An Extensive Green Bond Market Analysis from 2015 to 2021

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Climate change is indubitably one of the biggest challenges for humanity in the coming decades. While the interest in solving this problem has been increasing recently, the window to minimize the temperature increase to 1.5°C has also been narrowing. Therefore, the transition to low-carbon economies to reach the Paris Agreement is significantly vital for the future of our home.

In this transition, finance is crucial in mobilizing capital toward low-carbon investments. Several innovative products are in the market to make this capital shift possible. Green Bonds are one of the recent products — they are very similar to conventional (vanilla) bonds but differ by applying an environmental label; this green label restricts the use of proceeds to green projects and assets exclusively.

The green bond market and research interest in the topic have expanded over the years. Researchers are asking if this market expansion is an appropriate way to mitigate the adverse effects of environmental pollution. There are different opinions about the expansion's effect on mitigation efforts. However, the details of the expansion of the Green Bond Market are mostly uncovered. The critical contribution of this research is to explore the details of the expansion of the market between 2015 and 2021. This thesis integrates the extensive literature review with data analysis and concludes with further questions and comments.

This research utilizes the database of the Climate Bonds Initiative (CBI) to examine the expansion of the green bond market. Specifically, the study employs a quantitative approach through descriptive analysis and statistical tests to analyze 8111 self-labelled qualified green bonds and similar debt instruments from 2015 to 2021. By examining the data by region, country, issuer type, external reviewer, date, the issued amount in USD, currency, and use of proceeds, the study aims to provide answers to the overall expansion of the green bond market, market comparison between regions and countries, types of green bond market participants, and market share of opinion providers. Furthermore, the study utilizes statistical tests to provide insights into the use of proceeds as well as a regional analysis of green bonds.

It was found that the growth of the green debt market did not result in advantages for many countries. Rather, a small number of countries, mainly developed ones, were the primary beneficiaries of the raised capital. This phenomenon, which we termed "concentration," was observed.

This concentration creates a lack of diversity, and instead, the market is dependent on several key players. For instance, in the US, which is the largest green bond issuer, almost half of the country's total amount was issued by a single entity, while just four second-party opinion providers held 93% of the opinion market. Similarly, in China, only one issuer type was responsible for half of the total amount issued. Overall, the top ten countries in the world accounted for 73.4% of the total capital, further highlighting the market's concentration.

Also, multilateral and national development banks failed to play an intermediary role in the green bond market in less developed regions. The findings of this study may be significant in encouraging key stakeholders to explore means of enhancing the benefits that underdeveloped and developing countries receive from the green bond market.

In addition to the findings, the comprehensive database presented in this research serves as a crucial resource for further research into the green bond market's structure and dynamics. This database, characterized by its novelty and detailed market expansion structure, is an important tool for both researchers and policymakers aiming to assess the role of green bonds and policy in fostering sustainable development and climate change mitigation. Moreover, the database lays a solid foundation for examining the relationship between green bond issuances and the actual reduction of greenhouse gas emissions for further studies, helping to address the critical question of whether the green bond market is genuinely "green."

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1. Introduction

The Earth has been getting through an unprecedented time. While ordinary people currently need to cope with Covid-19, inflation, the energy crisis, armed conflicts, and other pressing social and economic issues, the future is under severe threat by climate change. People could be the next victim of drought, flood, heatwave, or other extreme weather events.

The increasing amount of greenhouse gases in the atmosphere causes an increase in the world's temperature, affecting the world's critical balance. IPCC (2021) stated that historical data strongly suggests that surface temperature and CO2 concentration are clearly coupled, and CO2 concentration has been at the highest level since the observations began. Human influence in this concentration is unquestionable.

Therefore, the Climate Change Challenge is no longer a remote problem for humanity, or it may never be. IPCC (2021) expects temperature increase will reach 1.5°C over the next 20 years. This increase means that extreme temperature events will happen 4.1 times more, heavy precipitation over land event will happen 1.5 times more, and agricultural and ecological droughts in drying regions will be doubled; extreme temperature events, which occurs once every fifty years will happen 8.6 times more within the next 20 years.

