LUISS

DEPARTMENT OF ECONOMICS AND FINANCE

Chair of Financial Markets and Institutions

Green bonds: convenient means to mitigate climate change?
Between market growth and greemium

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Acknowledgements

"Everything has to come to an end, sometime."

-L. Frank Baum, The Marvelous Land of Oz

I would like to thank my Mama, who has always been by my side. I would also like to thank my dear Franz, for all the support and encouragement that he has given me since the very beginning.

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ABBREVIATIONS

ABS	Asset-Backed Securities
AUM	Assets Under Management
BEC	Breakthrough Energy Coalition
BNP	Banque Nationale de Paris
CBI	Climate Bonds Initiative
CBS	Climate Bonds Standard
CFI	Corporate Finance Institute
CFLI	Climate Finance Leadership Initiative
CICERO	Center for International Climate and Environmental Research Oslo
CSR	Corporate Social Responsibility
DFI	Development Finance Institutions
EIB	European Investment Bank
ESG	Environmental, Social and Governance
ETF	Exchange Traded Funds
EU	European Union
EUR	Euro
FE	Fixed Effects
GBF	Green Bond Framework
GBP	Green Bond Principles
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HSBC	Hongkong & Shanghai Banking Corporation Holdings
ICMA	International Capital Market Association
IFC	International Finance Corporation
KPMG	Klynveld Peat Marwick Goerdeler
LED	Light-Emitting Diodes
MDB	Multilateral Development Bank
MSCI	Morgan Stanley Capital International
MTA	Metropolitan Transportation Authority
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
OTC	Over the Counter
PIMCO	Pacific Investment Management Company
PPA	Power Purchase Agreement
PRI	Principles for Responsible Investment
PWC	Pricewaterhouse Coopers International
R&D	Research and Development
S&P	Standard and Poor's Dow Jones
SDG	Sustainable Development Goals
SRI	Socially Responsible Investment
SSA	Sovereigns, Supranational and Agencies
SWF	Sovereign Wealth Funds
TCFD	Task Force on Climate-Related Financial Disclosures
UN	United Nations
US	United States of America
WB	World Bank
WWF	World Wildlife Fund

INTRODUCTION

In the past decades, it has been widely noticed that the global economy, in particular when talking about income per capita, has not been achieving the level of growth to which most countries aspire. Widening inequalities, persistent unemployment, etc. are splitting the society into two, furthermore such events have also raised questions and concerns on how benefits of growth are shared. Thus, many countries are "reinvigorating" and "reinventing" their economies, whereby especially the quality of growth, as for example the meeting of expectations on health and education, is getting to play a major role. To improve the general well-being of a country's population, the benefits of growth should be felt by everyone in the short term, while in the long term, growth should additionally be economically, socially and environmentally sustainable. To this day, the global economy mostly relied on cheap natural resources, as for instance fossil fuels, in order to meet the demand of the rising and ageing populations and unfortunately, has little value been given to the social and environmental costs of this exploitation. It is now clear that, paradoxically, this exact growth model is now threatening the foundations of continued growth. Indeed, environmental pressures, as climate change and its related scale of potential damage, pose major challenges to the global development.

The good news is that all these challenges and risks present an unique investment opportunity that is linked to the transition to a low-emission carbon-neutral economy. Recent estimates suggest that within the next ten years, there will be need of an infrastructure investment of at least hundreds of trillion dollars in order to achieve some of the set goals (i.e. in the Paris Agreement) that help to support the transition. Thus, addressing climate change, requires substantial sums of investment not only by the public, but also by the private sector, which is the most important source of investment in renewable energy and energy efficiency worldwide. One major problem to get private finance easily involved in this new investment opportunity and in this new type of market, is that there still exist many factors, including poor governance, policy imperfections, corruption, etc., that present risks and challenges (policy and legal) which are unfavorable for the investment climate. Luckily, for those that decide to invest in a climate resilient future, opportunities and benefits keep emerging, these include for instance the opportunity to cut costs, to shift consumer and producer preferences, or to exploit new markets.

This thesis in particular, focuses and proposes one financial tool that could help to overcome the various obstacles, challenges and risks that investors, and especially private ones, face. The tool we are talking about is the so called "green bond", which not only appears to promote sustainable growth and to be a reasonable candidate, but which is also able to achieve and be coherent with climate change mandates and to decreases climate change while boosting the transition to a low carbon economy, but which also seems to have an adequate risk and return portfolio that has been attracting hundreds of thousands new investors in recent years.

As we will see, the main difference between green and conventional bonds is the commitment to use specific earmarked proceeds and to finance exclusively eligible green projects and infrastructures, as for instance those including energy, buildings, transport, water, etc. What we will also learn in further chapters is that the green bond market has undergone an enormous development and growth in terms of both, numbers as well as investor and issuer differentiation, since the first green bond has been launched by the EIB in 2007. Some of these green bonds, which started off as small transactions, have in fact become worth even 1 billion dollars throughout the years, at the same time, each of the various new investors, that have been ranging from small privates to major corporates or even national or subnational governments, have formed an additional typology of green bonds. Moreover, parallel to the process of market growth, there has been an increase in demand for integrity and quality, which gives issuers and investors greater security. Thus, several standards guidelines and rules have been invented and introduced to support the financial decision makings and that unify all the related reports, disclosures etc.

The most important points, that the present thesis will elaborate on, are structured as follows: the first chapter explains the issue of climate change and the possible actions (and its related actors) that can be taken to overcome this issue. The same chapter will also mention the risks, challenges and opportunities that this issue brings. the second chapter will finally focus on the "main character" of this thesis: the green bond, which is one tool as well as one possible solution proposed by this thesis to the financial sector to overcome climate change. The second chapter will furthermore define the green bonds' market, its related market players and barriers and their issuance, while the third chapter will try to give an answer to our main question "if green bonds are a convenient means to mitigate climate change?". To do so, this thesis conducted a literature review on a seven peers-set of academic studies which focused on the financial performance of green bonds and more specifically on their green premium.

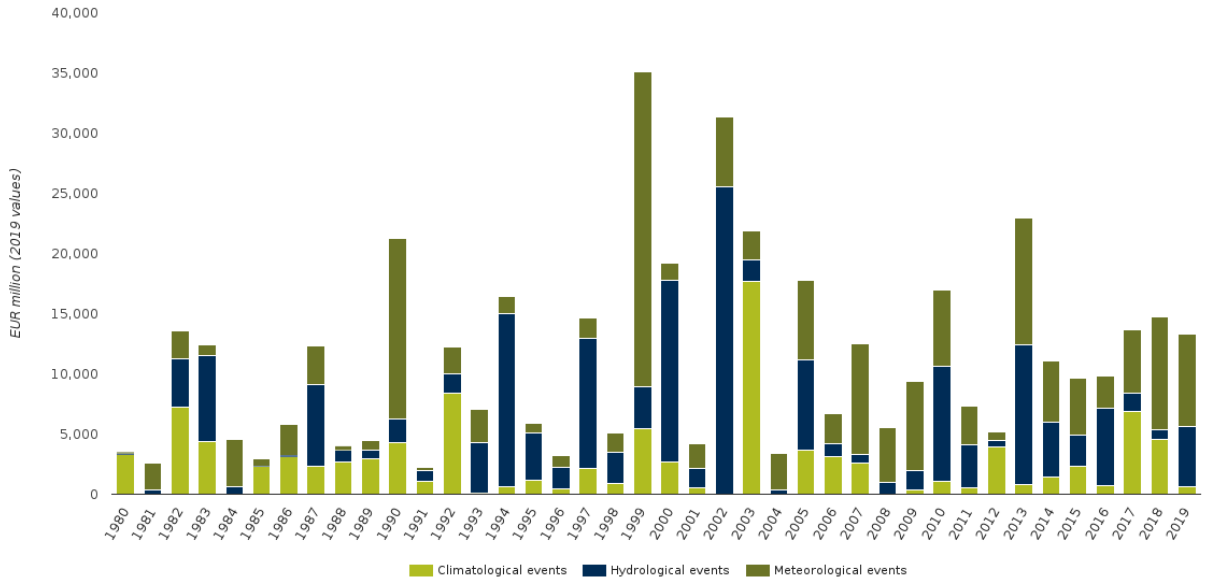
CHAPTER 1: TOWARDS A LOW-CARBON FUTURE

1.1. THE ISSUE

The climate change and its related hazards which we are facing in the past decades, such as meteorological (i.e. heavy precipitation), hydrological (i.e. flooding, mass movement, etc.) and climatological events (i.e. temperature extremes, droughts, wildfires, etc.), pose a major risk to the wellbeing of humanity and other living creatures, to the ecosystem and our economy. These hazards account for around 38%, 39% and 23% of total recorded damages and losses respectively. Among such losses, meteorological ones are in general better insured (65%) than hydrological (28%) and climatological (8%) losses. The latter, heat waves in particular, are by far the most reported reason of total deaths trough climate hazards (91%) in Europe. Climate change has natural causes, as the brightness of the sun which passes on an increasing amount of energy to the earth's atmosphere, but unfortunately the causes are also more and more human. Mankind produces fossil-fuel combustions, industrial productions, deforestations, monoculture farming, livestock ranching, etc. which emit GHGs that accelerate the greenhouse effect and that have a negative impact on ice sheets, vegetation, temperatures, etc. The alarming point is that many civilizations of developing countries especially, which depend strongly on the environment (including nature and soil) in which they live, have already collapsed in the face of these rapid and severe changes. In fact, three billion of the world's poorest suffer from health, as well as economic, consequences of climate damages, mostly due to missing income-generating activities and insufficient essential facilities and services as medical support and education.

Apart from developing countries, have industrialized ones also noticed the outcomes of climate-related risks as they begun to materialize. Factors as growing population, economic wealth and urbanization drive disaster losses. These losses made up for 81% of total economic losses of EU member states in the 80's, which was about 3% of their annual GDP. However, harms are expected to further increase and to make up for 10% to 12% of GDP on a global scale by 2100 (a value of 43 trillion dollars). To this day, some of the most important perils within and across the hazard categories are hydrological perils, whereas the costliest are flooding, accounting for 34% of total economic losses, and winter storms, which are also the most covered in terms of insurance (59%), followed by severe storms (54%). In the period of 1980-2019, Germany recorded the largest per unit of land and per capita economic loss among European states, while Switzerland accounted for the most hazard-exposed country. (Jackson, 2020)

Figure 1: Economic damage due to climatological, hydrological and meteorological events, Europe, 1980-2019



Source: (Jackson, 2020)

Most of the losses comprise only for the financial value of the damage to assets and the recovery costs, while losses propagated through supply and demand shocks are generally not accounted. Together, these damages do not only demolish actual tangible assets, but they also represent other financial risks, in the sense that they raise the credit spread, speed up pricing readjustment and bring to precautionary saving. To minimize, avoid, mitigate and absorb future disaster losses, there is need of measures as risk assessment, prevention, preparedness, response, risk transfer and compensation. The problem is that to do so it is necessary to have accurate information coming from advanced science. Such is often difficult to get, because data normally vary by diverse factors and information is disputed and considered to have low confidence. However, with the right risk-aware policy and decisions on the cost and benefit of the above-mentioned measures, loss and damage can be limited. (European Environment Agency, 2017)

1.2. ACTIONS

Governments have lately begun to recognize most of the issues that are related to climate change and they started to understand how urgently these need to be addressed. The 2015 Paris Agreement and the 2030 Agenda for Sustainable Development reconfirmed once again that a growth and development cannot continue without an economic and social transformation and without tackling climate change, while boosting environmental sustainability. In both of these two important events, authorities have therefore agreed to restrain the global average temperature increase to less than 2°C and preferably to 1.5°C compared to pre-industrial levels, to achieve a climate neutral world by 2030. (European Environment Agency, 2020)

Furthermore, governments decided to monitor the impact of climate hazards and to develop policies and structural reforms that increase low-carbon investment on one hand, and the transition of carbon-intensive sectors on the other. Since such a transition necessitates significant investments and innovations, the Paris Agreement provides for financial, technical and capacity building support to those countries that are less endowed and more vulnerable. According to the European Commission, to become carbon-neutral by 2050 requires exactly 350 billion euros of additional investments in 2021-2030, which is more than double of the whole European budget expenditure for 2020 (155 billion euros). Thus, in order to achieve the set goals, there is surely need of the engagement and involvement of private finance, because the demanded size of investments goes far beyond what governments are able and willing to fund directly. To attract private capital for projects that have larger political and commercial risks, governments use different approaches, for instance loans, subsidies, feed-in tariffs, matching grant schemes, blended finance and guarantees. In addition to authorities also the financial sector has a crucial role in mobilizing private finance. Not only should the latter give social support to those corporations and communities that have relied on high-emission activities or operations, but it should also serve as partner in fostering relationships between the private sector capital and the public finance institutions to scale up the financial flows of investments. To form these partnerships, it is important that both public and privates gather an extensive understanding of each other and especially of their complex investment chains. (Luigi Federico Signorini, 15th October, 2020)

Figure 2: The 17 sustainable development goals

Source: (United Nations, 2021)

Apart from offering enormous financial assistances, privates have the fundamental task of functioning as role models in promoting greener behavior across their supply chains, customers, investors and others. Indeed, privates themselves have acknowledged the importance of addressing climate change and environmental challenges, because they understood that it is key for managing business risks and ensuring long-term returns on investment. Furthermore, firms realized that improving environmental performance can help them to reduce costs, to streamline operations, to increase efficiency and to develop new products and services. (OECD, 2016)

1.3. ACTORS

As mentioned above, the investment chain is a complex system that involves the public and the private financial sector and that is in a constant state of change. In the following section we will see who their exact components are:

1. **The private-sector institutions**

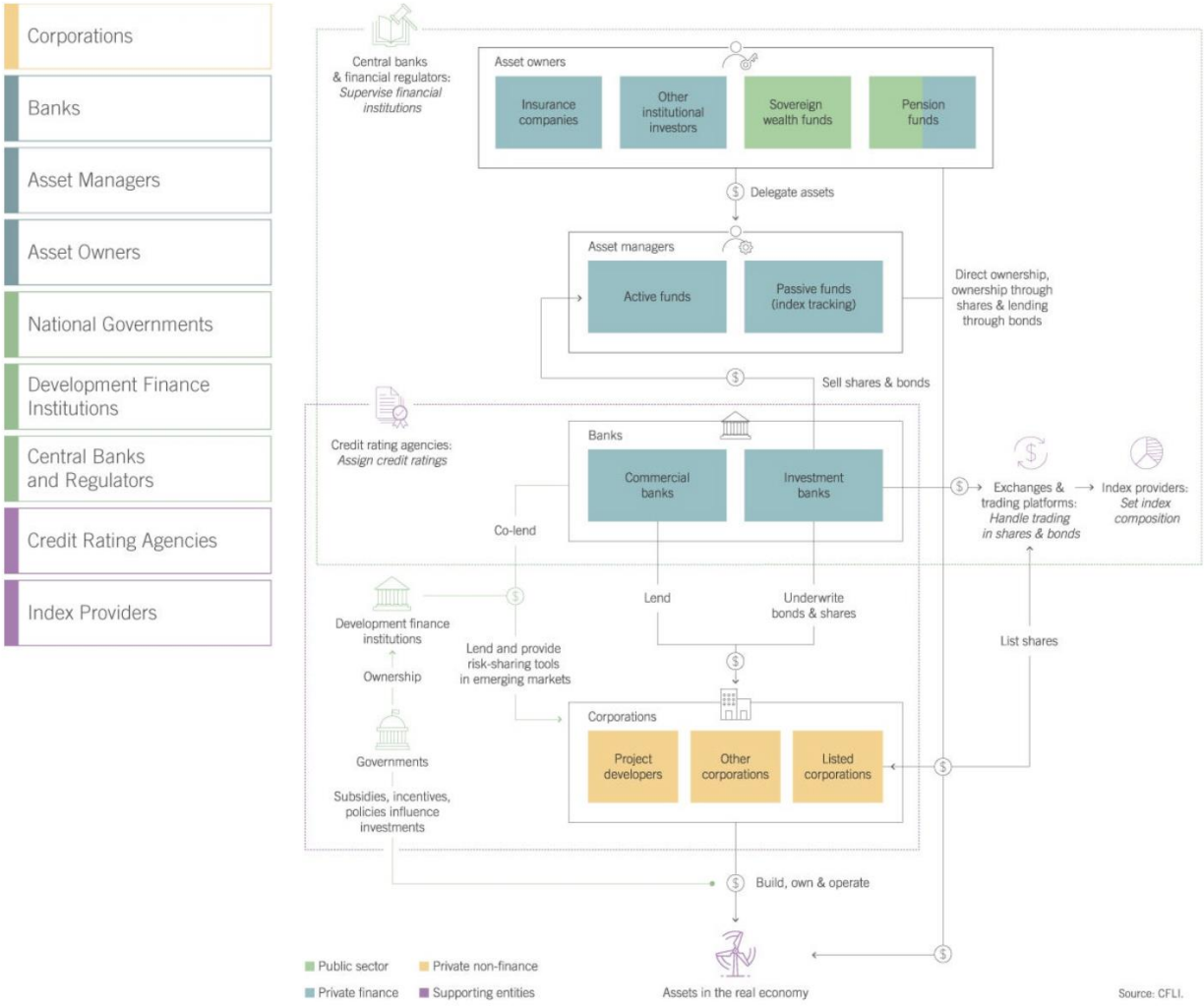
Corporations and project developers: These invest in assets and typically source finance to build and develop new assets. Project developers own and operate projects and sell them to other investors to clear capital for new projects, while corporations own and operate assets, equities and capital instead, and make decisions on their operations. Projects developers often get financing trough loans or bonds, on a specific project basis which depends on the risk-return components of the project. Corporations, on the other hand, can finance projects either with cash in hand, which they possess thanks to their retained earnings, or by accessing bank loans and issuing bonds or equities, which leaves them flexibility in deciding how to invest.

