocks. Large-cap GMB reacts more strongly in the current and most recent week for example, small-cap GMB start to react significantly after three weeks. Moreover, separating the effects of green and brown stocks, the green stocks reaction happen in the same month of the news, and the reaction (negative) of brown stocks appear for the previous month's stocks. Finally, the effect of climate news on small stocks is limited to brown stocks.

Another important consequence of these results is that the greenium doesn't only depend on taste-related investment effects but also on the ability of green stocks to hedge against climate news. Investors are found to be willing to pay for the hedging property of green stocks, and if

climate-hedging demand increases during the sample period, it pushes even further the demand for eco-friendly stocks.

4.3.2 The MCCC index, more insights

Ardia et al. (2022) use the MCCC index from data collected from the major US newspapers (Los Angeles Times, New York Times, New York Daily News, New York Post, Washington Post, Houston Chronicle, Chicago Tribune, Arizona Republic, Wall Street Journal, USA Today, Associated Press Newswires, and Reuters News). The ratio of the choice is because investors and consumers generally rely on the media to get informed about the state of the world. For the selected news articles, they define a concern score, measuring and mixing the levels and negativity for each article (recall Figure 13). Short articles with less than 200 words are filtered out because lexicon-based methods are noisy for brief texts. The source with the most publications is the Associated Press Newswires, with 10,061 articles. The Wall Street Journal is the one with the highest coverage of climate change relative to the total number of articles (0.26%).

The empirical analysis focuses on S&P 500 firms from January 2010 to June 2018. As a proxy, the firm's greenness is based on ASSET4/Refinitiv carbon-dioxide-equivalent (CO2-equivalent) greenhouse gas (GHG) emissions data scaled by firms' revenue, a measure of the firm's emission intensity; this is the number of tonnes of CO2 equivalent GHG emission necessary to generate USD 1 million in revenue. Firms below the 25th percentile of the GHG emissions intensity are the green firms and those above the 75th percentile are the brown firms. The fixed-effect panel regression, performed to estimate the shifts of individual firms' stock returns to unexpected climate change concerns, reveals how firms with lower emission intensity, on days when unexpected climate concerns rise, perform better than brown companies' stocks. Concerns are defined as "the perception of risk and related negative consequences associated with this risk."

To measure the unexpected changes in climate concerns, Ardia tries to capture them as follows:

Formula 4.

$$\Delta CC_t - E[\Delta CC_t | I_{t-1}]$$

Source: Ardia et al. (2022)

Where ΔCC_t is the change in climate change concerns at time t and I_{t-1} is the information set at *t-1*. The challenge is that CC_t isn't directly observable. ΔCC_t is proxied day-by-day using the news data.

From the definition of concern, a score is constructed from the information of the newspapers. The score is built in this way: there's a media universe of of *s=1,...,S* news sources. On each day *t=1,...,T* source s publishes *n=1,...,* $N_{t,s}$ articles talking about climate change. Then, given the number of risk words $RW_{n,t,s}$, positive words $PW_{n,t,s}$, negative words $NW_{n,t,s}$, and total words $TW_{n,t,s}$ in an articles n published on day t by source s, the concerns score is the following.

Formula 5. Article concerns score

$$concerns_{n,t,s}=100 \text{ x } (\frac{RW_{n,t,s}}{TW_{n,t,s}}) \text{ x } (\frac{NW_{n,t,s} - PW_{n,t,s}}{NW_{n,t,s}+ PW_{n,t,s}} + 1) / 2$$

Source: Ardia et al. (2022)

The first product measures the ration between the risk words and total words, this accounts for variability in articles' lengths. The second ratio, $(\frac{NW_{n,t,s} - PW_{n,t,s}}{NW_{n,t,s}+ PW_{n,t,s}} + 1)/2$, measures the degree of negativity of the article.

Therefore, a daily index that captures the changes in in climate change concerns by aggregating the scores across articles, is constructed.

Formula 6. Aggregation

$$concerns_{t,s}= \sum_{n=1}^{N_{t,s}} concerns_{n,t,s}$$

Source: Ardia et al. (2022)

Thus, the index gathers the level of media coverage and the average level of concerns expressed. If no news is published, $N_{t,s} = 0$, which is seen as no news equals good news (100% sentiment according to Formula 5).

To account for heterogeneity between sources, a further step is necessary. For each source *s*, the standard deviation of the source index over a time period *τ1* to *τ2* (both between 1 and *T*) is the following:

Formula 7.

$$\sigma_s = \sqrt{\frac{\sum_{\tau=\tau 1}^{\tau 2}\left(concerns_{t,s} - \overline{concerns_s}\right)\text{^}2}{\tau 2 - \tau 1}}$$

Source: Ardia et al. (2022)

Where $\overline{concerns_s}$ is the sample mean computed from $\tau 1$ to $\tau 2$. σ_s is used to to normalize the source specific index over the sample period $nconcerns_{t,s} = \frac{concerns_{t,s}}{\sigma_s}$. Such normalization is required to sum every source index. Finally, to compute the MCCC index at day *t,* a concave function *h(.)* is applied to the average of the normalized source-specific climate change concerns for the day:

Formula 8. MCCC

$$MCCC_t = h\left(\frac{1}{S}\sum_{s=1}^{S} nconcerns_{t,s}\right)$$

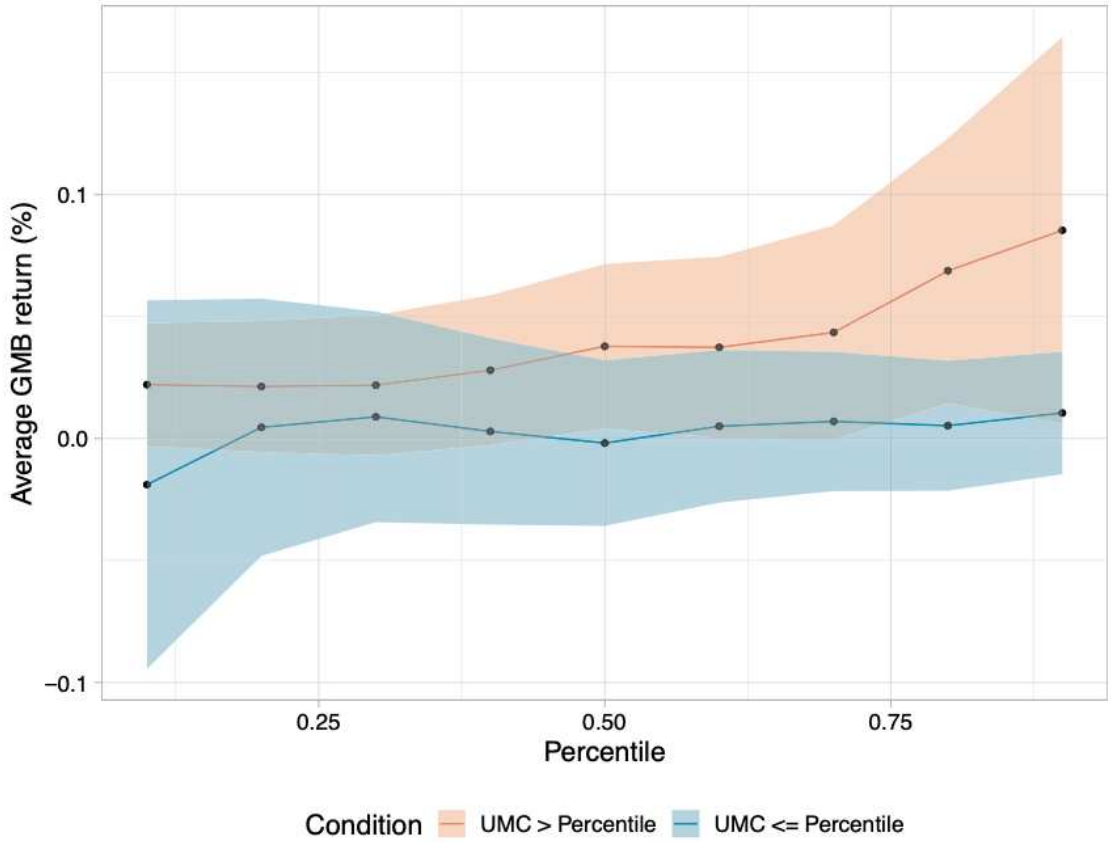
Source: Ardia et al. (2022)

The concave function *h(.)* is applied to capture the increasing climate change concerns following news coverage but at a decreasing rate (as mentioned in the previous paragraphs). A coverage about climate change discussed twenty times surely will increase the concerns about the topic, but now by twenty times.

The newspapers' concern score ranges from 0.31 for the Arizona Republic to 0.44 for USA Today and the New York Post. The newspaper with the larger number of zero concern scores is much larger for the Arizona Republic. Also, this explains perfectly why standardization is necessary.

The empirical analysis of the authors strengthens the results of Pastor et al. (2022): a first explanation is given by the average returns of the GMB portfolios (equally-weighted for three groups: brown, green, neutral) conditional on the unexpected climate concerns.

Figure 14. GMB portfolio average return. 2010-2018.



The average daily return of the GMB portfolio (vertical axis) is conditional on the daily unexpected changes in climate change concerns being above or below a specific threshold (horizontal axis). Thresholds are established as percentiles of unexpected changes. Colored bands are the 95% confidence interval. UMC stands for unexpected media climate change concerns.

Source: Ardia et al. (2022)

Figure 14 confirms what has been said: when the unexpected change is above its median, there's a strong increase in the GMB portfolio average return. Additionally, a one unit increase in UMC enhances the returns of 7.2 basis points. There's also a negative coefficient for the brown portfolio, given an increase in UMC.

Some other interesting factors affecting the returns on the portfolios are, for example, the prospects about the economy; when prospects are good, green stocks outperform brown stocks. And eventually, it is curious to point out that green stocks are negatively correlated with oil and gas prices.