To cope with the adverse effects of climate change and mitigate further damage, investors need needs to invest in sustainable development projects. However, the investment gap in even conventional infrastructure is about $3 trillion per year (McKinsey&Company, 2016). This gap is too big to be filled by only government efforts (Sengupta et al., 2018). Additionally, making these new developments in a sustainable way will have an extra cost.

Green bonds are considered one of the innovative tools in the finance industry to raise capital for green projects. The expansion of green bonds has been increasing. Since the first issuance, the green bond market has cumulatively raised, as of September 2022, US $1.95tn. This rapid expansion made green bonds a promising tool to raise capital for sustainable development projects. Banga (2018) showed that growing interest is backed by investors who have

environmental concerns. He also suggested that multilateral and national development banks can play an intermediary role in the green bond market.

The literature also shows the necessity of standardization in the green bond market along with current standardization efforts such as the International Capital Market Association's Green Bond Principles, EU Green Bond Standards, and Climate Bond Initiative's Green Bond Standard Version 3.0. Despite the lack of standardization, the expansion of the market continues. Climate Bond Initiative (2021) and European Investment Bank (2022) presented that the green bond market significantly expanded. Geographically, Bansal (2022) pointed out the barriers in India to the green bond market. Elliott and Zhang (2019) presented the policy innovations in China to steer the capital into the green bond market. Bernabé Argandoña (2022) underlined the Latin American and the Caribbean's recent attack to get more attention to their green bond market.

However, research on green bonds has mostly focused on the financial side of the instrument. There is little known about the green bond market expansion in detail, such as the direction of the green bond market and global and regional trends, the breakdown of the bonds by their characteristics and regions, and the over and under performance of the market. This research aims to reveal the details of this market expansion by region, country, issuer type, use of proceed, and second-party opinion provider. This study will give the researchers and policy makers a new perspective on the expansion of the green bond market, outline the trends and momentums, and underline the strength and weaknesses of the market. This research is especially timely because it encounters the expansion of the market, which will be seen later in the analysis. Therefore, the transition from the "niche" to the "potential mainstream'' could be seen in the analysis.

In this research, 8111 green bonds and other debt instruments issued worldwide between 2015 and 2021 were analyzed. The analysis demonstrated a concentration of the capital around several players across and within the regions, a lack of diversity, and fail of the multinational development banks as an intermediary role in the green bond market. Our research indicated that the expansion in the green debt market did not bring benefits to a large number of countries. Instead, it was primarily benefited by a select few, primarily developed, nations. We called this "*concentration."*

2. Research Objective and Questions

Climate Bond Initiatives (2021) showed that the green bond market expanded exponentially in the last decade. Our research aims to enlighten the market's profile for the six years between 2015-2021. This research is timely because it encounters the expansion of the market. Therefore, the transition from the "niche" to the "potential mainstream could be seen." The literature on sustainable finance and green bond has been growing. Researchers are asking if this market expansion is an appropriate way to mitigate the adverse effects of environmental pollution. There are different opinions about the expansion's effect on mitigation efforts. However, the details of the expansion of the Green Bond Market are mostly uncovered. The objective of this research is to explore the details of the expansion of the market between 2015 and 20221.

The research will seek to answer the following questions:

- How trends and momentums have changed in the Green Bond market in the last six years, including defining the leading countries and issuers in the regions?
- How does this database contribute to our understanding of the authenticity and effectiveness of green bonds?
- How can we evaluate the applicability of institutional theory and the priority of sustainable finance theory within the context green bonds?
- Did developing and underdeveloped countries receive substantial money within this period? How does their performance compare to developed countries?
- Are there any significant differences between regions and countries regarding the size and number of issued bonds?
- What was the trend and market share distribution among second-party opinion providers?
- How was the all-around diversity of the Green Market? Does it depend on only several players, or does it show a robust and diverse market that includes various players?

Our research will study the green market by analyzing 8111 green bonds and other debt instruments. This analysis will provide insightful results which can be connected with our theory to determine the priorities of the regions and countries and compare them with each other.

3. Literature Review

This literature review consists of three parts: Green Finance, Green Bonds, and Major Developments in Green Bond Standardization. In the first part, what green means economically will be presented, and then what green bond is will be summarized. Later, the readers will dive into the significant efforts for developing green bond standards such as International Capital Market Association's Green Bond Principles, Climate Bonds Initiative's Bond Standard: Version 3.0, and European Union Green Bond Standards.