Commercial and investment banks: Both act as providers of capital and financial intermediaries between investors and corporations or project developers. Investment banks can be either stand-alone entities or part of financial institutions. To serve as intermediaries, they need to underwrite bonds or equity offerings to trade them and other financial products (currencies, derivatives, commodities, etc.). Commercial banks, on the other hand, lend directly to projects and companies and their portfolios are basically their loan books or the payable loans which are overdue. Both types of banks seek to make returns for their shareholders, therefore they need to comply to regulations and their decisions need to depend on the creditworthiness of the firm or project. In general, commercial and investment banks are affected by legal capital requirements, as authorities require banks to keep a certain share of equity or capital against business and projects that are considered risky. (CFI Corporate Finance Institute, 2021)

Asset managers: Asset managers are intermediaries that manage investments across all asset classes of large institutions, specialized firms and individuals. They need to buy and sell financial assets, but they can also invest directly in assets in the real economy. Asset managers have the legal liability and duty to act in their clients' best interests and in the case of smaller institutions, they can normally choose the investment approach themselves.

Asset owners: These are investors, as for example endowments, family offices, banks, high net worth individuals, foundations, pension funds, insurers or sovereign wealth funds that have long investment horizons. Many asset owners delegate parts of their portfolios to asset managers or they invest them in passive funds. Asset owners try to optimize returns over the long run without taking major risks, but their decisions on the investment depend also mostly on their tolerances and regulatory constraints. (Climate Finance Leadership Initiative, September, 2019)

Figure 3: The investment chain: Interaction between private and public sector



Source: (Climate Finance Leadership Initiative, September, 2019)

2. **Private-sector entities**

Credit rating agencies: These evaluate if company or green project is able to pay back debt, then they rate this examination and provide indexes and scales that can rank and that range from least to most creditworthy. Ratings can be used by investors to get informed and to make decisions on asset allocations or to integrate them into financial products.

Index providers: Such affect the capital distribution of asset owners by developing and determining index composition, which funds use to benchmark performance or which ones they use to track. (CFI Corporate Finance Institute, 2021)

Insurers: These underwrite and reduce, in exchange of an annual premium, some of the risks that investors' assets face, as those of liability, damage and business interruption and they also guarantee that they will still pay out in case of losses.

3. **Public-sector actors**

National governments: These set policies that are supported by public budgets and that establish frameworks and conditions for investments. The subsidies can be used to aid R&D for new technologies and can also make projects, that were too expensive or uncertain, more interesting.

Central banks and financial regulators: These control the financial system and limit financial risks by using monetary policies to manage inflation and unemployment. Central banks sometimes supervise individual banks through industry-specific regulations which guarantee the financial stability of the system, the protection of retail customers and the solvency of firms.

Development finance institutions: DFIs are government development agencies and the private-sector's segments of MDBs. They try to make sustainable economic development more popular in emerging economies by providing various tools, as for instance investment-friendly market standards, to stimulate investment. DFIs operate as investment banks of the public sector and are in most cases the principal sources of asset finance in emerging markets. DFIs play a central role in pioneering clean energy transactions: on one hand they furnish political risk insurance, guarantees, hedging and debt subordination, on the other hand they establish standards, concessions and financing agreements for investors which invest alongside DFIs and which also seek to enter new countries and markets with higher perceived risks. Moreover, they help to implement regulatory frameworks and to develop stronger value chains, which can lower the costs of sustainable projects and facilitate the shift to newer technologies. (Climate Finance Leadership Initiative, September, 2019)

1.4. BENEFITS AND DRAWBACKS:

1.4.1. Risks

As investments are mostly over a longer term and involve great costs, multiple shareholders and financing structures that are not always standardized, private investors are only interested in those projects that have clear revenue streams. Unfortunately funding often entails risk factors that are difficult to mitigate and quantify as for example the creditworthiness of a country, currency volatility over the project lifetime, the political instability and corruption, the market and the policies involved. A general principle is that an increase of actual or perceived risks is parallel to the increase in the returns demanded by investors and also parallel to the costs that are paid by users and governments to fund these green projects. Risks can be divided in transition risks and physical ones.

The transition to a lower-emission economy is related to changes in policies, technologies and markets, that have different natures and drag along financial and reputational danger for organizations. Transition risks can be split in various types: political or regulatory, macroeconomic or business, and lastly, into technical risks. The formers emerge because of the fact that low-emission projects depend on policy makers which enact regulations that either forbid certain actions that boosts climate change or that stimulate the adaptation to climate change. Henceforth, deviations in the political commitment and policy action around climate change can bring to changes in remuneration schemes and subsidies which in turn influence investments. In emerging markets, these kinds of challenges are even more elevate because of the major lack of enabling policy frameworks and because of their barriers to enter. Macroeconomic and business risks on the other hand, are due to factors as the interest rate environment, the energy prices, sovereign default, the currency convertibility, but also due to demand and supply, and all these components are highly volatile in climate-related projects. (OECD, 7th November, 2018)

The third type of risks, the technical one, is often perceived by investors because, even though technological innovations have generally positive effects on organizations, they know that at the end of the creative destruction cycle there will appear some winners but also many losers. These risks are linked to problems of connectivity, technical failures and issues on the reliability of cost or time forecasts of the realization of the project. Policymakers can help mitigate such risks by using clear methods and by permitting processes that guarantee that the projects will not have great delays and that can thus be accredited on time.

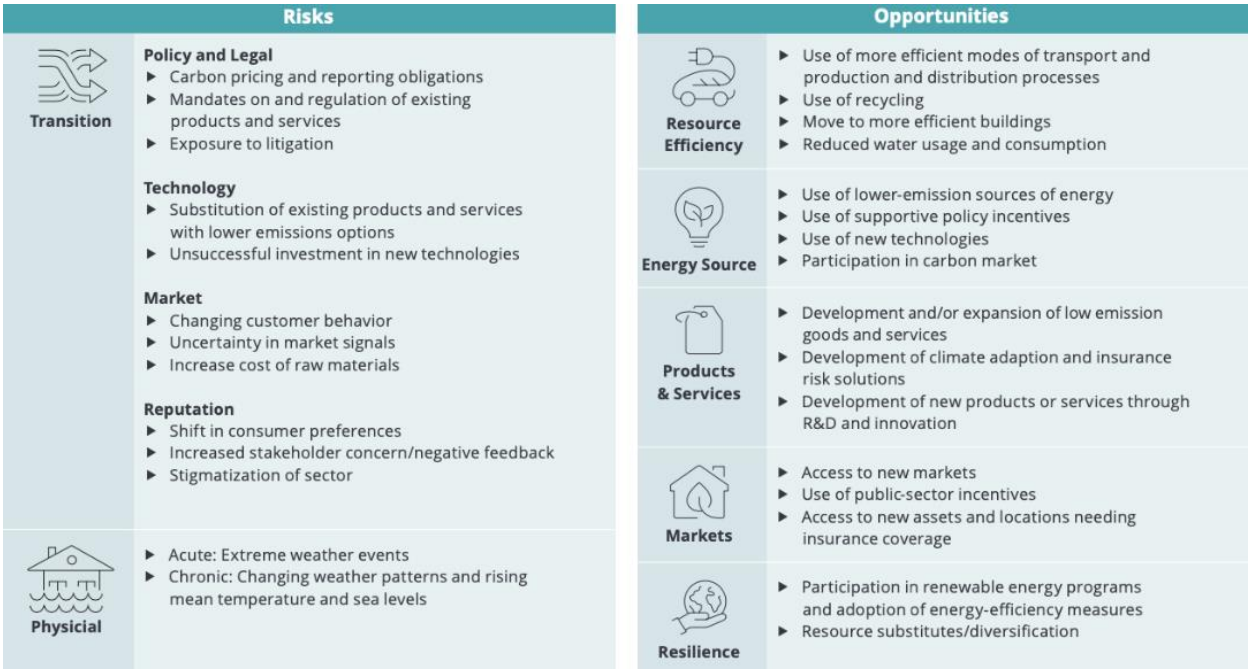
Returning to the second category of risks (physical risks), we divide them in acute ones, thus driven by events of extreme weather and in chronic ones, which carry with them long-term shifts as increases in the sea level. Both of them emphasize damages to assets, the supply chain, safety, etc. which not only harm low-emission project investors but hypothetically also all other kind of investors even if their investments have not directly to do with green projects. (TCFD Task Force on Climate-Related Financial Disclosures, 15th June, 2017)

1.4.2. Opportunities

The adaption to climate change gives rise to many risks, but it has at the same time also some positive rewards and offers firms diverse opportunities, such are for example resource efficiency, cost savings, new products, services and markets, etc. that will be discussed below:

1. **Energy source:** To achieve the emission-reduction goals, states will need to switch to low emission alternatives of energy generation, as wind, solar, nuclear, hydro, carbon capture, biofuels and geothermal energy generation. This can improve storage capabilities and save costs for especially those firms that still fully depend on power grids. (Goldman Sachs, 2019)

Figure 4: Climate related risks and opportunities



Source: (TCFD Task Force on Climate-Related Financial Disclosures, 15th June, 2017)

2. **Products and services:** Firms that modernize their products and services or develop new low-carbon ones, could shift consumer and producer preferences and at the same time also their demand and supply. New goods and services could attract consumers, for example because of their small carbon footprint, which is increasingly becoming a trend in the travel, fashion and food & beverage sector, or because of for example a firms' emphasis on the reduction of emissions. (TCFD Task Force on Climate-Related Financial Disclosures, 15th June, 2017)

3. **Resilience:** Climate resilience means that firms develop adaptive capacities to respond to climate change by managing risks and seizing opportunities. The opportunities that are related to resilience are notably important for firms with fixed assets and broad supply or distribution networks.

4. **Markets:** Firms that see and exploit opportunities in new markets can switch to new activities and can at the same time improve their position in the transition to a low-emission economy. These opportunities are captured through the underwriting of green bonds and through the process and shift they bring, and they can be supported by governments, banks, entrepreneurs, etc. through various types of financing. (Goldman Sachs, 2019)

5. **Resource efficiency:** With the improvement of energy efficiency, materials, water and waste management, firms not only contribute to the global efforts to curb emissions, but also reduce operating costs, across their production processes, their supply chain, their buildings, machinery and mobility. The energy efficiency stems mostly from innovation in technology, as for example efficient heating solutions, LED lighting, industrial motor technology, geothermal power, electric vehicles, etc. (TCFD Task Force on Climate-Related Financial Disclosures, 15th June, 2017)

1.4.3. Challenges

Apart from the various risks and opportunities that sustainable project investors and other market players face, there exist also challenges, that particularly authorities encounter when they try to implement plans that should contribute to an adaption to climate change and that should achieve the goals of the diverse agreements. The public, but more specifically financial institutions and businesses have become doubtful on the question if to invest and how to mobilize investments for the right kind of new energy-efficient, climate-resilient and low-emission infrastructures or technologies and for the just reallocation of resources. (de Mariz, 2020)

Challenges derive from diverse sources, one of them is for example the fact that the threat of future implications is not taken seriously enough because people tend to focus more on short-term gains and because a transition to a low-emission economy is connected to elevate costs. Hitherto little value has been given to social and environmental costs because demand has always been satisfied trough technologies that were based on cheap high-carbon options and fossil fuels. Admittedly, it is true that low-carbon investments are not economical yet due to their capital intensiveness, their cost structures and the lack of incentives, as a result of great budgetary disciplines or because of their revenue models. (Climate Finance Leadership Initiative, September, 2019)

Nevertheless, renewable energy, EVs and others are becoming more and more cost-competitive, while in the heavy industry or the land sector there still not exist enough financially viable alternatives. Both of these latter categories miss a revenue model that can support large-scale deployment, while when speaking of the technology that is used, it would be possible to find some possible substitutions. The problem with such technologies is that many of them are still in the research and development or in the demonstration phase and most have also not been proven yet. Thus, even though governments and industries are sometimes skeptical about these technologies, authorities will nonetheless need to hold onto such to overcome in the meantime the lacks in demonstration and commercialization. With this in mind the private sector recently founded some initiatives as for example the BEC to fund early-stage technologies and innovative ideas, etc.

On the other hand, the technologies that are used in the agricultural sector face challenges that are connected to the scarcity of information and knowledge that is given to find answers to the question on how to reduce the climate impact. Another challenge is the fact that many investors only have small activities, and they have therefore difficulties to finance them. In response to these kinds of problems, many public and private lending platforms and financial products started to emerge and also started to address them, one of such is for example BNP Paribas, which structures agriculture investments or loans and backs them into bonds. Green bonds can cope with both of these obstacles, whether they be linked to the size of project and investments or to the lack of acknowledged data and methodologies. For example, GBPs are criteria that describe how projects need to address climate change. They hence ease the inclusion of climate risks and opportunities into decision-making and strategies. (de Mariz, 2020)

There is another way for the private financial sector to assist the transition to a low-emission future apart from the pure financing itself: firms can develop sustainable products which not only help to generate demand for these types of goods, but which also create incentives for suppliers to invest in emission reduction measures. The task of public institutions remains at the same time that of providing subsidy mechanisms, loans and budgets to fund the R&D of these commodities. As we have seen, by leaving aside costs, it becomes evident that the financing of means that can boost a transition is absolutely necessary because recourses are becoming scarcer every day and because looking at the long-term benefits, we realize that investments will surely be paid off.