4.4 Comments

In conclusion, we cannot ignore the fact that there is complexity in analyzing green stocks along with traditional stocks. That means for example, that if it were possible to compare green stocks relative to brown ones then such an attempt would serve as a good case study on how they differ from each other. For instance, in a decade, green stocks have outperformed their brown counterparts in many countries especially those characterized by stringent climate policies and investors' awareness about sustainability. The reason behind this scenario lies mainly in heightened awareness concerning global warming; demand for eco-friendly investments continues to rise therefore resulting into changing regulatory frameworks supporting decarbonization.

Although brown stocks might be subject to more climate risks hence attracting a higher risk premium, green stocks have been portraying better realized returns; henceforth this raises questions of the conventional carbon-premium hypothesis. In particular, in six G7 nations, there were consistently higher returns from green portfolios with France recording the best performance while Italy was an exception where brown stock performed markedly better.

The different greenness measures (such as CO2 emissions, emission intensity), different periods of analysis and different methodologies are key determining factors for such mixed results in the literature. However, in cases where emission intensity was used as a proxy for greenness, green stocks consistently showed better risk-adjusted performance than their brown counterparts.

In addition to this, updated theories and exploratory works point out that eco-friendly possessions receive greater revenues as well as act as an insurance against climatic dangers; hence, more so increasing the growth of sustainable funding due to investors who want them. The increasing prominence of green monetary instruments such as bonds whose earnings are generally lower than those paid by their analogs not connected to conservation proves that it is possible for investors to agree on the "greenium," which matches with ecological beliefs.

Overall, the findings highlight the evolving landscape of green finance, where financial returns and sustainability are increasingly linked. Investors can potentially achieve "doing well by doing good," as green investments provide both financial gains and contribute to broader environmental goals.

Concluding Remarks

Due to the increasingly adverse effects of climate change on all aspects of human existence, financing mechanisms to facilitate the world's transition to a sustainable and low-carbon economy have received a big emphasis.

It was observed throughout the present work that although the green finance topic has gained traction in the last ten years, there are still considerable barriers that need to be addressed to exploit the potential it holds.

The increase in green financial instruments has mainly been as a result of the changing perspective of investors about environmental, social, and governance (ESG) factors in their investments. Additionally, regulatory regimes particularly in the EU have helped develop the green finance sector. The EU Taxonomy and the Sustainable Finance Disclosure Regulation (SFDR) are examples of such regulatory frameworks that have assisted in increasing confidence and consistency in what can be termed as "green" finance and investment products.

However, despite the immense progress that has been made, there remain several issues, particularly concerning transparency, standardization, and accessibility. The most crucial of these concerns is the absence of standards that are enforceable in practice, and which have an international shared effectiveness about green financial products. Relevant institutional provisions exist, for instance, the Green Bond Principles, but the lack of a global and enforceable standard has resulted in the fragmentation of the market. Inconsistency such as this, creates challenges in placing certain green financial products and services of such nature across geographical locations and industries, leading to a risk in the suspicion in the credibility of some green finance initiatives. Even though several studies show that the prevailing issue of greenwashing is present in all industries, it is more pronounced in created markets like green finance, where companies or financial institutions overstate the return of the investments on the environment. This poses a major drawback as it erodes most of the trust surrounding the market for green finance.

To solve these problems, appropriate standards and reporting regimes must be developed by the regulators, financial institutions, and corporations more coherently and strongly. In this regard, an appropriate level of transparency needs to be ensured because the investors would want information on the environmental performance of their investments that is accurate and consistent with other available information.

In addition, enhancing the auditing and certification processes of green bonds and similar instruments will ensure the proper utilization of resources raised for environmental projects and the achievement of the desired environmental objectives.

The green finance market also encounters the problem of expensive green financial product issuance costs as compared to traditional financial products. In addition, the costs involved in seeking, for instance, augmenting the certifications, and hiring consultants to comply with the regulations on reporting may be unbearable, especially to smaller or underdeveloped markets. It is imperative to mitigate these obstacles if the green finance horizon is to broaden. Governments can make a difference by way of subsidies, tax breaks or other guarantees that will enable companies to profitably raise green bonds or other forms of sustainable finance.

What is more, although green finance has been on the rise in most developed economies, many barriers still abound in the case of emerging markets. There has been also a considerable delay in the embracing of green finance instruments in areas dependent on fossil fuels or those that do not have proper financial systems. These challenges could be resolved by specific measures such as green credit guarantees or the use of blended finance mechanisms that can de-risk investment in these regions and promote healthier levels of investment.

There is still a need for financial institutions, investors, and governments to further develop the existing tools, policies, and frameworks so to facilitate in the making of a more sustainable economy globally. The problems are many, but also the possibilities, not only in financial terms but also the environmental ones.

Green finance can bring in changes in industries, lowering the carbon output, and helping in the fight against global warming, but only if measures are taken to simplify and made appropriate. All things considered, there is no doubt that the green finance industry has come a long way however it is still a developed but developing sector of the economy. To realize the possibilities of this young industry all challenges need to be tackled, and the market restructured into a cohesive and open environment. This way, green finance can contribute towards the achievement of international climate change targets and prospects of economic growth and development of the society while making the world a healthy and bearable place for future generations.

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