3.1 Green Finance

The ideas of green, climate, environmental, and sustainable finance are generally used interchangeably (Tripathyionel et al., 2020). The concept could be named differently, but finance has one vital role in coping with climate change— mobilizing capital.

The raised capital through green bonds needs to fund green projects that will mitigate the risk of climate change; therefore, central banks, governments, and the financial industry need to mobilize resources to cope with the climate crisis. However, despite the increasing importance of green finance, there is confusion about the definition of green (Donovan & Bardalai, 2017). With respect to subjectivity and diversity in opinions for being green, a shared set of standards would benefit the finance industry and the world's collective fight against the climate crisis. Table 1 summarizes the definitions of green/sustainable finance.

Table 1. Summary of definitions of green finance and green investment[1]

Source:	Summary of Definition:
PwC (2009)	"…financial products and services, under the consideration of environmental factors throughout the lending decision making, ex-post monitoring and risk management processes, provided to promote environmentally responsible

[1] Source: Adapted from (Donovan & Bardalai, 2017).

	investments and stimulate low-carbon technologies, projects, industries and businesses."
Eyraud et al. (2011)	"the investment necessary to reduce greenhouse gas and air pollutant emissions, without significantly reducing the production and consumption of non-energy goods."
Bergedieck et al. (2011)	"… that green finance definitions feature many similarities, including obvious sectors such as renewable energy and green buildings, as well as differences regarding specific sectors such as nuclear power, noise abatement, and carbon capture and storage, reflecting the country-specific nature of definitions."
Höhne (2012)	"…financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy." They split green finance into three categories: green energy, climate mitigation and 'other.'
Inderst et al. (2012)	Broad definition of green investments as assets that can be described as green. Investing is defined as the act of "committing capital or money to an endeavour[...] with the expectation of receiving future profit". They argue that the greenness of a given good or service is more accessible to deduce than for an economy-level assessment.
Zadek et al. (2013)	"The overall capital cost of the transition to a green economy, such as reducing greenhouse gas emissions, increasing resilience, securing food systems and managing of water, forest, transport and waste systems." Their definition of green finance similarly describes itself as a cost and includes "operational costs such as project preparation and land acquisition costs."
Lindenberg (2014)	A three-part definition includes: 1) the financing of private and public green investments, 2) the financing of public policies, and 3) components of the financial system that deal specifically with green investments.
Volz et al. (2015)	"…all forms of investment or lending that take into account environmental impact and enhance environmental sustainability."
G20 Green Finance Study Group (2016)	"…financing of investments that provide environmental benefits in the broader context of environmentally sustainable development."
Donovan & Bardalai (2017)	'' Green finance matches sources of funding new capital and operating expenditures that generate measurable progress toward the achievement of a well-recognized environmental goal.''

The definitions in Table 1 goes back to 2009 and illustrate that each institute or researcher has its unique understanding of green finance. However, definitions mainly gather around the positive environmental impact that the finance industry could make in energy production, development and operation practices, and policy developments. As seen in Table 1, the abundance of green/sustainable finance definitions makes standardization challenging while opening doors for green and social washing.

Overall, green finance could be generally understood to be the financing of assets and activities that support climate change mitigation, adaptation, and resilience (Tripathy, Aneil, Lionel, Mok, & De Chandrond, 2020). Climate finance could also be considered a subset of environmental finance, a developing study area interested in the transition to a sustainable economy and the possible effects of climate change on industries (Linnenluecke et al., 2016).

In their paper, Donavan & Bardalai (2017) explore the green finance market. Based on their study, it can be summarized that the green finance markets as Debt Markets as Green Loans and Green Bonds; Listed Equity Markets as Green Exchange Traded Funds and YieldCos (a yieldco is a company that is formed to own operating assets that produce a predictable cash flow (GERMI, 2016); Private Equity Markets as Unlisted Infrastructure, Venture Capital, and Growth Private Equity; Alternative Finance as Crowdfunding.