A second challenge is that the investment models are not replicable at scale, as a matter of fact the investor's enthusiasm for green projects is often greater than the number of opportunities of investment. In times of crises, as the Covid-19 pandemic, some renewable energy capacity additions encountered periods of stagnation due to uncertainties or reversals in policies. This has hurt the long-term stability of revenue models that support clean energy investment, and it also gave rise to a couple of doubts on the profitability of green projects. Many investors therefore returned to prefer coal based power stations even in those industries where low-carbon substitutes were already cheaper. Thanks to this happening, authorities have understood that price stability is fundamental for clean energy projects investments and that revenues could be guaranteed through public budgets. Thus, they started to support investors by reducing risks and facilitating innovation trough tariffs, subsidies or premiums and by awarding contracts through competitive auctions, which give investors the just confidence to deploy capital over extended periods. Privates can also themselves find methods which make prices stable without asking any financial aid from the public sector, such techniques are for example PPAs. PPAs, by conferring the exact revenue certainty that is needed, have started to attract also more investors form the private sector, which in turn has commenced to offer a larger pool of investment capital. In this sector, asset managers and owners still have the problem that there are not enough financial products that suit their asset allocation approach, as they normally prefer to allocate large sums per transaction. Henceforth, private investors begun to use bonds to aggregate green investments into their financial products. These bonds allowed them to achieve bigger scales while still supporting small projects. The securitization of project debt provides the opportunity to access capital markets for fixed-rate, long-term financing without the use of non-resource loans and it also helps to deploy capital to small assets while also freeing up one for new investments. (Climate Finance Leadership Initiative, September, 2019)

1.5. A POSSIBLE SOLUTION

As we have seen so far, no government budgets, no capital requirements on banks, or similar, can make-up enough funds to finance the predicted additional annual investment required for the transition to a low-carbon future, thus there is a fundamental missing piece that needs to be engaged which is the private sector. The latter is important not only because it offers financial aid, but also because it plays a major role in the difficult process of transition, as it helps to spread awareness and catch consumers attention through the development of new technologies, sustainable products, etc. In fact, the private sector has been an enormous help in increasing operational efficiency and it has been supportive in a way that goes much further than mere financing. The investments that are made in this sector depend on the balanced match of expected risks or returns, with the just size of tolerance that investors have for them. Thus, to find investors, projects need to risk-adjust their returns, they need to balance blended finance interventions and they need to use a specific risk management. Governments, by using diverse techniques and incentives, try their best in matching suitable levels of returns, but as mentioned above, privates themselves have increasingly found their own methods to mitigate risks, for instance, standardized tariffs and PPAs or currency swaps. Investors should always benefit from them and try to apply these tools in their investments, but they should also benefit from the diverse capital market channels, the financial instruments, the partnerships and the expertise of experienced players. (World Economic Forum, 2019)

Sustainable finance investments can be split in direct investments, as infrastructure projects, or indirect ones as those of debt and equity. The latter are having more and more potentials because, if traded in publicly securities, they are not subject to a lot of constraints. Thus, the bond market has been growing in the past years, not just because of the low amount of constraints, but also because the market has the right investment profile and size, the just liquidity and the right legal freedom to become a further source of fund for green solutions. Particularly green bonds, by involving principally private capital, are seen as “the game changer” in solving the funding gap problem of green finance. Those bonds are the solution for the shift to a sustainable investment as they lower the cost of capital by furnishing a larger pool of possible investors which therefore can finally scale even in smaller projects. Secondly, they can give access to securitized long-term debt, backed by financing or refinancing specific low-carbon assets and lastly, governments, banks, supranational, etc. can, through green bonds, offload risks from their balance sheets. (OECD, 23th May, 2017)

CHAPTER 2: GREEN BONDS

2.1. WHAT IS A GREEN BOND?

In the last decades the world perceived a considerably trend of financial markets moving towards a low carbon economy. The upswing started in 2007 when the market for self-labelled "green bonds" arose. A green bond is a vanilla fixed-income financial instrument or asset to raise a fixed amount of capital through the debt market. Such debt securities issued by financial, non-financial or public entities carry the credit risk of issuers, which raise for a certain period of time capital from investors, while paying interests or coupons until repaying the whole amount when the bond matures. Some of these debt securities' credits are directly exposed to project and revenue streams. A green bond is therefore structured in the same way as a standard bond, in the sense that it has the same characteristics in terms of seniorities, execution processes, ratings and pricings. The only key difference between green and conventional bonds is that the formers allow investors to help mitigating climate change while keeping the same returns. In fact, green bonds are issued to fund, finance or re-finance new and existing eligible "green" projects, business activities or assets that have environmental or climatical benefits. (S&P Dow Jones Indices, November, 2019)

Normally such projects include for example the protection of ecosystems, renewable energy, energy efficiency, clean water and sustainable water, fishery and forestry, clean transportation, waste management, sustainable agriculture, pollution prevention, biodiversity conservation and many others. The majority of issued green bonds are of the type "green use of proceeds". Prior to their emergence, investors gave little attention to the use of proceeds, but then has growing demand brought to concerns on the definition of green bonds, thus globally accepted standards, principles and indexes have emerged to secure that proceeds are actually used for what constitutes a green activity. To be labeled as "green", bonds need eligible criteria, they need to express covenant for the allocation of proceeds, they also have to routinely disclose a second opinion and offer a general description of the project that could be or is eligible and lastly, they need to report back on the projects that the proceeds have supported. While guidelines and standards exist for issuing green bonds, there is not yet a fully-developed and widely-accepted definition of what makes a bond "green". The failure of defining clear standards can make an issuer face accusations of greenwashing or it can lead to reputational risks, as well as public distrust, which undermines the credibility of the market and therefore worsens its development. (KPMG's Global Center of Excellence for Climate Change and Sustainability, 2015)

2.1.1. Types and typologies of green bonds

1. **Corporate bond:** A corporate bond also called a “use of proceeds bond” is issued by a corporation with appeal to the issuers’ debt obligation and it has the same credit ratings as other bonds of the same issuer. The proceeds from such bonds are ring-fenced by the issuer and reserved for green projects and are covered by the entire balance sheet of issuers. This category includes bonds as the EIB’s "Climate Awareness Bond" or Barclays Green Bond. (Climate Bonds Initiative, 2021)

2. **Project bond:** Such is backed by one or multiple green projects for which an investor is directly exposed to the project risks, with or without possible recourse to the project's assets and balance sheet of the bond issuer. Project bonds’ proceeds are ring-fenced for the specific underlying green projects and they include various bonds as for instance those of Invenergy Wind Farm.

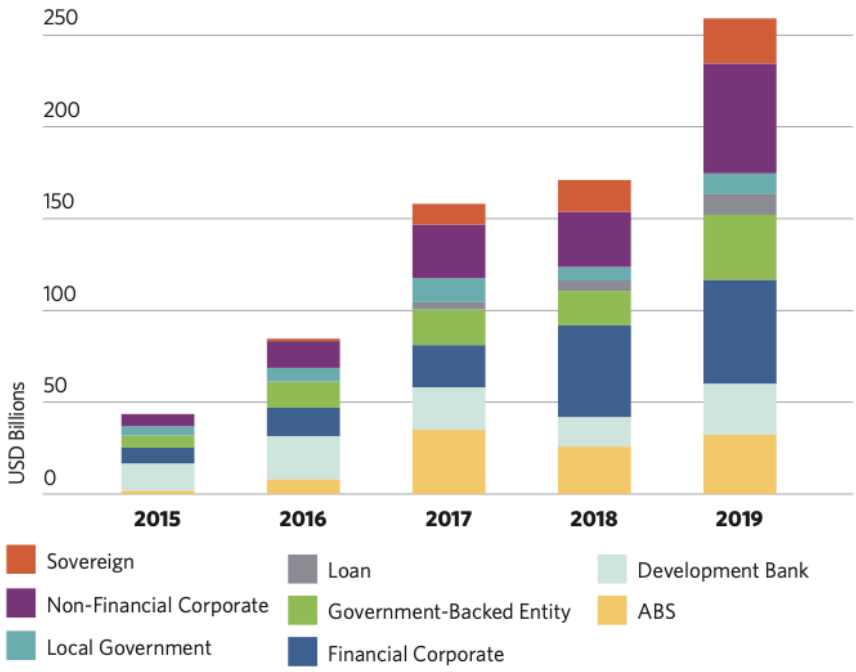
3. **Asset-backed security:** These are bonds which are secured by specific projects, which normally provide a recourse to a few projects that have been put together as solar leases or green mortgages, except if they are covered bonds. For the latter, the primary recourse is to the issuer, while the secondary recourse is to an underlying pool of assets in case of default of the issuer. Their proceeds are usually a refinanced portfolio of a green project or green proceed which are designated for green projects. Examples of ABS bonds are Tesla Energy (secured by residential solar leases) or Obvion (covered by green mortgages).

4. **Supranational, sub-sovereign and agency bond:** SSA bonds or “green use of proceeds revenue bonds” are issued by international financial institutions such as the WB. These types of bonds are comparable to corporate bonds that concern the “use of proceeds” and which are alternatives to the issuers’ debt obligations with credit exposure to the cash flows of the revenue streams, even though fees and taxes are collateral for the debt. Their proceeds are also ring-fenced by the issuer and earmarked for refinance green projects. This category is constituted of bonds such as agency bonds as the issuance by export-import banks, Hawaii State (backed by fee on electricity bills) and sub-sovereign national development banks.

5. **Municipal bond:** These are bonds which are issued by a region, municipal government, or city. Theoretically, can also national government entities issue a sovereign or municipal bond.

6. **Financial sector bond:** This is one type of corporate bond that is issued by a financial institution to explicitly lift capital to provide loans for green activities. (Bank of America Merrill Lynch, 1st December, 2015)

Figure 5:Types of green bonds issued over the period 2015-2019



Source: (Climate Bond Initiative, 2019)

7. **Covered bonds:** Proceeds of such bonds are allocated for suitable projects that are part of a the covered pool with recourse to the issuer or, if the issuer is incapable to pay back the bond, to the covered pool. This category includes bonds as the Dutch Sparebank 1 Bolligkredit green covered bond. (IFC International Finance Corporation World Bank Group, December, 2016)

8. **Loan:** The proceeds of these bonds are designated for eligible projects or they are secured on qualified assets with full recourse to borrowers in the event of unsecured loans and recourse to collaterals in case of secured loans. They can also have limited recourse to the borrowers, such are for examples bonds as those of MEP Werke, OVG and many more.

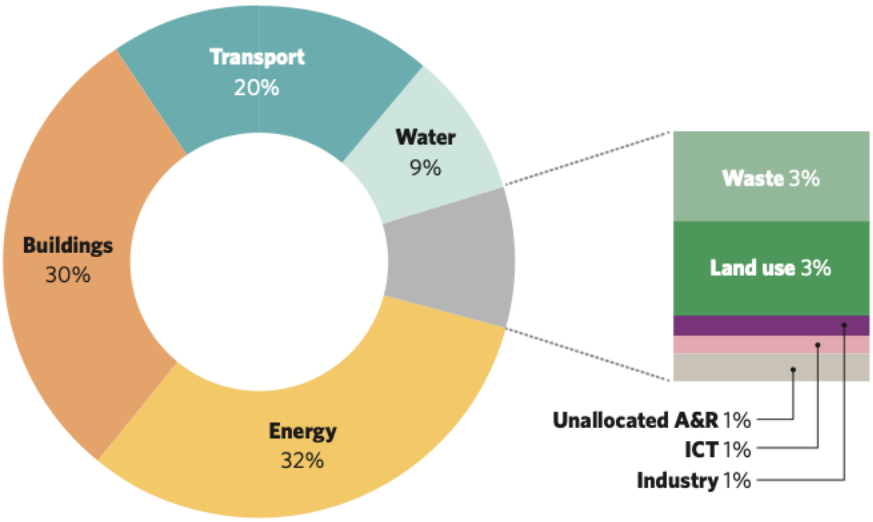
9. **Other debt instruments:** Their proceeds are allocated for eligible projects. This category includes convertible bonds or notes, commercial paper, debentures, etc. (Climate Bonds Initiative, 2021)

2.1.2. Eligible green projects

As previously stated, the funds from green bond issuances can be used to finance or refinance green projects. Firstly, for these projects and assets to be eligible, they need to be parts of either physical assets or of projects which belong to the issuer. The formers include existing equipment, machinery, infrastructure, buildings or land, while projects include the redevelopment, upgrade, expansion, value creation or enhancement activity of assets. Secondly, projects and assets can be part of debt or other financing arrangements that are given by the issuer to fund such projects and assets. Debts and financings include for instance an undertaken capital expense to rise the value and life span of assets or projects, the acquisition costs for a company which holds assets, projects and leasing structures that give the right of use of assets, liabilities and that additionally bring leaseholds on buildings and land, loans, infrastructure, mortgages, tax incentives, subsidies, credit schemes and grants and other similar arrangements provided by public entities or agencies. (ICMA, June, 2019)

Thirdly, projects or physical assets can also be part of related and supporting expenditures for green projects. These include, for example, installation and routine maintenance expenditure, a performance monitoring cost that tracks climate credentials and climate information services or they can also include relevant R&D, training and program implementation costs. Nevertheless, until today there are no universally accepted criteria that describe what a project must meet in order to be eligible and in order to be defined as green. In fact, even the GBPs list only broad categories of projects but no specific criteria that qualify a project as sustainable. The types of projects that are included in the climate bond taxonomy are:

Figure 6: Top use of proceeds categories of 2019 issuance

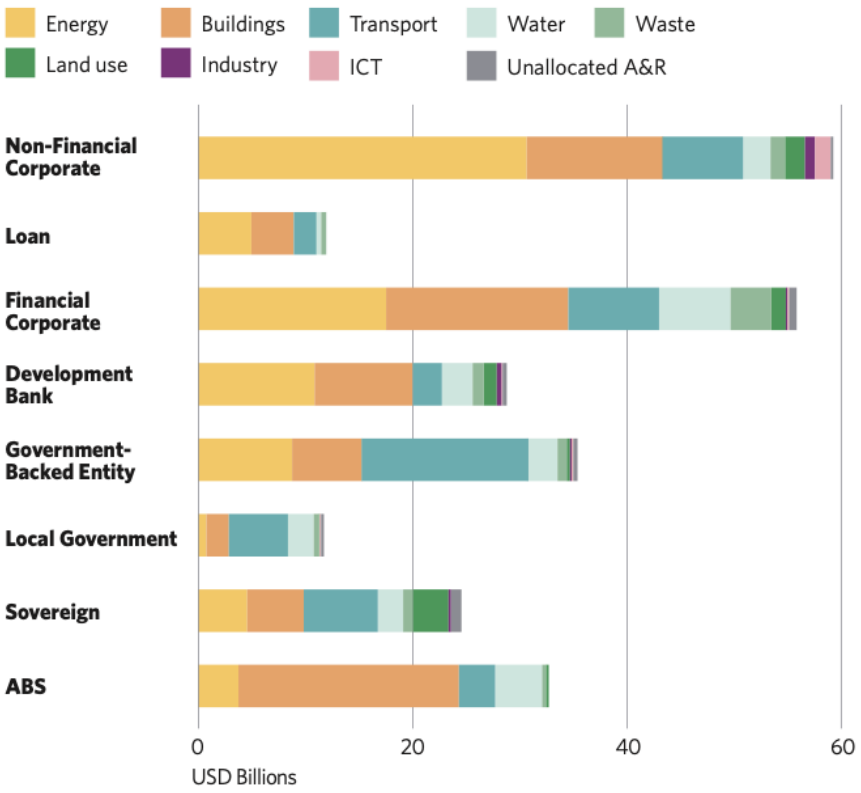


Source: (Climate Bond Initiative, 2019)

1. **Renewable energy and energy efficiency:** Such can be solar, wind, hydro-electricity, nuclear and geothermal energy, grid connections to renewable energy, biomass energy generation, marine renewables, energy efficiency projects, energy storage, district heating systems and rehabilitation of transmission facilities to reduce GHG, etc.

2. **Clean transportation:** These can be mass transit (public and private), rolling stock for railways, rail line electrification, electric vehicles, bus rapid transit systems, aviation, rail track capital expenditure, water-borne, and their related infrastructure, hybrid bus fleets and similar.

Figure 7: Use of proceeds by issuer type 2019



Source: (Climate Bond Initiative, 2019)

3. **Sustainable water management:** These are for instance monitoring, storage, treatment and distribution of clean water and drinking water, storm water drains adaptation measures, nature-based solutions, habitat restoration, flood defense, river revitalization and preservation, flood mitigation and ports infrastructure to address increased storm surge risk and so on.

4. **Buildings:** Such include low-carbon buildings, LED lighting installations, public housing with energy efficiency standards, products and systems for efficiency, urban development, etc.

5. **Sustainable land use and biodiversity conservation:** These could be sustainable agriculture, forestry and land use, ecosystem conservation and restoration, fisheries and aquaculture, agriculture supply chain improvements, protected areas as national park or biosphere reserve, seed banks, sacred plant, home garden, cryopreservation and others.

6. **Climate change adaptation:** Such as reductions in GHG emissions, energy efficient motors, waste heat recovery systems, etc. in the steel, iron, aluminum, glass, chemical and fuel cement production.

7. **Sustainable waste management:** These comprise preparation, reuse, biological wastewater and sewage treatment plants, recycling plants, low-emission garbage tracks, qualified waste-to-energy generation, landfill, radioactive waste management and many more.

8. **ICT:** For example broadband networks, telecommunicating software and service, data hubs, power management and others.