3.2 Green Bonds

Bonds are fixed-income debt instruments issued by corporations or government bodies such as municipalities, provinces (states), or federal governments. Investors, also called debt holders, loan their money to bond issuers in return for fixed interest for a defined period to finance or refinance the projects (Weber & Feltmate, 2016). Demand and the price of the bonds are based on several factors: size and time-to-maturity of the bond, credit quality, timing of issuance, and supply in the market (Harrison & Boulle, 2017; Scoot-Quinn & Cano, 2015). Green bonds are very similar to conventional (vanilla) bonds but differ by applying an environmental label to their

bonds (Aneil, Mok & De Chandrond, 2020). This green label restricts proceeds with only green projects and assets. Even though green bonds' proceeds will be exclusively applied to fund eligible green projects, the definition of green is not always straightforward due to its voluntary and self-labelling nature. In the following section three significant standardization efforts were mentioned: International Capital Market Association's Green Bond Principles (GBP), Climate Bonds Initiative's Bond Standard: Version 3.0, and European Union Green Bond Standard (EU GBS).

This voluntary nature hinders the growth of the global green bond market (IIAC, 2020). Greenwashing is one of these negative consequences damaging the confidence of the green market. Greenwashing happens when green bond proceeds go to activities with little or no environmental value (Bartels et al. 2015; Whiley 2017). S&P Dow Jones, Barclays MSCI, Bank of America Merrill Lynch, and Solactive developed tools and rating products to analyze and compare green bonds' performance (Ehlers and Packer 2017).

Despite these concerns, the green bond market is expanding. In 2008, the European Investment Bank (EIB) issued the world's first green bond; the total green bond issuance has since exceeded USD 1.5 trillion (EIB, 2022). The growing attention of investors to green bonds brings more researcher to the table.

Banga (2018) showed that growing interest is backed by investors who have environmental concerns. In the same paper, Banga also suggests that developed countries have not yet utilized the green bond market. He suggested that multilateral and national development banks can play an intermediary role in the green bond market.

Sovereign bond issuance appeared as one of the ways that countries could raise a large amount of money. Laskowska (2019) highlighted that the first sovereign bond was issued in 2016 by Poland's Ministry of Finance. Just after Poland's issuance, other countries like France, Belgium, Nigeria, and Indonesia followed the Polish sovereign bond (ibid.). Sovereign bonds rapidly increased, reaching a total of $2.9 trillion at the end of June 2022; their participation in the green bond market was late, but they rapidly increased their presence (Cheng et al., 2022).

On the other hand, Bansal (2022) emphasized that India had several obstacles most obvious ones are lack of clear risk profiling and legislative support, lack of market knowledge, and lack of demand. Unlike India, another major emerging country, China, had a completely different journey in the green bond market. Elliott and Zhang (2019) states that there is coalition of policy makers, organizations, and corporations to catalyze policy and innovation which is steered and led by People's Bank of China.

Bernabé Argandoña (2022) underlined that green bonds are gaining more and more importance in Latin America and the Caribbean (LAC). Chile, Brazil and Mexico appear to be the leaders of the region. These bonds in the region mainly focused on energy efficiency, pollution prevention, sustainable agriculture, fishery, and forestry (ibid.).

Furthermore, academics also want to research the real impact of these investments. In academia, there are different opinions about green bonds. Several researchers suggest that investors are willing to sacrifice their return to help the transition toward a sustainable world (Gianfrate and Peri, 2019; Hachenberg and Schiereck, 2018; Immel et al., 2021). However, other researchers, including MacAskill et al. (2021), Larcker and Watts (2020), Bachelet et al. (2019), and Karpf and Mandel (2018) present that green bonds' premiums and liquidity are higher than conventional bonds.

In the meantime, Broadstock and Cheng (2019) proposed that there are many macroeconomic conditions affecting the green bond market, including but not limited to news, crude oil prices, and major economic activities. Reboredo and Ugolini (2020) showed that green bonds weakly co-move with conventional stocks but strongly co-move with fixed-income and currency markets. These findings are similar to Daszynska-Zygadlo et al. (2018), suggesting that green bonds are highly correlated with traditional bonds mainly because of their small market size. Huynh's (2022) similarly found that green bonds co-move with triple-A-rated prime government bonds. Lastly, Kanamura (2020) proposed that green bonds negatively correlated with WTI and Brent oil prices.

The green bond market and research interest in the topic have expanded over the years. Researchers are asking if this market expansion is an appropriate way to mitigate the adverse effects of environmental pollution. As it was seen in this literature review, there are different

opinions about the expansion's effect on mitigation efforts. However, the details of the expansion of the Green Bond Market are mostly uncovered. The critical contribution of this research is to explore the details of the expansion of the market between 2015 and 20221.

3.3 Major Efforts for Developing Green Bond Standards

Establishing a globally recognized set of standards for the green bond market will create more opportunities to bring issuers and investors together (IIAC, 2020). Thus, a set of globally recognized standards to define the eligibility of projects is paramount for the future of the green bond market.

There have been several developments to create certification schemes and green bond taxonomies: International Capital Market Association's Green Bond Principles, Climate Bonds Initiative's Bond Standard: Version 3.0, and European Union Green Bond Standard (EU GBS) are three of them. They will be described in the following sections.

3.3.1 International Capital Market Association's Green Bond Principles (GBP)

The Green Bond Principles recognize a wide range of projects that contributes at least one of the five major objectives: Climate Change Mitigation, Climate Change Adaptation, Natural Resource Conservation, Biodiversity Conservation, and Pollution Prevention and Control (ICMA, 2021a). In addition to the project objective, issuers seeking to align their bonds with Green Bond Principles (GBP) should explain four fundamental components (ICMA, 2021c). Use of Proceed indicates that green bonds should be issued according to legal requirements and contribute to positive environmental purposes. The proceeds could be used for either financing or refinancing the project. GBP accepts a wide range of projects that contribute to the mitigation of environmental degradation, the adaptation of climate change, the conversation of natural resources, and pollution prevention and control. The project categories that can be eligible for GBP include, but are not limited to (ICMA, 2021c), Renewable Energy, Energy Efficiency, Pollution Prevention and Control, Environmentally Sustainable Management of Living Natural Resources and Land Use,

Biodiversity Conversation, Clean Transportation, Sustainable Water, and Wastewater Management, Adaptation to Climate Change, Circular Economy Adapted Products, Production Technologies, and Processes, and Green Buildings.

If the objectives and use of proceeds are aligned with ICMA'S Green Bond Principles, the next step will be the Process of Project Evaluation and Selection. Those seeking to align with ICMA's Green Bond Principles shall clearly communicate to the investors (ICMA, 2021c) about the project's Environmental objectives, the project's category (categories are explained above), and the management plan for the potential social and environmental risk this project may cause.

After that, the Management of Proceeds requirement should be met. Proceeds of green bonds could be managed on either a bond-by-bond basis or a portfolio basis, which manages a group of green bond issuance together. GBP indicates that an amount equal to the total issuance should be credited to a sub-account moved to a sub-portfolio or adequately tracked by the issuer (ICMA, 2021c).

Lastly, ICMA request clear and timely Reporting. International Capital Market Association (ICMA, 2021c) suggests keeping up-to-date use of proceeds information available to update their reports annually until total allocation. Also, a timely update is needed if any material change occurs. In the case of confidentiality, GBP suggests using generic terms in the report. GBP recommends being transparent, which means using qualitative and quantitative indicators wherever possible. Disclosure of the methodology is also an essential part of being transparent when reporting; reporters, where possible, should follow the Harmonized Framework for Impact Reporting, and these core components should be accessible to investors.

3.3.2 Climate Bonds Initiative's Bond Standard: Version 3.0

Climate Bonds Initiative (CBI) is a not-for-profit organization founded in 2010 to promote large-scale, low-carbon, and climate-resilient investments (CBI, 2019). In CBI's Bond Standard, the term ''Bond'' covers various instruments, including bonds, loans, or some other form of debt. The table

below summarizes the types of eligible debt instruments, which are called ''Bond'' under Climate Bonds Standard version 3.0 (CBI, 2019).