2.2. THE GREEN BOND MARKET

2007: The green bond market starts to develop trough the work of MDBs as the European Investment Bank, which issues its first green bond called the Climate Awareness Bond and thanks to the WB, which one year later launches its first green bond in response to the demand of Scandinavian pension funds.

2010: Many new public entities start to issue their first green bonds, but these issuances are still dominated by small transactions and the issuer's immense effort to raise awareness through all their available means and powers. (European Commission, November, 2016)

2013: The green bond market explodes and reaches more than 10 billion dollars, because of the issuance of diverse municipality and national or subnational government green bonds as for example those of the State of California (US), Johannesburg (South Africa), Ile de France (France), Province of Ontario (Canada), etc. The same year the World Bank Green Bond Symposium, a group of investors and issuers, understands that to foster demand and the growth of the market, there is an urgent need of high standards of integrity and quality. This important insight is in a second moment seen as a milestone for the green bond market and for the development of the GBPs, whom provide guidelines to new market entrants that harmonize reporting templates and support the decisions of issuers, investors, etc.

2014: The market evolves beyond SSA or MDBs when private-sector institutions, as corporate issuers, join the market and issue their first corporate green bonds. Such are ruled by the energy, utilities, consumer goods and real estate sectors and the biggest bond issuance (3.45 billion dollars) is made by the utility company ENGIE to finance renewable energy projects. Corporations even extended the green bond label to asset backed securities: Toyota sells securities of which proceeds are used to invest in electric vehicles and hybrids. Still in 2014, we experience the first issuance of a high yield green bond by NRG Yield and others, which permanently introduces different credit ratings to the market. At the same time several green bond indices as the S&P Dow Jones Green Bond Index, the Merrill Lynch Green Bond Index and the Barclays MSCI Green Bond Index family are launched.

2015: The Paris Agreement and the UN Sustainable Development Summit of 2015, by setting new targets and challenges for both industrialized and developing countries (the latter started to join the market by leading to a total annual issuance of 41.8 billion dollars), are seen as a milestone in the development of the global green bond market. In 2015 corporate green bonds account for 36%, municipality green bonds for 15% and green bonds from banks for 12% of total green bond issuance. Out of all of these, about half of the proceeds are allocated to renewable energy, while the rest is allocated to low carbon buildings or sustainable water, transport and waste projects. (CFLI Climate Finance Leadership Initiative, November, 2020)

2016: The market doubles with respect to 2015, reaching 80 billion dollars and the first sovereign issuers begin to enter the market: Poland is the first in absolute, with an issuance of 750 million euros of sovereign credit, followed by many others as France (7 billion euros), etc.

2017: The volume doubles with respect to the previous year and reaches 162.1 billion dollars.

2018: The market grows only by 3% compared to the market volume of 2017, being now net worth 167.3 billion dollars. This slowdown is mostly due to a decrease in the issuance of US municipality bonds. Nevertheless, at the same time, the market value of other, similar financings as ESG and social bonds rises to 266.1 billion dollars. Thus, the UN develops the SDG bond framework to clarify definitions and differences of use of proceeds between green bonds, sustainability bonds, which combine green and social assets and projects and social bonds, which raise funds for projects with positive social aims. (OECD, December, 2015)

2019: The issuances become larger and larger, indeed more than a dozen bonds are worth 1 billion dollars at least. This increase is linked to the overall increase in the appetite for yield and the increase of issuance of EUR bonds, although investors become more cautious because of problems related to the Brexit uncertainty, etc. Still, the numbers of green and vanilla bonds in 2019 are the largest since the beginning of their issuances. (WWF, 2016)

2020: The green bond market is subject to serious injuries and impacts due to the COVID-19 pandemic. The yields rise in the first quarter of 2020 when the market starts to aggressively sell-off; some commercial paper markets freeze, while other credit markets steadily stabilize by the end of the quarter. In the second quarter, issuers get again more confident, and a record level of corporate bond issuance is registered. In Europe, credit issuance reaches 1.05 trillion euro by the end of the second quarter, which is a 33.4% increase on the same period in 2019. In the global financial market, there are over 100 trillion dollars of assets managed by institutional investors. Of these assets, only a small percentage are green bonds, but if we consider how difficult it is to expand interest for sustainable fixed income investment, the numbers still add up. (Pension Fund Service, December, 2017)

However, the green bond market has been growing rapidly in the past years as there has been a bigger understanding of how climate risks can potentially affect the value of portfolios. At the beginning, the market has been driven by specific demand as for example pension funds. These have been the first to promote the incorporation of environmental criteria into decision-making and the first to change the investors' approach of asset allocation, by combining sustainable investment with sustainable development outcomes. The green bond market really has laid the foundations for a new way of thinking for investors, whom have shown more and more interest in a sustainability-driven investment.

The number of green investments has risen in particular since investors are able, through the standardization of guidelines and disclosure frameworks, to access transparent information needed for the assessment of the suitability of a green bond. Another reason why the market is growing, is because there are now more opportunities of interaction between investors and issuers, which creates more engagement and interest from the side of new investors. Besides the new regulatory support, that facilitates the portfolio analysis of green bonds, investors and companies have themselves understood that the active managing of the portfolios' footprints helps to decrease the exposure to juridical and reputational risk and it also helps to overcome future regulatory changes which aim at encouraging the transitions to a low-carbon economy.

Hence, it is in the firms' and investors' interest to invest in green and sustainable assets, not only because of their social and personal values and goals, but also because they want to create portfolios that fulfill financial expectations and requirements on one hand and balance returns within the scope of objectives on the other. As we have seen, the investors' appetite for green assets has increased but it remains concentrated in stiff defined green bonds. The problem is that the green bond market includes labelled green bonds and also still unlabeled ones. The formers are those that have been labelled as such by the issuer, while the latter are the ones for which the use of proceeds is not specially assigned for environmental or climate projects, but the underlying assets fall into one of the eligible categories of green projects. Thus, the money raised from "real" green bonds is used for the development of specific green assets, backed by one or multiple projects. (WWF, 2016)

Many issuers today seek third-party certification that confirms the environmental credentials of the issuance and most issuers follow frameworks, as the GBP, which state what the eligible categories of green projects are. The frameworks are useful for the investor's decision making but they are not fully effective in supporting the shift to a low-emission economy yet, because although projects, that follow the suggestions of frameworks, are green, they cannot always help to promote the transition by standing alone. For instance, a power utility uses a combination of measures to reduce emissions, as improving efficiency, shifting from coal to gas, decommissioning fossil fuel plants, enhancing grid operations and many others. (CFLI Climate Finance Leadership Initiative, November, 2020)

Figure 8: Worldwide green bond market 2019, 260 billion dollars of green bond issuances

Source: (Climate Bond Initiative, 2019)

2.3. ISSUANCE

The issuance is divided in pre-issuance, launch or issuance and post-issuance phase. The first phase is about meeting relevant conditions, designing a framework and having the latter reviewed, establishing structures for managing proceeds, developing a sales strategy, preparing relevant legal documents, identifying suitable market conditions, terms, and target markets, issuing in both domestic and international markets, registering the green bond issue and so on. The second phase is about announcing the green bond issue, pricing the green bond book building and conducting the transaction, while the last phase is about managing proceeds, monitoring and reporting the use of proceeds and environmental impact, listing the bond on a stock exchange, trading on secondary markets, obtaining external reviews, and lastly about repaying the bond. (Climate Bond Initiative, 2015)

To begin with, in the pre-issuance phase, when an issuer decides to issue a green bond, there are three preconditions that have to be fulfilled to actually issue them. Firstly, as mentioned above, proceeds need to be used to fund green projects that align with green criteria, which can be imposed by a regulator or by an issuer. Secondly, green bonds are the most suitable instruments to boost financing for projects or assets. Lastly, the issuers need to meet regulatory, financial and legal prerequisites to issue a bond. When these requisites are finally met, the issuing institution should approach investment banks to get advice on the issuance process. New issues do in general get on the market through a group of banks or through a syndicate. At the same time, do investment banks act as intermediaries between issuers and the public and prepare and conduct the deal, while issuer have the task to provide a concise and transparent green bond framework, that describes and reflects the specific circumstances and commitments regarding the green features of the bond. Such frameworks are mostly based on the GBPs and developed with environmental consultants and structural advisors, which elaborate the issuers' approach of defining and selecting eligible projects, managing proceeds and reporting. Then, these frameworks are typically reviewed by independent second opinion providers, third-party auditors or green bond certifiers that are experts in the field and that assure that investors make good investment decisions. Frameworks also usually define that issuers need to open a separate earmarked account to ensure the tracking of proceeds and to ensure that they report to the public on a regular basis the information on how money has been used. (Climate Bonds Initiative, December, 2019)

When issuers look for qualified project categories, then they can refer to the GBPs, which provide for a list of categories that issuers can adapt and refine depending on their portfolio and sector. While doing so, issuers need also to bear in mind the environmental policies and laws of the respective jurisdictions and national authorities. For example, in China, the "Green Bond Endorsed Project" introduced 6 categories and 31 sub-categories of eligible green projects and activities that are in line with the GBPs. Something similar exists in India, through the "Disclosure Requirements for the Issuance and Listing of Green Bonds" and also in Brazil where it is called the "Guide to Issuing Green Bonds in Brazil". To assess the financial creditworthiness of issues, which is independent from the bond's green label, rating agencies provide ratings that reduce financial uncertainties and which are based on the risk-return profile of the issuers or the projects. Normally, the risk, the premium and the spread is determined by lead managers and issuers based on the type, rating, expected liquidity and overall market conditions of the bond. Green bonds are normally priced according to the same criteria as regular bonds with similar maturity and base rate.

The coordination of legal requirements, trade documentation, marketing coverage, bookkeeping and the booking and delivery, are usually assigned to a lead manager. The issuing of green bonds does not require additional legal documents compared to regular bonds, but the use of proceeds should be stated in the terms and conditions of the bond. In the domestic market, issuers avoid costs from currency swaps and hedges and experience cost advantages thanks to name recognition. Such benefits facilitate especially the access for smaller issuers to debt capital markets, on the other hand, because of a smaller issuers or investor base, domestic markets will limit liquidity levels, which will result in higher capital costs and volatile trading prices. Hence, it is important to carefully assess the market conditions, the risk-return profiles, the restrictions on investments and the asset portfolios of the markets in which the bond is to be issued. When issuers and lead managers meet regulatory and disclosure requirements, then finally they agree on the type and structure (in terms of a bond's coupon, spread, size, payment mode, tenure and currency) of the green bond issuance. The last step for an issuer, before launching green bonds, is to register them at the responsible supervisory authority, by submitting relevant documents as for example financial records and statements. (German Federal Ministry fo Economic Cooperation and Developement, January, 2018)

In the launch phase and issuance, lead managers announce publicly on the upcoming transactions and then they start to solicit orders from investors (in terms of size, maturity, etc.) and build a book for the issue. After a go or no-go call between lead managers and issuers, the issuance is announced to the public and the initial price thoughts are communicated, the prospectus must always be provided to the public. Instead of a public offering, bonds can be issued through a private placement in which investors and the issuer agree on the terms of the transaction. When the order book is officially opened, the sales teams contacts potential investors to examine their interest in participating in the transaction. Until the order book is open, the lead managers provide the issuer with updates on the book and guide them in defining strategies and prices. The price is normally negatively correlated with the overall amount of orders. When the book building process is finished, issuers decide how many quantities are allocated and what the issuance prices will be. However, the final price is determined at the selling time, thus, current market conditions are priced-in and not all bonds are underwritten by using the conventional syndicate process. Once the bond is issued, the parties sign a subscription agreement, while the remaining documents are signed when the deal is closed and the bond is delivered to the bondholders. (German Federal Ministry fo Economic Cooperation and Developement, January, 2018)

The post issuance phase starts when a deal is settled, and the amount of the issue's net proceeds is transferred to the earmarked account. The latter is managed by issuers according to the traditional management of unallocated proceeds and the standard liquidity management practices, which were defined in the green bond framework. Issuers have to make timely payments; such are for example the coupon or the principal at maturity. Depending on the respective jurisdiction, settlements need to be prepared through a clearing system or a national depository. Furthermore, issuers are expected to report, describe and list all financed projects, all amounts that were allocated and all use of proceeds that are still unallocated. Issuers should also report and monitor the actual or expected environmental impact. In the secondary market, bonds are mostly traded OTC or on exchanges and through the periodic trading of an issue, do issuers obtain regular information about the value and price of various bonds and their interest rates. Investors can decide whether to hold the bond or whether to trade it on the secondary market, in both cases will the debt cease at the date of maturity and the borrower will redeem the issue by paying the principal or the face value. Issuers are responsible for all the interest payments, the principal's redemption, the record keeping, etc. but they usually ask fiduciary agents, that have to act as trustees for the bonds, to execute these tasks. (UBS, 18th December, 2020)

2.3.1. Green bond principles

As mentioned before, the green bond market plays a fundamental role in financing projects that contribute to environmental sustainability. The GBPs have therefore been invented to promote the integrity of this market by giving issuers the possibility to use the GBPs guidelines (that recommend transparency, disclosure and reporting) in a voluntary process. Such guidelines can also be used by other market participants to get all the available information that they need in order to increase capital allocation for sustainable projects. The GBPs focus especially on the use of proceeds, which facilitate the tracking of funds and which give insight into their estimated impacts. Furthermore, GBPs refer to eligible green projects categories that can contribute to climate change adaptation and mitigation, biodiversity, natural resource, pollution prevention, conservation and control and so on. The GBPs are divided in four core components:

1. **Use of Proceeds:** One of the first information that green investors look at when deciding whether to invest or not to invest in a project are its green credentials. Hence GBPs lay emphasis on the green bond's use of the proceeds for green projects. These uses should be reported in a juridical documentation and should also provide clear environmental benefits. When proceeds are used for refinancing, issuers should estimate the respective share of financing and of re-financing and they should also clarify which project or investments portfolios could be refinanced. The list of project categories contains 8 peers that are conform with the Climate Bonds Taxonomy and that are described in the subchapter "2.1.2 Eligible green projects". Apart from these specific categories there are also some green projects that support other expenses such as for instance research and development and that may relate to more objectives or categories.

2. **Process for Project Evaluation and Selection:** Green bond issuers should clearly disclose the sustainable objectives, the process which determines the eligibility of projects and the associated eligibility criteria, as for instance the exclusion criteria or other processes that identify and manage potential risks of the projects. Issuing institutions are urged to position information within the context of their objectives, strategies, policies or processes relating to sustainability. Issuers should also disclose all green standards and certifications that refer to the project selection. (ICMA, June, 2018)

3. **Management of Proceeds:** Net proceeds of the bonds should be moved or credited to a sub-portfolio or account and attested to by the issuer in a formal internal process that is connected to the issuer's investment and lending operations. Until the bond is outstanding, the balance of tracked net proceeds should be adjusted periodically to equal the allocations of eligible projects that were made during that period. Furthermore, the issuer should give information to investors on the planned sorts of provisional placement for the balance of unallocated net proceeds.

4. **Reporting:** Issuers should always be able to give up-to-date information on the use of proceeds, on the material developments and on an aggregated portfolio basis. A report that is made annually should list projects to which the proceeds have been allocated and such a report should also contain a summary of the allocated amounts, the projects and their expected effect. (Baker McKenzie, May, 2019)

To become and stay transparent, the GBPs recommend that issuers should use qualitative or quantitative performance and that they should disclose the key methodologies and assumptions of the quantitative determination. Furthermore, should issuers, if possible, monitor impacts and include them in their regular reporting. All the GBPs are voluntary guidelines aiming at harmonizing frameworks for impact of water or wastewater projects, energy efficiency, renewable energy and waste management projects. Additional guidelines for further sectors are in the stage of development. (Climate Bond Initiative, 2015)

2.3.2. Climate bond standards

The CBS and certification scheme, developed by the Climate Bonds Initiative, is a voluntary certification initiative aligned with the GBPs. This means that basically all issuers that comply with CBS automatically incorporated the GBPs. The climate bond standard provides sector-specific eligibility criteria for asset classes or projects and is therefore another tool that aims at providing trust and assurance around green credentials by developing clear criteria for what can be qualified as a green and by letting externals as for example verifiers control the green bond's conformity to these credentials. The standard thus functions as screening tool for investors. This makes them confident that the projects that they are funding are actually delivering concrete environmental benefits. As soon as a verification is made, a bond can be awarded with a certification.