Table 2.Type of debt Instruments [2]

Type of the Debt Instrument	**Definitions**
Standard Use of Proceeds Bond	''standard recourse-to-the-issuer debt obligation which is either listed or unlisted.''
Revenue Bond	'' a non-recourse-to-the-issuer debt obligation, either listed or unlisted, in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes etc., and whose use of proceeds go to related or unrelated projects.''
Project Bond	''a project bond, either listed or unlisted, for a single or multiple projects for which the investor has direct exposure to the risk of the projects, with or without potential recourse to the issuer.''
Securitized Bond	''a bond, either listed or unlisted, collateralized by one or more specific projects or assets, including lease, loan and other revenue receivables Asset Backed Securities ("ABS"), Mortgage-Backed Securities ("MBS"), including Agency MBS, Residential MBS, Commercial MBS, Commercial Mortgage-Backed Securities (CMBS) Collateralized Loan Obligations ("CLO"), Collateralised Debt Obligations ("CDO"), Whole Business Securitisation ("WBS") and other securitization structures.''
Convertible Bonds or Notes	''Bonds or notes, either listed or unlisted, which have the right but not the obligation to convert into a specified number of ordinary shares (or other securities) under specified terms and conditions. If the bond or note was Certified when it was issued and then later converted to equity, then its status as a Certified Climate Bond would end at the point of conversion.''
Sukuk	'' refers to various types of quasi-debt securities that have been developed to meet the strictures of Islamic finance. One core principle underlying Islamic finance is avoiding the payment or collecting of interest. A variety of financial instruments have been created that serve the same purpose as bonds and other debt securities, but on which interest is not paid, and investors share in profit distributions?''
Schuldschein	''a traditional German floating or fixed debt instrument. Some features of a Schuldschein are similar to those of loans, while other features are more similar to bonds.''

[2] Source: Adapted from (CBI, 2019)

Loan Facility	''credit line made available to borrowers to finance projects and assets which meet the relevant Sector Eligibility Criteria of the Climate Bonds Standard. Loans can be unsecured (with general recourse to the obligors) or secured (non-recourse or limited recourse to obligors).''
Commercial Paper	Short-term debt securities. Unsecured promissory notes issued by strong credits, including financial institutions and non-bank corporates.
Debt Instruments issued by a Green Bond Fund	'' a Green Bond Fund is a fund which invests in green bonds based on a set of screens or criteria. Screens for the fund could include that the underlying projects and assets must meet the relevant Sector Eligibility Criteria of the Climate Bonds Standard. The fund will likely issue securities such as units in a trust or use similarly structured arrangements to raise equity. Certification is only available for the debt instruments issued by the fund. The fund itself is not eligible for Certification under the Climate Bonds Standard.''
Covered Bond (Pfandbriefe)	''a dual recourse bond relies primarily on repayment from the issuers but also has access to a pool of assets (the cover pool). The cover pool often comprises mortgages, but other assets can be used as collateral too. For instance, the German Pfandbrief market includes Mortgages Pfandbrief, Public Pfandbrief, Ship and Aircraft Pfandbrief. In Luxembourg, it is possible to issue renewable infrastructure-covered bonds.''
Green Deposits	''client funds held by a financial institution which are identified and allocated to a portfolio of projects and assets which meet the relevant Sector Eligibility Criteria of the Climate Bonds Standard.''

To acquire CBI's certification, the conditions outlined below must be met (CBI, 2019).

- the investment needed to be aligned with the Green Bond Principles from the International Capital Market Association,
- mandatory requirements for the use of proceeds should be met,
- issuers should meet the sector criteria,
- an assurance from third-party verifiers should be obtained,
- Moreover, mandatory independent verification and annual reporting after obtaining the certification should be published.

3.3.3 European Union Green Bond Standard (EU GBS)

The first criteria of the European Union Green Bond Standard are to align the projects with EU Taxonomy and determine if the economic activity is environmentally sustainable (EU-TEG, 2020).

Like other standards, EU GBS also restricts the use of proceeds for only green projects. According to EU GBS (2020), green projects should:

"A. Contribute substantially to at least one of the six environmental objectives of the EU Taxonomy Regulation:

1. Climate change mitigation,
2. Climate change adaptation,
3. Sustainable use and protection of water and marine resources,
4. Transition to a circular economy,
5. Pollution prevention and control,
6. Protection and restoration of biodiversity and ecosystems.