Post-issuance verifiers check and verify that proceeds have been earmarked as anticipated and that the issuer meets the requirements of the standard of how to report (annual reporting is obligatory) and those on the use of unallocated proceeds. The climate bond certification may only be preserved if the post-issuance certification is confirmed within one year from the first issuance of the bond. The standard provides much more precise requirements and criteria around the management of proceeds, use of proceeds and the reporting, in confront to the GBPs, which provide only guidelines and recommendations but no real requirements. The following points are the thirteen requirements by the standard:

1. **Project nomination:** An issuer must ensure that at any point in time it can be verified that the bond is associated to eligible projects.

2. **Use of proceeds:** An issuer must use the funds that are raised to finance eligible projects.

3. **Non-contamination:** An issuer must assure that financial flows and projects that are not tainted by activities inconsistent with a low-carbon goal.

4. **Environmental and social Integrity:** To get a certification, firms must disclose to which extent their projects will actually give an environmental and social benefit.

5. **Verification:** Verifiers audit whether or not an issuer is complying to the standard.

6. **Climate bond certification and limits of use:** The standard's board will issue a certificate when the report of the verifier confirms that the proposed issue complies with the standard.

7. **Non-compliance:** If an issue becomes non-compliant, this must be disclosed and told to the standard's board.

8. **Eligible projects and physical assets:** Projects and physical assets are eligible for certification if they either contribute to developing low carbon industries or to technologies and practices or if they are an essential adaptation to the consequences of climate change.

9. **Traceability:** The proceeds of a corporate climate bond must be traceable. (IFC International Finance Corporation World Bank Group, December, 2016)

10. **Project holding:** An issuer must hold projects within its portfolio that have a fair market value at the time of issuance and that are at least equal to or greater than the original amount of the related climate bond.

11. **Confidentiality:** In some circumstances, confidentiality agreements may limit the extent of permissible disclosure about projects.

12. **Settlement period:** An entity issuing climate bonds must ensure that the funds raised are either disbursed to acquire or construct projects.

13. **Ring-fenced cost centers:** An issuer must make sure that assets are ring-fenced from other cost centers. (Climate Bonds Initiative, May, 2015)

One more discrepancy between green bond GBPs and green bond standards is that the former provides categories of what types of projects can be financed, while the latter provides criteria for what is green. Climate bonds criteria are developed by specialist institutes, academic experts, investor representatives, development bank scientists, etc., which are supervised by a board of investor representatives. In conclusion it can be said that the use of standards brings the benefit of simplifying the issuance process which makes the green bond market grow. The drawback of using specific definitions can, however create problems as flexibility is missed, for instance the boundaries for what is and what should be labelled as green may vary between different countries and these thresholds and stringencies may even evolve over time. (Climate Bond Initiative, December, 2019)

2.4. MARKET PLAYERS

There are six diverse actors in the green bond market that are listed below. In the following sub-chapters, we will further find out who they really are and what they do:

1. issuers
2. underwriters
3. external reviewers
4. market intermediaries
5. index providers
6. investors

2.4.1. Issuers

As we have seen, since the first green bond has been launched by the EIB and the WB, the market participants have shown great interest in such bonds, thus, their number of issuances or issuers and their reciprocal types, products and currencies have been growing steadily. Something else that was already mentioned is the fact that soon some new types of investors have entered the market, these are for instance insurance companies, asset managers, corporates, capital market associations and even standard setters, regulators, rating agencies and many others. Now the question comes up on who these issuers are and how they exactly issue these green bonds and why they do so? (HSBC, 2021)

Simple as it is, an issuer can either be an organization which issues debt instruments, that in most cases are bonds, or they can be a borrower or other type of obligor, who takes out a loan or debt instrument, otherwise they could also be a financial institution which receives a designated deposit. Sometimes, in particular in the case of small loans, the lender can make some parts of the role of the issuer to his own task, as for example to create a GBF or to define selection criteria. In general, there is no restriction on who can issue green bonds and how green an organization must be, although it can be essential in terms of trust, as investors could accuse issuers of greenwashing. The private and public financial sector started to issue green bonds, when people begun to look for fixed-income investments that supports the transition to a climate-resilient world and when issuers themselves felt the need of seeking opportunities that solve challenges and risks that are imposed by the climate change. These challenges need enormous financings, that present various commercial opportunities and that make the labeling of green bonds more interesting for issuers as it improves their credentials of being a sustainable and responsible organization. Normally we divide issuers in:

1. **Supranational, sovereign & agency and municipalities:** SSAs and municipality issuers include MDBs and national sovereign governments, development banks, cities, regions, and agencies. They are crucial for the development of the green bond market because they stimulate demand and supply, they build a benchmark yield curve and they create the best market practices for future issuances. SSAs issuances are able to increase private capital at a low cost and to disperse it between diverse markets that need funding for smaller projects and that would not normally have access to such capital. Supranational and municipality often secure structured green bonds which have, instead of fixed coupons, returns that are linked to an equity index and which they issue with balance sheets and rate as AAA. (OECD, December, 2015)

They also identify eligible projects, ascertaining their green eligibility and they ensure that their targets are met. Among the biggest SSA bond issuers there is the EIB, with a total cumulative issuance of over 20 billion dollars, the KfW, with over 11.5 billion euros and the WB, with over 10 billion dollars. As we have already seen, the first sovereign green bond that was ever issued was by Poland in December 2016, which was then followed one month later by France with the largest (8.6 billion euro) and longest-dated benchmark (25 June 2039) green bond ever issued until date, while the first muni green bond was issued by Göteborg (Sweden) in 2013. One of the first and most important agency green bond was that of the New York MTA in 2016 with over 500 million dollars. Out of all these bonds, the most prevalent types are those around energy efficiency and low-carbon transport. In the US, many focus also on water projects, such as upgrading canal, sewage and water filter systems, installing flood defenses, etc. (KPMG's Global Center of Excellence for Climate Change and Sustainability, 2015)

2. **Non-financial corporates:** In 2013 did the first corporate green bond come to the market. Two years later did the total corporate bonds' issuances already amount 13 billion dollars. The value even doubled by 2016, when among the most first corporates, the first in absolute technology company (Apple) issue a green bond of the value of 1.5 billion dollars. The firm also promised that it will further use its proceeds for making its facilities, products and the supply chain greener. Other major issuers and first in issuances for utilities was EDF, while for engineering it was Skanska, for food it was BRF and lastly for cosmetics it was Unilever.

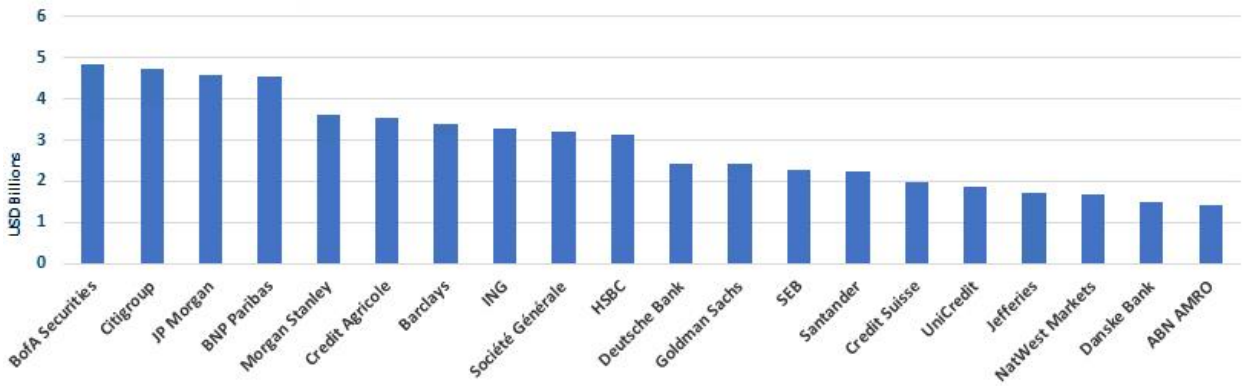
3. **Financial institutions:** Financial institutions represent in general the biggest sources of funding and loan providers, green bonds in turn have the most important role in funding and financing the financial institutions' lending activities. Green bond issuances by financial institutions are growing steadily and the estimates of the OECD show that this growth will strongly continue and that it will hit its first trillion of worth in 2025. Coming back to the question why issuers decide to issue green bonds, we can see that it is because of the fact that they have the same or at least comparable pricing characteristics of classic bonds, meaning that investors are not necessarily charged with a premium when they buy them. Issuers now see which enormous benefits green bonds can bring, they can now reach a broader range of investors, for example those that focus on sustainable and responsible investing and that would not have considered other bond offerings. (Climate Bond Initiative, 2016)

At the same time are issuers now able, trough the green "use of proceeds" bonds in which the repayment is tied to the issuer instead of the success of the project, to finance multisector green portfolios and to attract even those investors that would normally be afraid of investing in green projects as they perceive them as linked to higher risks. The diversification of the investor base can reduce the exposure to demand fluctuations and with the time can the steadily growing demand bring the issuer many favorable terms and also better prices compared to regular bonds. On the other hand, it has to be taken into consideration that there are also some remarks for the issuers, for example, is the issuance of green bonds associated to additional certification, reporting, verification and monitoring requirements which are often very costly. Furthermore, if issuer break green clauses and investors seek penalties for green default, then issuers need to pay the bond in full. Lastly, because of the absence of national standards and also the absence of bodies that monitor the bonds' "greenness" from a legal perspective, issuers do often face reputational risk, criticism and accusations of greenwashing if the bond's credential is challenged. (Baker McKenzie, May, 2019)

2.4.2. Underwriters

Green bond issuers often mandate investment banks to arrange or structure their bonds. These are normally underwriters which administer the issuance and distribution of green bonds, by working with the issuers to establish the bond-offering price. Some of the largest underwriters in the green bond market are in terms of volume the Bank of America Merrill Lynch, J.P. Morgan, HSBC, Credit Agricole, Barclays and many others. (Climate Bond Initiative, 2021)

Figure 9: Top 20 green bond underwriters 2020



Source: (Climate Bond Initiative, 2021)

2.4.3. External reviewers

As issuers face many risks, they often look for someone that can guide them in designing criteria or processes and that can provide evidence on the use of proceeds and on the robustness of criteria for investors. Such "someone" are normally external reviewers which serve the different purposes of issuers or investors: firstly, they review all or only certain parts of the green bond framework and they provide an independent opinion on the green bond's alignment to specific guidelines and standards. Secondly, they safeguard the environmental integrity of the market, the practices determine by the issuer for issuing a green bond, the credibility of the product, the transparency of the green features of the bonds and they do also mitigate concerns of green washing. In general, we can divide reviews into four different types:

1. **Consultant Review and second opinion:** Almost 70% out of all green bonds get external review in form of second opinion by consultants, consulting firms or institutions, which are experts in terms of the green, environmental and sustainable aspects of the issuance of a green bond. Issuers seek reviewers' advice to make them revise, review and assesses green bonds, their associated frameworks, their sustainability reports and their general business strategy, with the ultimate purpose of providing for information that the investor needs for the decision making. Frameworks are first-party opinions which are made by the issuer and which contain information on projects, management of proceeds, project selection and reporting practices.

When consultants have finished the assessment of documents, they provide a description in which they present the findings or an evaluation of strengths and weaknesses and their deducting recommendations. Apart from the positive rewards and the consistency that such second opinions can bring and despite of their broad use and recognition, there also still exist some limitations and challenges to their provision. Firstly, the different providers use diverse quantitative indicators or rating methodologies. Secondly, some of them only evaluate specific projects, while others revise the structures and processes of the issuer's definition of eligible projects. Thirdly, as reviewers are directly accredited by the issuer and as they often advise them in developing the green bond framework, there may arise conflicts of interest, which in turn will be assessed by the exact same consultancy and what therefore might give rise to questions on the independency of the assessment. Furthermore, there is no post-issuance verification on whether the bond has been managed as intended. Among the most important second opinion providers there are CICERO, Sustainalytics, Vigeo, Oekom, and KPMG. (German Federal Ministry fo Economic Cooperation and Developement, January, 2018)

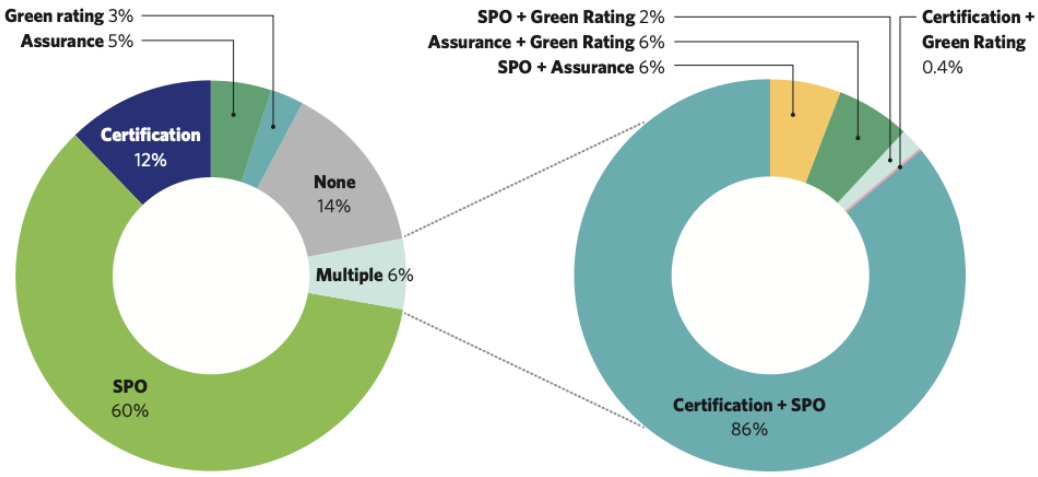
2. **Certification:** Issuers can certify their green bonds, framework or use of proceeds against an external assessment standard that not only defines certain criteria, but that also qualifies the alignment of third-parties with these criteria. Certifications are the most rigorous form of assessments as they review the bond criteria, the project selection and evaluation, and the non-financial data on environmental outcomes. Since 2017, the CBS which is released by the CBI, portrays the sole globally acknowledged green bond certification scheme. The CBS converts the GBPs into requirements that every issuer, that wishes to obtain a certificate for their bonds, needs to satisfy. The Climate Bonds Taxonomy that is associated with CBS provides a detailed, science-based and technical sector specific standard which is divided into categories and which obligates projects to meet certain criteria. The eight categories include water, energy, buildings, transport, land use & marine resources, industry, waste and information technologies and communications. (European Commission, November, 2016)

Furthermore, the CBS requires an earmarking or ring-fencing management of proceeds and an allocation of funds within a 24 months settlement period. Cash or cash equivalents are also eligible for a temporary investment of unallocated proceeds, but they must exclude GHG-intensive projects. The certification provides for a clear identification of what qualifies as green and imposes to the issuers to constantly update their catalogues based on the most recent technological developments. In fact, to maintain the certification status, issuers need to acquire within one year after the issuance a post-issuance engagement assurance that confirms the ongoing eligibility. Also, they are necessary to disclose to the public and to their investors at least once a year their management and use of proceeds and their environmental objectives and impacts. There are 22 accredited institutions that are approved by the CBI's board and which, among others, comprise KMPG, Oekom, PwC, Sustainalytics. (ICMA, June, 2018)

3. **Verification or auditing:** Issuers can independently verify, by qualified third parties that are called auditors, their green bonds, their project selection, internal processes for tracking proceeds, their framework and underlying assets against internal or external reference criteria. This verification refers to the pre-issuance, as well as to the post-issuance auditing of the green bond process and it checks if the latter is in compliance with the statements made by issuers. Verification is the most independent form of assurance for investors and it is recognized by the GBPs as the most rigorous form of assessment. On the contrary to a certification, the auditing checks whether internal standards align with the claims made by issuers. The most important accredited auditing firms are KPMG, PwC, EY and Deloitte. (European Commission, November, 2016)

4. **Rating:** Issuer can have their green bonds rated by qualified third parties, as specialized consulting firms or rating agencies, whose ratings typically apply to individual securities and green bonds. Ratings aim at evaluating different aspects of the issuance according to a defined rating scale, as for instance that of S&P, which created a green bond evaluation tool, a scoring methodology and an ESG evaluation framework to assess green bonds for their diverse corporate issuers. Ratings, if conducted under the same methodology, can help investors to compare different green bonds and they can show them the actual or expected environmental impacts of the projects, the governance structures and the transparency aspects of green bonds. (Bank of America Merrill Lynch, 1st December, 2015)

Figure 10: Forms of external review 2019, 86 % of issuance had at least one form of external review



Source: (Climate Bond Initiative, 2019)

2.4.4. Other market intermediaries

Intermediaries are in most cases stock exchanges and banks. The formers have started to build up green bond platforms to trade green securities and to launch dedicated green bond listings or segments that fulfill a set of criteria and that provide added capabilities, diverse data quoting, different market modes and secondary market trading for market participants. Among all the different market intermediaries that list green bonds, we have some of the most important stock exchanges of the world, which are Oslo, Stockholm, Mexico, Shanghai and London. The positive rewards about these lists are that they help to improve the visibility of green bonds to potential investors and that they encourage secondary market trading. Also, they force the market to use external reviews of the green credentials of bonds and they push the market to common definitions of what is "green".

Banks, on the other hand, are working in global capital markets and have lately devoted teams to support their customers in issuing green bonds. For instance, Morgan Stanley created its Global Sustainable Finance platform and Goldman Sachs launched its Sustainable Finance Group. All types of intermediaries serve to enhance visibility and data access and to impose some requirements as for example that they have to obtain a second opinion. (European Commission, November, 2016)

Figure 11: Dedicated green or sustainable bond sections of Stock Exchanges in the period 2015-2021

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
Shanghai Stock Exchange	Green bonds	March 2016
Mexico Stock Exchange	Green bonds	August 2016
Luxembourg Stock Exchange	Luxembourg Green Exchange	September 2016
Borsa Italiana	Green and Social bonds	March 2017
Taipei Exchange	Green bonds	May 2017
Johannesburg Stock Exchange	Green bonds	October 2017
Japan Exchange Group	Green and Social bonds	January 2018
Vienna Exchange	Green and Social bonds	March 2018
Nasdaq Helsinki	Sustainable bonds	May 2018
Nasdaq Copenhagen	Sustainable bonds	May 2018
Nasdaq Baltic	Sustainable bonds	May 2018
Swiss Stock Exchange	Green and Sustainability bonds	July 2018
The International Stock Exchange	Green bonds	November 2018
Frankfurt Stock Exchange	Green bonds	November 2018
Santiago Stock Exchange	Green and social bonds	July 2019
Moscow Exchange	Sustainable bonds	August 2019
Euronext	Green bonds	November 2019
Hong Kong Exchange	STAGE, Sustainable and Green Exchange	June 2020

Source: (Climate Bonds Initiative, 2021)

2.4.5. Index providers

These are normally credit rating agencies or banks that develop indices, which have diverse requirements for eligible green bonds, and which help investors to compare data performance. Indices are broadly defined as metrics, that track the performance of securities or investments of green bonds and that create benchmarks or reference points for these performances. Indices do in general aim at providing clear risk-return data, which lower information barriers for investors. The establishment of indices contributes to the scaling up of green investments because they allow passive funds such as ETFs. The most important indices are the S&P Green Bond Index, the Barclays MSCI Green Bond Index, the Solactive Green Bond Index and the Bank of America Merrill Lynch Green Bond Index. Each of these uses different methodologies for its calculations and diverse eligibility thresholds in terms of currency, size, project, rating and extra-financial characteristics of green bonds. (The Green Bond Principles, June, 2018)

2.4.6. Investors

As we have seen, the strong interest and demand for green bonds have increased promptly in the last years. The number of investors that have engaged to invest according to PRI has grown to almost three thousand signatories and the aggregated volume of AUM represented by this group amounts to 90 trillion dollars. The PRI supports investors in integrating ESG factors into ownership practices and investment decisions. By signing the PRI, investors promise to adopt 6 principles and to act according to their fiduciary duty. This subchapter elaborates why to invest green and why especially green bonds are so attractive for investors. Furthermore, this subchapter investigates what kind of investors are involved in the green bond market and what might impede others from investing in green bonds.

Green bonds were invented in response to the investors' demand for fixed-income instruments that could access green investment opportunities and that would fit within fiduciary mandates. These fiduciary responsibilities of the various pension funds, asset managers, insurance companies, etc., lie in the task to act in the best interest of their clients, to ensure prosperity and to assure that the money is indeed invested green. When the first green bond emerged, such a fiduciary duty has been seen as an obstacle for asset managers to account for sustainable factors, because they were interpreted as of having a potential diminishing impact on returns. Then, later on, a common understanding has arisen, in which the integrating of ESG factors into decision making has become permissible and a key requisite. This "agreement" between the parties reflects the increasing recognition of these ESG factors and their significant impact on the long run risk-return performance of an issuer and investments.

Hence, green bonds seem to fulfil their fiduciary responsibility in diverse ways. These in turn seem to be the most effective ones among all available sustainable assets. Firstly, they create a positive environmental impact and thereby contribute to the SDGs. Furthermore, the green bond market is growing and nascent, representing 3% of global bond market transactions, which requires more breadth, depth, liquidity and diversity of deals from the market. Thirdly, green bonds have long-term returns which are similar to plain vanilla bonds and it is expected that the more the demand for green bonds increases, the less volatile they will become and they will therefore outperform other bonds. Lastly, green bonds provide transparency on the environmental impacts of the projects they finance. (Pension Fund Service, December, 2017)

Another positive reward of green bonds is that most of them have the features of long-term (as their average maturity is 3-10 years), low-risk investment opportunities (as 82 % of their issuances are classified as BBB- or higher), which offer a predictable, steady return and are priced in line with regular bonds. They also bring diversification to portfolios as they are priced in diverse currencies. The green label demonstrates the compliance to responsible investment commitments or mandates. Additionally, this label lowers the investors' transaction costs because, in order to get one on a green bond, issuers have to disclose and report their use of proceeds and environmental impacts and to assure them through external reviewers. Apart from this kind of cost benefits, have green bonds also some other peculiar strengths which lie for instance in the possibility to adopt them without efforts not only by green investors but also by other investors or in the fact that they can communicate their sustainable strategy and engagement to the public without major additional costs. In general, can investors be divided into retail investors (WB issuances for retail investors through Morgan Stanley Wealth Mangers, Merrill Lynch Wealth Mangers, SolarCity and IFC issuances through Incapital and so on), into institutional investors as for example pension funds (as North Carolina Retirement System, California Teachers' State Retirement Systems, South Africa's Government Employees Pension Fund, Swedish AP-Fonden, University of California etc.), investment funds, national development banks, asset managers (BlackRock, BNP Paribas Investment Partners, PIMCO, Legal & General Management, Amundi, Allianz Global Investors, APG, etc.), hedge funds, insurance companies (Aviva, etc.), into SWF (Norwegian Government Pension Fund Global), into corporate treasury (Barclays, Apple, etc.), into sovereign and municipal governments (as the Central Bank of Peru, Central Bank of Bangladesh, California State Treasure and others) or lastly into private investors as commercial banks, households or specialist, ESG and responsible investors (Natixis, Mirova, etc.). (European Commission, November, 2016)

2.5. BARRIERS OF THE GREEN BOND MARKET

Many green projects with stable cash flows are good candidates to finance the bond market, which nowadays makes up about a third of total funding for corporates globally, but which has not yet played an equivalent role in green financing. The possibility of expanding the green bond market is enormous, still, according to the climate bonds initiative "although many investors are conscious of the climate change issue, to transform this consciousness into investment decisions is normally seen as a huge challenge" as the growth of the market will depend in a large extend on the policies and barriers constraining its development.

The following sub-chapter will identify several challenges and obstacles for the growth of the green bond market, by taking to account that their importance may vary throughout different markets.

1. **General challenges to the development:** Here the challenges are the underdevelopment of the institutional investor base and the credit rating system, the lack of benchmark yield curves and risk-hedging instruments, and also the insufficient market liquidity.

2. **Difficulties for international investors to access local markets:** International green investors have difficulties in accessing some local markets mostly because the definitions and disclosure requirements differ across markets, meaning that it also increases transaction costs.

3. **Lack of awareness of the benefits of green bonds:** In many states, authorities have problems in understanding potential benefits of the green bond market amongst policy makers, issuers, and investors. At the same time these countries have sometimes a lack of knowledge of existing international standards. Both of these lacks are major barriers, which can be removed partly through supranational organizations and MDBs, that can communicate benefits, etc.

4. **Lack of local guidelines:** In some states, policy incentives aim at supporting the local green bond market, which may require additional definitions and disclosures than the GBPs require from issuers. The barriers for these countries are therefore the lack of definitions and requirement for the disclosure of green bonds. (Pierpaolo Grippa, 2019)

5. **Capacity building for issuers:** Another challenge is it to motivate the issuers that already have portfolios of suitable green projects, to tap the market to finance their projects.

6. **Lack of supply of labelled green bonds:** In many markets, investors' appetite for green bonds is huge as evidenced by all the oversubscriptions of the latest issuances, which give rise to a lack in supply of labeled green bonds.

7. **Limited bankable green projects:** Lack of clarity in terms of types and numbers about the green project pipeline makes it difficult for investors to plan their investments.

8. **Costs of meeting requirements:** The verification of green bonds and the monitoring of their use of proceeds is, depending on the exact market, very costly: verifications, etc. range from ten to hundred thousand dollars, which poses a major barrier especially for small issuers.

9. **Lack of ratings, indices and listings:** Until today there exists only a small number of index companies, stock exchanges rand rating agencies that promote green policies and green products. (Pawan Kumar Chugan, 2017)

10. **Greenwashing:** Greenwashing, also known as "green sheen", is the conveying of false impressions or the providing of misleading information about how a company is environmentally friendly and therefore more natural, free of chemicals, healthier, less wasteful or recyclable. Firms that do greenwashing might for instance claim that their products derive from recycled materials or that they have the benefits of saving energy. These claims made by these firms can also be partly true, but often the firms' green engagement is very small, meaning that some companies exaggerate on the extend their benefits. Thus, any firm that unsubstantiated claims that its products provide green benefit, is involved in greenwashing. Hence is greenwashing an attempt to take advantage of the demand for green products. Some examples of green washing firms are recently for instance some of the world's biggest carbon emitters, which greenwash through a process of renaming, rebranding, or repackaging. (Kenton, 2021)

CHAPTER 3: THE PRICING OF GREEN BONDS

3.1. THE PRICING

As we have already seen, besides of having to ring-fence or ear-mark the use of proceeds, which is generally required in order to get the green label, green bonds have identical financial characteristics as conventional or plain vanilla bonds from the same issuer. The so called "flat-pricing" has contributed to a high demand from the invertors' side and to a growth of the respective market which tries to unlock private capital to finance green solutions through diverse projects. This explosion has demonstrated a clear unified momentum towards green preferences and thus towards changes in production and consumption patterns for both, bond issuers and investors alike. The capitalization of such preferences offers an important catalyst for delivering the estimated investment of ca. 50 trillion dollars required to avoid the dangerous impacts of climate change. Although the market has grown in recent years, it has remained rather small, but it could become a significant segment of the universal fixed-income market. Green bonds are issued in form of revenue bonds, senior unsecured obligations, project finance, and securitizations with collateralized projects and assets. Because of their flat pricing, green bonds have no pricing advantages at primary issuance, nevertheless, evidence has appeared that some green bonds are able to price at a few basis points tighter than conventional bonds due to strong demand, oversubscription and an imbalance of supply and demand. (Serena Fatica, 2019)

Several studies even claim that green bonds trade at a premium on secondary markets. This could lead to a reduction of the participation of mainstream investors in the market because most of them are unwilling to pay for green benefits. The "price" they would have to pay is called the green premium or greenium, which is the difference between the yield of a conventional bond (higher yield) and that of a green bond (lower yield) with similar characteristics. This means that in the primary market, price differentials show a higher price for green bonds, while in the secondary market, they are traded freely and are subject to price movements. On one hand, because of the fact that green bond holders do not own any additional right on underlying projects, there seems to be at first sight no rationale that the "greenness" of a bond influences its yield. On the other hand, the fact that green investors are willing to accept a lower yield, suggests that there exist enormous other benefits as for example a higher equity return for those companies that pay attention to green concerns. Another benefit could be that issuers, that finance sustainable projects, are rewarded with a lower cost of finance. In general, until today there has been reached no real consensus between the results on the pricing of green bonds and the existence of a premium.

In fact, as green bonds are a rather new type of financial instrument, the results have often been conflicting and ambiguous due to a difference in sample selection, currencies, control variables, time periods, ratings, methodologies and the properties of the issuers and the bonds themselves. Moreover, as the number of outstanding green bonds has been relatively small, also the studies that investigate their price have been limited. Thus, to address this research gap, this thesis has provided for a systematic literature review, with the ultimate aim of identifying, synthesizing, and examining studies that claim the existence or nonexistence of a green premium and this review can furthermore give a greater understanding of the green bond premium, of its drivers and of the characteristics that determine it, etc. (Mohamed Ben Slimane, 2020)

3.2. METHODOLOGY

"A systematic literature review identifies, selects and critically appraises research in order to answer a clearly formulated question" (Dewey, A. & Drahota, A. 2016). This review draws upon a 7 peers-set of academic and industry previous studies, that analyze pricing discrepancies of green versus similar conventional bonds. The method is organized, transparent and replicable and follows a three-step process which explains which resources are included in the sample. In the first step, key research questions, database and appropriate search terms are defined. Step two involves practical screening criteria while step three involves methodological screening criteria (methods and paper focus). The three steps are described in the following subsection:

3.2.1. Research questions, database and appropriate research terms

To begin with, the review provides insights into the following three fundamental questions:

1) What are the driving factors for the demand of green bonds?

2) Does there exist a greenium within the primary and secondary green bond market?

3) Why are there so many differences in valuation?

Secondly, this thesis uses, as mentioned above, a set of seven studies which in turn engage global datasets of private and public issuances between 2007 and 2019 and which are drawn from developed markets as for example Baker et al. (2018), Ehlers & Packer (2017), Gianfrate and Peri (2019), Karpf and Mandel (2018) and Zerbib (2019), as well as emerging markets as Bachelet et al. (2019) and Nanayakkara and Colombage (2019).

Thirdly, there has been established a systematic approach to the search terms, to ensure that relevant and appropriate content matching is made. Thus, journal articles and industry reports published in the period between 2007-2019 have been selected. The search criteria for this review contained the keyword “green bond”, to screen all relevant literature while mitigating the effects of confirmation bias. Not all papers use exactly the term “greenium” or “green premium” but some of them use also different terminologies to name the various pricing asymmetries. The databases that were used in this thesis were Google search and the search results are limited to articles in the English language.

3.2.2. Practical screening criteria

Journal papers with a robust methodology take priority in the review. Only studies that examine green bonds in the primary and secondary market, which provide for quantitative results were included in the review. In total, seven full-text articles are included in the final analysis. Some of these examine the greenium characteristics of green bonds in confront to conventional bonds under different scenarios and while controlling for effects as for instance the size, the rating, the alignment with GBPs and the external review verification, within the primary and secondary market. Some of these papers also provide for observations of green bond pricing characteristics while letting control variables or data samples vary.

3.2.3. Methodological screening criteria

The articles on which this review focuses, examine mostly the pricing differentials between green bonds and conventional bonds, furthermore they are also able to answer to the second research question of this thesis, namely whether there exists a green premium, that was developed in subchapter 3.2.1 “Research questions, database and appropriate research terms”. This review has used no favoritism in terms of methodologies or control variables. Many of the studies that have been analyzed focus on estimates of the green bond premium and its relationship with bond characteristics such as rating, amount issued, non-governmental or governmental issuer, liquidity, or volatility. The review aims in general to investigate whether a premium exists and under what conditions, where a basis points yield differential is found, the average result of the study is carried forward.

3.3. THE DRIVING FACTORS FOR THE DEMAND OF GREEN BONDS

There exist some driving factors which not only drive the demand for green bonds, but also support the development of their market and push the propensity for a green premium. Such factors can be divided into social, economic, and environmental factors and they normally stimulate the green bonds' issuers and investors green preferences.

1. **Economic drivers:** These have been linked to the under-supply of green investment products. Indeed, the demand-side growth of green bonds is evidenced by an oversubscription (by more than three times on average) of their new issuances. As green bonds offer diversification benefits, they are particularly less risky and volatile than vanilla bonds when they align their tight spreads with risk-adjusted returns. Since the green bond market consists mostly of long-term investors, their presence could imply lower liquidity among green bond issuances and price stability. Some short-term investments have shown that they lead to problematic asset price bubbles within financial markets. In general, firms that are highly engaged in CSR have achieved favorable stock returns, they often benefited from a lower cost of equity capital and it also has appeared evidence, that their green bond issuances have positive effects on their stock prices. (Dragon Yongjun Tang, 2018)

2. **Environmental drivers:** These are more broadly associated with the other two, economic as well as social, drivers. Green bonds demonstrate a proven and measurable impact on environmental concerns and they also offer synergies with carbon-reporting requirements to mitigate environmental impacts and climate change. Research has found out that pricing benefits often exceed the cost and that a nonfinancial disclosure of proceeds can influence the prices for green bonds. For example, some studies discovered that green bonds, which engage an independent third-party reviewer, report a greemium that suggests that investors and issuers highly value ESG impact reporting.

3. **Social drivers:** Green bonds are a medium between organizations' CSR-related objectives and SRI interests. Thus, the expansion of the green bond market surely coincides with the trend towards CSR practices in public and private organizations and at the same time with the increasing investors' demand for SRI and ESG products. The threat of climate change gives rise to a sense of personal and moral obligation amongst market participants. In fact, ESG criteria and CSR and SRI objectives, have emerged to show the firms' approach and interest on collective issues deemed important to society.

Such issues include environmental stewardship of nature, social issues as human rights and diversity and issues of governance as management structure and employee relations. As ESG and SRI practices encompass initiatives which support climate change mitigation efforts, governments started to give some support in the form of pension, sovereign wealth, and insurance funds. (Ryan Preclaw, 2015)

3.4. GREEN BOND PRICING IN THE VARIOUS MARKETS

1. **Green bond pricing in the primary market:** As mentioned above, the green bond issuance process is similar to that of conventional bonds. Nevertheless, one of the small differences is that through the green label and in order to increase investors' confidence in green credentials, more emphasis is given to governance, traceability and transparency which obliges the issuers to use the funds in the way it has been promised. Although we do not expect green bonds to be more expensive than vanilla bonds, it has appeared some evidence lately, that green bonds are actually priced tighter than similar conventional ones. This greemium is somehow an anomaly, primarily due to the unmet demand for the green debt which is largely driven by green investors and increasingly also by regular ones. The evidence that has appeared is mostly in the form of studies, as for example the panel data regressions of Fatica et al. (2019), which show that there is no effect on green bonds issued by financial institutions but that there exists a premium for those green bonds, that were issued by corporates and supranational institutions. Furthermore, also the results of Kapraun and Scheins (2019) revealed a greenium (ca. 20 to 30 bps) in the primary market, which can vary over time, across currencies and with the issuer types. Even Partridge and Medda (2020) found a statistically significant greenium of 4 bps through an index that comprised 521 green municipal bonds in the primary market and that outperformed the S&P index from 2013 to 2018. In a more detailed literature review, which can be found in the next subchapter, we will see in that also Ehlers and Packer (2017) and Gianfrate and Peri (2019) found a premium of about 18 basis points. (Julia Kapraun, 2019)

2. **Green bond pricing in the secondary market:** Many academic papers evidenced a greenium in the secondary market, but such results have to be read very carefully. Indeed, when comparing green and conventional bonds in the secondary market, it has to be considered that the analysis has some limits and errors. One of these limits is for instance that the results are not corrected for the liquidity bias, which is the difference in liquidity between bonds. The data on the bonds is normally market based and strongly affected by liquidity, as bonds are normally bought in the primary market and held until maturity.

Meaning that even if they could be liquid, they would not be traded in secondary markets and their price would therefore not be reliable. One of the first pieces of evidence of a green premium in the secondary market appeared in the study of Bour (2019), which examinedthe existence of a greenium and which identified a yield discount of 23.2 basis points in green bonds. Another study on the secondary market (Preclaw and Bakshi (2015)), which performed a regression analysis, suggested, after taking into consideration spread duration (capturing investment length), rating factors (capturing credit risk) and time since issuance (capturing the liquidity premium in off-the-run securities), that green bonds are traded at a statistically significant premium of 17 bps tighter in options-adjusted spread. Furthermore, we will see in the following literature review that also Baker et al. (2018), Gianfrate and Peri (2019), Zerbib (2019) and Nanayakkara and Colombage (2019) found evidence of a greemium in the secondary market. At the same time there has appeared non-significant evidence of green premium. One of these evidences is for example the study of Hyun et al. (2019) which investigated how the greenness of a bond is priced, by using the green bonds' liquidity-adjusted yield premium over their conventional bonds. The results indicated that normal green bonds had no significant yield premium or discount, while those certified by an external reviewer enjoyed a greemium of about 6 to even 15 basis points if they had obtained a CBI certificate. Another study (Larcker and Watts (2020)) analyzed and confronted non-green and green municipal bonds and found that when returns and risks are constant, investors saw both of these bonds as almost exact substitutes. In fact, the difference between the bonds was 0.45 bps, meaning that the greenium was essentially zero. Additionally, also Östlund (2015), which examined the spread differentials between green and conventional bonds, found no significant evidence of a greenium. In total there were also three cases of a positive green premium (on average of +7 bps) in the secondary market. The evidence about this positive premium has appeared in three studies: Bachelet et al. (2019), Kapraun and Scheins (2019) and Karpf and Mandel (2018). (Lucia Alessi, 2020)

3.5. LITERATURE REVIEW

3.5.1. Bachelet et al. (2019)

Bachelet et al. (2019) conducted a study on the secondary market in which a global sample of 89 private and institutional bond couples were assessed to control for bond characteristics. This study has been made between 2013 and 2017 and the OLS and FE regression methodologies were used.

The outcome was mixed: it showed that private green bond issuers had positive premia (2.1 to 3.4 bps) with respect to conventional correspondents in the presence of a rather small liquidity and little lower volatility. Furthermore, it showed that if private issuers are committed to certify their bonds as "green" by third-party verification, then they had higher premia. Instead, private issuers that have no green label, had even higher premium (3.2 and 12.4 bps). At the same time, institutional issuers had negative yield premia (-1.87 to -0.9 to) before correcting for their lower volatility, their much higher liquidity (18 bps) and their yield standard deviation. It is therefore likely that the results are linked to the fact that institutional issuers attract large institutional investors which allocate a significant amount to fixed income and who have a strategic interest in investing in green projects. Furthermore, institutional issuers have transparency and information rules that diminish asymmetries in information and overcome the questioning of their products' greenness. Hence, it is probable that the higher premium of private green bond issuers reflects an exposure to the greenwashing risk.

Figure 12: Descriptive statistics for green and brown bonds

Green Bonds	Count	Mean	SD	1st Perc.	25th Perc.	50th Perc.	75th Perc.	99th Perc.
Yield	39,333	2.03	2.55	−0.45	0.39	1.54	2.45	11.82
Price ask	38,435	100.87	4.71	79.68	99.55	100.62	102.40	115.53
Price bid	38,513	100.64	4.69	79.63	99.41	100.41	102.16	115.02
Liquidity	38,435	−0.22	0.34	−1.75	−0.26	−0.13	−0.08	−0.011
ZTD	39,333	0.053	0.225	0	0	0	0	1
Yield SD	39,329	0.06	0.074	0.01	0.033	0.049	0.075	0.42
Coupon	39,333	1.93	1.66	0.12	0.75	1.62	2.3	8.5
Amount ($)	39,333	0.169	1.32	0.0003	0.00032	0.005	0.006	4.45
Time to Maturity	39,333	3219.02	2833.80	77	862	2743	2745	9936

Brown Bonds	Count	Mean	SD	1st Perc.	25th Perc.	50th Perc.	75th Perc.	99th Perc.
Yield	39,333	2.01	3.21	−0.45	0.44	1.51	2.32	11.93
Price ask	38,869	101.14	4.71	80.94	99.67	100.70	102.16	116.08
Price bid	38,964	100.85	4.85	79.02	99.50	100.51	101.94	115.82
Liquidity	38,869	−0.27	0.44	−2.5	−0.27	−0.13	−0.07	−0.01
ZTD	39,333	0.056	0.23	0	0	0	0	1
Yield SD	39,329	0.11	1.80	0.01	0.032	0.049	0.08	0.49
Coupon	38,778	2.01	1.66	0.12	0.75	1.62	2.5	8.5
Amount ($)	39,333	0.26	3.07	0.00013	0.0031	0.0075	0.011	0.78
Time to maturity	39,333	3248.82	3102.90	45	700	2292	4322	11,360

Source: (Maria Jua Bachelet, 2019)

3.5.2. Baker et al. (2018)

Baker et al. (2018) made a study in the secondary market on a sample of 2,083 green US municipal bonds and 643,299 ordinary bonds issued between 2010 and 2016. They also made another sample of 19 green US corporate bonds and one of 8,315 ordinary corporate bonds issued between 2014 and 2016.

In this study, Baker et al. (2018) used the OLS regression model, in which they discovered that those municipal green bonds are priced at a premium of -7.6 to -5.5 bps and that they earn lower returns. It has to be said, that these results were constructed by using after-tax yields, whereby it has to be considered that the pricing of the US municipal market is in general highly sensitive to taxes. In fact, in the first half of the sample period, some green municipal bonds were still taxable, thus they were traded at higher yields, in the after-tax period, on the other hand, they were sold at a premium. All these estimates of the premium controlled for factors related to ratings maturity, tax status, the yield curve and other bond characteristics. The yield difference corresponds to approximately 0.60% difference in value, which is absolutely economically meaningful. What has also been found, was that such premium can even double or triple for bonds that are labeled as green and that are externally certified. In general, it can be said that green municipal bonds, in confront to ordinary ones, have longer maturities, higher credit ratings and that they are larger and more likely to be taxable, while green corporate bonds resemble ordinary corporate bonds. For the study, Baker et al. (2018) invented a consistent simple framework to analyze pricing and ownership patterns of green bonds by featuring a subset of investors whose objective function includes sense of social responsibility, in addition to standard portfolio mean and variance. This framework also estimated green bonds' ownership concentration (trough the Herfindahl-Hirschman index), which was found particularly strong for small bonds.

Figure 13: Characteristics of green and ordinary bonds, data on municipal bond characteristics (panel A) come from Mergent, while data on corporate bond characteristics (panel B) are from Bloomberg

	Green				*Ordinary*				*Diff*	
Variable	**Mean**	**Median**	**Min**	**Max**	**Mean**	**Median**	**Min**	**Max**	**Mean**	**P-Value**
Panel A. Municipal										
Rating (AAA=1)	2.78	2.00	1	14	3.40	3.00	1	21	-0.63	(0.005)
Maturity (Years)	11.94	11.22	1	30	10.70	9.82	1	30	1.25	(<0.001)
Insured (Yes=1)	0.060	0.00	0	1	0.170	0.00	0	1	-0.11	(<0.001)
Taxable (Yes=1)	0.280	0.00	0	1	0.069	0.00	0	1	0.21	(<0.001)
Taxable AMT (Yes=1)	0.000	0.00	0	0	0.011	0.00	0	1	-0.01	(<0.001)
Taxable State (Yes=1)	0.056	0.00	0	1	0.091	0.00	0	1	-0.03	(0.101)
Bond Size ($M)	6.3	2.3	0.1	250	3.0	0.7	0.1	3500	3.27	(<0.001)
Bank Qualified (Yes=1)	0.016	0.00	0	1	0.383	0.00	0	1	-0.37	(<0.001)
New Money (Yes=1)	0.711	1.00	0	1	0.434	0.00	0	1	0.28	(<0.001)
General Obligation (Yes=1)	0.147	0.00	0	1	0.468	0.00	0	1	-0.32	(<0.001)
Callable (Yes=1)	0.544	1.00	0	1	0.519	1.00	0	1	0.03	(0.109)
Puttable (Yes=1)	0.000	0.00	0	0	0.001	0.00	0	1	0.00	(<0.001)
CBI Certified Green (Yes = 1)	0.066	0.00	0	1	0.000	0.00	0	0	0.07	(0.029)
Any Certified Green (Yes = 1)	0.117	0.00	0	1	0.000	0.00	0	0	0.12	(<0.001)
Panel B. Corporate										
Rating (AAA=1)	9.26	8.00	2	14	9.10	9.00	1	21	0.17	(0.879)
Maturity (Years)	6.84	7.03	2	10	8.37	7.52	1	30	-1.52	(0.085)
Bond Size ($M)	605	500	250	1,500	487	350	0.1	11,000	118.0	(0.129)

Source: (Malcolm Baker, 2018)

3.5.3. Ehlers and Packer (2017)

Ehlers and Packer (2017) made a study on the primary market in which they assessed a sample of 21 green bonds (US dollar and euro-denominated) between 2014 and 2017. Their research was conducted through the yield comparison method between green and conventional bonds from the same issuer, meaning that they compared credit spreads at issuance of cross-sectional data, by trying to determine if investors' decisions are based only on idiosyncratic factors, as for example expected risk or return, or also on non-monetary characteristic, as for instance the green label, which affects pricing and at the same time the yield that an issuer is willing to pay for a bond. Ehlers and Packer (2017) decided to not include project bonds in their study, as different projects normally have diverse risk characteristics, therefore they restricted the sample to fixed rate bonds with similar maturity in order to avoid that yields and pricing could be influenced by debt seniority or by the uncertainty of floating rates. The results indicated that green bond issuers borrow at lower spreads than those of conventional bonds, with a mean difference in spread of around 18 bps. These results are probably related to the fact, that the demand for green bonds is high, while supply is low. Ehlers and Packer (2017) also examined the yield differences in the secondary market by examining hedged-returns, unfortunately, they did not find statistically significant differences in returns between green and global bond indices.

Figure 14: Green bond indices: return characteristics, annualized monthly total returns, July 2014–June 2017

		Hedged returns[1]				Unhedged returns[2]			
		Cumulative over 36 months	Mean (1)	Std dev (2)	Sharpe ratio = (1)/(2)	Cumulative over 36 months	Mean (1)	Std dev (2)	Sharpe ratio = (1)/(2)
Green bond indices	Standard & Poor's	.	.	.	.	–4.18	–1.48	18.44	–0.08
	BofA Merrill Lynch	9.17	3.06	8.64	0.35	–6.45	–2.15	18.92	–0.11
	Solactive	.	.	.	.	–4.52	–1.51	18.66	–0.08
	Barclays MSCI	10.23	3.41	9.61	0.35	–3.43	–1.14	17.23	–0.07
Global bond indices	Broad-based	11.26	3.75	11.64	0.32	3.46	1.15	14.97	0.08
	AA average rating	10.29	3.43	10.21	0.34	0.97	0.32	14.16	0.02
	A average rating	11.02	3.67	10.99	0.33	3.12	1.04	14.08	0.07

Source: (Packer, 2017)

3.5.4. Gianfrate and Peri (2019)

Gianfrate and Peri (2019) made a study on the primary (between 2013 and 2017) and on the secondary (on three different dates in 2017) market in which they assessed, trough propensity score matching, a sample of 121 and another one of 70 to 118 euro-denominated green bonds respectively.

For the sample they took only those bonds that had no variable interest payments: bonds with a size that is bigger than 200 million euro and bonds which have low risk of default. What Gianfrate and Peri (2019) found, is that green bonds are issued at a greemium of about 18 basis points in the primary market and at a greemium of 5 to 11 bps in the secondary market. This means that issuers experience some benefits from labeling their bonds as "green", even though such a label may have some extra-costs because of its certification, etc. The benefit can be expressed in a reduction of the cost of debt finance, through a lower interest (0.18% on the overall bond value) that issuers have to pay to investors annually.

Figure 15: Primary market OLS regressions results

Variable:	Coeff.	Std. Err.	t	p > |t |	Regression's R2
Sample1					
Green dummy	−16.63***	3.51	−4.74	0.000	0.733
Sample2					
Green dummy	−23.42***	6.90	−3.40	0.001	0.535
Sample3					
Green dummy	−10.26**	4.06	−2.52	0.012	0.753

Notes: (***) (**) (*) indicate significance at the (1%) (5%) (10%) level.

Source: (Gianfranco Gianfrate, 2019)

3.5.5. Karpf and Mandel (2018)

Karpf and Mandel (2018) made a study on the secondary market between 2010 and 2016 in which they assessed, through the Oaxaca-Binder decomposition, a sample of 1880 US Municipal green bonds. Their results, similar as those of Bachelet et al., show that there exists a positive premium of the value of 7.8 bps, which probably derives from the fact that both studies, that of Karpf and Mandel (2018) and that of Bachelet et al., neglected the effect of taxation in the US municipal securities market. According to these outcomes, the greenness of a bond does indeed penalize the market, as it has been shown that green bonds are traded at lower prices and higher yields than expected by their credit profiles. What their results highlighted, apart from the positivity of the spread in returns between brown and green bonds, was that if the market would value green bonds as conventional ones, they would have a lower expected mean return then conventional bonds. This means that the former would have to pay a higher return than the latter ones with same properties.

Figure 16: Brown Bonds (1), Green Bonds (2), Pooled Data (3) (days to maturity; volume of transaction; dummy variable indicating whether the bond has A or B rating; accumulated local debt in a state, state debt; real growth of the state, population of a state)

	Dependent variable:		
	ytc		
	(1)	(2)	(3)
dtm	0.530***	0.538***	0.287***
	(0.001)	(0.001)	(0.003)
amount	−0.031***	−0.032***	0.003**
	(0.001)	(0.001)	(0.001)
paissuance	0.026***	0.028***	−0.099***
	(0.001)	(0.001)	(0.005)
freq	−0.013***	−0.013***	−0.009***
	(0.001)	(0.001)	(0.003)
ratingA	−0.036***	−0.048***	−1.639***
	(0.002)	(0.002)	(0.468)
ratingB	0.626***	0.676***	−1.418***
	(0.004)	(0.005)	(0.468)
treasury	0.556***	0.548***	1.131***
	(0.001)	(0.001)	(0.005)
broker	0.103***	0.105***	0.063***
	(0.001)	(0.001)	(0.003)
local_debt	0.057***	0.053***	−0.149***
	(0.001)	(0.001)	(0.005)
state_debt	0.072***	0.063***	−0.076***
	(0.001)	(0.001)	(0.005)
realgrowth	−2.996***	−3.237***	−4.217***
	(0.038)	(0.038)	(0.248)
population	−0.738***	−0.759***	−0.185***
	(0.020)	(0.020)	(0.056)
Constant	1.183***	1.279***	4.833***
	(0.083)	(0.087)	(0.465)
Observations	1,613,792	1,543,394	70,398
Log Likelihood	−1,801,736.000	−1,730,589.000	−34,872.340
Akaike Inf. Crit.	3,603,502.000	3,461,207.000	69,774.680
Bayesian Inf. Crit.	3,603,686.000	3,461,391.000	69,912.110
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: (Andreas Karpf, 2017)

3.5.6. Nanayakkara and Colombage (2019)

Nanayakkara and Colombage (2019) conducted a study on the secondary market between 2016 and 2017 in which they assessed, through panel data in a hybrid model, a sample of 43 global green bonds. As soon as they identified the presence of fixed effects, they started to use the hybrid model as they thought that it would be a better approach to seize fixed-effects in random effect modelling. This hybrid model is able to identify the coefficients that are likely to be correlated with the bond-specific unobserved variables. Nanayakkara and Colombage (2019) demonstrated that green bonds are traded with a tighter spread of 62.7 bps. Furthermore, their study showed that credit spreads of domestic variables are tighter (50.6 bps) than those of foreign currencies.

This phenomenon can be explained by the fact that an investment in a green bond that is denominated in local currencies has lower risks even when it is invested overseas.

Figure 17: Hybrid, correlated random-effects and random-intercept models for OAS data with panel corrected standard errors

	Equation (6) Hybrid	Equation (7) Correlated random-effects	Equation Equation (8) Random-intercept
GB	−0.627***	−0.627***	−0.585***
	(0.063)	(0.063)	(0.060)
LC	−0.506***	−0.506***	−0.651***
	(0.121)	(0.121)	(0.111)
MR		26.732***	30.716***
		(7.844)	(7.991)
TR		0.194***	0.288***
		(0.012)	(0.012)
GDPG		0.00003	0.001
		(0.005)	(0.005)
CPI		−6.018***	−9.344***
		(1.905)	(1.756)
DMR	26.732***		
	(7.844)		
DTR	0.194***		
	(0.012)		
DGDPG	0.00003		
	(0.005)		
DCPI	−6.018***		
	(1.905)		
MMR	1155.679***	1128.946***	
	(110.266)	(110.723)	
MTR	3.358***	3.352***	
	(0.534)	(0.534)	
MGDPG	−0.418**	−0.419**	
	(0.199)	(0.199)	
MCPI	31.919***	37.937***	
	(5.345)	(5.716)	
Constant	−158.172***	−158.171***	48.061***
Firm dummies	Yes	Yes	Yes
Unobservable hetero	Yes	Yes	No
Observations	27,953	27,953	27,953
χ^2	50,204.88	50,204.895	52,737.441
P $>\chi^2$	0.000	0.000	0.000
Mean dependent var	4.863	4.863	4.863
SD dependent var	1.166	1.166	1.166
R-squared	0.712	0.712	0.717

*** p < 0.01, ** p < 0.05, * p < 0.1.
Panel corrected standard errors in parentheses.

Source: (K.G. Madurika Nanayakkara, 2019)

3.5.7. Zerbib (2018)

Zerbib (2018) made a study on the secondary market between 2013 and 2017 in which he assessed a sample of 110 global green bonds by using a matching method based on maturity. In this study, Zerbib (2018) found a small premium of 1.8 bps, which was calculated (through a time-invariant fixed effect panel regression) as the unobserved effect of the difference in yields between green and conventional bonds on the differences in liquidity. This method is one of the best ones to overcome the problem of yield differentials in relation to liquidity. Zerbib (2018) describes the small premium as the small impact of investors' green preference on bond prices, which is not an obstacle for investors to support the market growth. Zerbib (2018) is also sure that the results suggest, that the premia can vary between different markets and industries, and that the rating and the amount issued are the main drivers of the premium.

Figure 18: The table shows average yield & maturity of 110 green bonds divided in sector, rating and currency

		AUD	CAD	CHF	CNY	EUR	GBP	INR	JPY	RUB	SEK	TRY	USD	Total
Basic Materials														
NR	Average yield (%)										0.96			0.96
	Average maturity (years)										4.74			4.74
	Nb. of GB										1			1
Consumer, Non-cyclical														
BBB	Average yield (%)					0.78								0.78
	Average maturity (years)					5.51								5.51
	Nb. of GB					1								1
Financial														
AAA	Average yield (%)	2.43				0.07	0.79				0.10		1.98	0.83
	Average maturity (years)	2.50				4.94	2.43				2.96		3.52	4.13
	Nb. of GB	1				10	1				1		6	19
AA	Average yield (%)	3.00				0.28							2.10	1.11
	Average maturity (years)	3.37				5.68							2.70	4.86
	Nb. of GB	3				8							1	12
A	Average yield (%)				3.70	0.36					0.77		2.17	1.34
	Average maturity (years)				0.53	4.25					4.13		1.98	3.09
	Nb. of GB				1	8					2		8	19
BBB	Average yield (%)					0.61							3.65	2.13
	Average maturity (years)					4.49							2.92	3.70
	Nb. of GB					1							1	2
BB	Average yield (%)												5.23	5.23
	Average maturity (years)												3.38	3.38
	Nb. of GB												1	1
NR	Average yield (%)										0.66			0.66
	Average maturity (years)										2.77			2.77
	Nb. of GB										11			11
Government														
AAA	Average yield (%)	2.41	1.57	0.03		0.26	0.59	5.70		6.65	0.49	10.28	1.73	1.92
	Average maturity (years)	1.33	2.85	7.10		5.54	2.18	3.15		1.57	4.75	1.24	3.15	3.50
	Nb. of GB	1	2	1		3	1	1		1	4	1	15	30
AA	Average yield (%)			0.31									2.16	1.23
	Average maturity (years)			11.92									1.64	6.78
	Nb. of GB			2									2	4
A	Average yield (%)								0.39					0.39
	Average maturity (years)								14.79					14.79
	Nb. of GB								3					3
BBB	Average yield (%)												2.68	2.68
	Average maturity (years)												2.25	2.25
	Nb. of GB												1	1
Industrial														
BBB	Average yield (%)					0.83								0.83
	Average maturity (years)					5.94								5.94
	Nb. of GB					1								1
Utilities														
A	Average yield (%)					0.49								0.49
	Average maturity (years)					2.85								2.85
	Nb. of GB					2								2
BBB	Average yield (%)					0.94								0.94
	Average maturity (years)					6.41								6.41
	Nb. of GB					3								3
	Average yield	2.77	1.57	0.22	3.70	0.34	0.69	5.70	0.39	6.65	0.62	10.28	2.09	1.31

Source: (Zerbib, 2018)

3.6. DIFFERENCES IN VALUATION

The various differences in results, that we have seen in the above-mentioned studies, have different "backgrounds". In the following section we are going to determine some of them.

1. **Supply and demand:** A difference in evaluation, may reflect the increasing interest in green products. This can result in an oversubscription and a mismatch between the supply and the demand of green bond issues. To make a greenium emerge, must the amount of demand be sufficient to clear the entire supply of the issue at higher prices and lower yields and spreads. Thus, has a green investor to be at the marginal trading for an asset in order to observe a greenium (always if it even exists). In case of oversubscription, do spread differentials stop if issuers see an opportunity for cheaper funding. This happens because of the fact that issuers would immediately gravitate towards the market which offers this opportunity and because inflows to funds (with green mandates) would slow down thanks to lower returns implied by tighter spreads.

2. **Time horizon:** When using data that is retrieved at different dates, it is quite impossible to observe the potential volatility of returns and the evolution of this volatility over time. Also, in the case of green bonds, it is not useful to take into consideration data from many years ago as there would not be enough green bonds available to successfully apply propensity score matching techniques.

3. **Volatility:** Green bonds are most of the times less risky or volatile than similar plain vanilla bonds. This makes the green bonds' tighter spreads which suite their risk-adjusted return. At the same time, some market players and studies have found evidence that investors that are environmentally friendly and that invest over a long-term, which mostly marginal buyers of green debt, could diminish trading activity and bring greater price stability to green issuance. (David F. Larcker, 2019)

4. **Liquidity:** Another explanation for pricing differences is, as some research has found, that the green bond market has poor liquidity. Multiple findings of negative relationships between bond yields and liquidity support this argument. The municipal securities market is by nature extremely illiquid and it has limited trading, exactly because of this fact are many commonly used liquidity metrics, such as bid-ask spread, not always available. In general, a higher value of quarterly turnover is indicative of greater market liquidity.

5. **Green preference:** The investors' preference and the tight spreads of green bonds indicate that investors gather sufficient other benefits to compensate the smaller cash flows. Such benefits are for instance psychological benefits, as brand value and influence with regulators. Nonetheless, there do not exist many investors that have been willing to set a precise price on their "greenness". In fact, some green-mandate portfolio managers have admitted that they have a prejudice towards green issues, except from the case in which they get a risk-adjusted remuneration that is equal to an investment in a conventional bond.

6. **Green credentials:** As we have already seen, greenwashing a barrier for investors in the green bond market. Greenwashing is mainly linked to the fact that universal agreements on the green criteria do not exist. Indeed, anyone can issue a bond under a green label as long as the issuer convinces the investors that funds are used for eco-friendly purposes. The problem is that this can bring to measurement errors which are a threat to our inferences. The lack of a greenium could henceforth be due to investors' uncertainty about whether the use of proceeds actually benefits the environment.

7. **Externalities:** It has been suggested by diverse market participants that green bonds should trade at tighter bps to reflect an externality as for instance that of climate risk mitigation through commitment to sustainable projects. The problem is that, even though often such externalities exist, it is very difficult to measure them, in particular, because green bond owners are not the residual claimants on benefits and because it is still not clear why conventional bonds would not also be able to obtain some benefits from the existence of green bonds while maintaining their spreads aligned. (S. MacAskill, 2020)

3.7. RESULTS AND DISCUSSION

Figure 19: Findings of the literature review

Study	Market	N° GB	Universe	Period	Method	Greemium estimate
Bachelet et al. (2019)	Secondary	89	Global	2013-2017	OLS model	+2.1 to +5.9 bps
Baker et al. (2018)	Secondary	2083 19	US Municipal US Corporates	2010-2016 2014-2016	OLS model	-7.6 to -5.5 bps
Ehlers & Packer (2017)	Primary	21	EUR & USD	2014-2017	Yield comparison	-18 bps
Gianfrate and Peri (2019)	Primary Secondary	121 70-118	EUR	2013-2017 2017	Propensity score matching	-18 bps -11 to -5 bps
Karpf and Mandel (2018)	Secondary	1880	US Municipal	2010-2016	Oaxaca-Binder decomposition	+7.8 bps
Nanayakkara and Colombage (2019)	Secondary	43	Global	2016-2017	Panel data with hybrid model	-62.7 bps
Zerbib (2018)	Secondary	110	Global	2013-2017	Fixed effect models	-1.8 bps

The literature review and data analysis investigated on the circumstances in which the green premium most frequently appears. Figure 19, which we can find above, summarizes the main findings of the various studies and articles which sought to determine whether a greemium is present or not in the primary and secondary green bond market. The findings in the primary market reveal the existence of a green premium: in both cases (Ehlers & Packer (2017) and Gianfrate and Peri (2019)) a greemium of 18 bps has been found. This confirms that a broad consensus exists on the existence or presence of a greenium. Also, in most of the studies that examine the secondary green bond market, there has been found evidence of the existence of a greemium. In fact, average spreads between green bonds and conventional bonds confirm this presence, although the results vary from +7.8 to -62.7 bps. In the case where a premium has been found, results vary from -1.8 to -62.7 meaning that the differences in spreads vary from almost non-significant to up to large differences between green and conventional bonds' spreads.

The variances in results within the secondary market data, suggests not only that one or more of the above-mentioned causes has brought to a huge difference in valuation, but also that further investigation is required and that studies need to employ a larger data set than it is currently available in the literature. As a result, this literature review does not present an average bps green premium for the secondary market, while it does for the primary market where spreads have been exactly the same (18 bps). This means that investors in the primary market are willing to invest in green bonds that are comparable to conventional bonds and that they accept a lower yield in exchange for green credentials. It can therefore be concluded that the findings confirm that the green bond label comes with a price and that it has a value. Additionally, it can also be said that there is a strong investors' demand for green projects, as the majority of studies of this review found a green premium in the primary as well as secondary market. These findings altogether are not only important for the future growth of the green bond market, but also for bond pricing, as they suggest that issuers should take into account also non-economic motives of investors.

CONCLUSION:

Even though some barriers still exist, such as challenges and risks for green bond market entrants, we can daily conceive more and more efforts and improvements, as for example the invention of standardized guidelines, etc. which are made by issuers, governments and others, that try to overcome these obstacles and that give integrity to the market. It seems that these efforts have paid off: the numbers show that there is a huge demand for green bonds and that up to today over 1 trillion dollars of green bonds have already been issued. This suggests that there have to be at least some benefits for those that invest in green bonds, indeed, the last chapter of this thesis mentioned a few of all the exiting benefits, which can be summarized as follows: firstly, green bonds' have in general identical financial characteristics as conventional or plain vanilla bonds from the same issuer. Additionally, there exist psychological benefits, as brand value, etc. furthermore, green bonds are normally less risky or volatile than similar plain vanilla bonds.

In general, it is not yet clear what further possible benefits green bonds could bring and which of them are preferred by investors. Above all, there is one thing that we can be sure about: benefits outweigh the eventual "price" (the green premium) one has to pay for a green label. This fact is expressed by the findings of the literature review of this thesis, which are that investors are willing to invest in green bonds and that they are also willing to accept a lower yield in exchange for green credentials. In conclusion, it is reasonably to say that green bonds are actually convenient means to mitigate climate change.

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