B. Not significantly harm any of these objectives,

C. Comply with minimum safeguards,

D. Comply with Technical Screening Criteria (TSC).

The issuer is required to publish their Green Bond Framework (GBF) under EU GBS. This document should be prepared to answer these subjects:

- Strategy and Rationale
- Alignment with EU Taxonomy
- Project Description
- Proceeds Allocation
- Reporting and Verification

Focusing on these subjects EU's GBF answers three major questions: (1) "Why" (including green strategy); (2) "What" (green projects, reporting, review, etc.); and (3)"How" (process for referencing green activities, verification approach, etc.) (EU-TEG, 2020).

Reporting of EU GBS consists of two major areas—allocation reporting and impact reporting. Until total allocation, the issuer should report on the allocation at least annually. The report should also reference the alignment with EU GBS and the EU Taxonomy (ibid.). Another

mandatory document is impact reporting; this must be issued at least one after full allocation and updated after any material changes. The reporter is responsible for explaining the report's methodology and assumptions. After these two reports, the issuer must obtain an external review called verification. EU GSB requires a pre-issuance verification and at least one- after full allocation- external review for allocations. These documents should be published on a communication channel, and they could publish as an integrated report (ibid.). As of 2021, EU GSB indicated four major voluntary-base external reviewers:

1. Non-financial rating agencies and sustainability consultancies specialized in second-party opinions,
2. Big-four audit firms,
3. Credit Rating Agencies,
4. Global technical inspection and certification bodies.

However, verifiers should meet specific criteria to be able to verify these reports. These criteria include, but are not limited to (EU-TEG, 2020),

- Have established an office in the EU or the EEA[3].
- Have an organizational structure, working procedures, and other relevant systems for carrying out the verification services.
- Employ appropriate staff with the necessary experience and qualifications for the scope of the external review being provided
- Have appropriate professional indemnity / professional liability insurance cover.

Verifiers also need to demonstrate that they have experience in issuing processes of market products, management of confidentiality, assessing the projects' environmental objectives and reference to EU Taxonomy, and providing assurance services."

To conclude, the green bond market has been expanding in the last decade, but it is also crucial to have a common understanding of what actually a green bond is. EU Taxonomy for Sustainable

[3]The European Economic Area (EEA) unites the EU Member States and the three EEA EFTA States (Iceland, Liechtenstein, and Norway) into an Internal Market governed by the same basic rules, see: https://www.efta.int/eea

Activities and EU Green Bond Standards, International Capital Market Association's Green Bond and Green Loan Principles, and Climate Bond Initiative's Bond Standards are leading the standardization of the green bond market. From rating agencies to second-party opinion institutions, to researchers, to sector professionals, and researchers, they reference these standards. These standardization attempts could improve the bonds' validation, assessment, ratings, and monitoring. These attempts could also prevent green and social washings. Standardization attempts are crucial in the green bond market because it is still being uncovered what green bonds are actually used for.

4. Theories

Several theories, such as the *institutional theory* and the *priority of sustainable finance* theory support this study.

Institutional theory is a framework that seeks to explain the structure, development, and functioning of organizations and industries within the context of their institutional environments (Scott, 2008). It posits that organizations and markets are influenced by a variety of institutional factors, such as regulations, norms, and cultural-cognitive elements, which shape the behavior of market actors and contribute to the stability and persistence of certain market patterns (DiMaggio & Powell, 1983). This theory asserts that organizations are embedded in a complex web of social, political, and economic institutions that determine the rules of the game, provide resources, and create constraints and opportunities for market participants (North, 1990).

Applying the institutional theory to the green bond market, one can argue that the distribution of this market should reflect similar patterns to those observed in the broader financial markets. The United States and Europe, as the world's largest financial markets, have developed extensive and sophisticated financial infrastructures, characterized by strong regulatory frameworks, well-established market norms, and a wealth of financial resources (La Porta, Lopez-de-Silanes, & Shleifer, 2006). These institutional factors have contributed to the dominance of these regions in the global financial landscape (Levine, 1997). Thus, it can be expected that the green bond market, as an emerging segment of the financial industry, would exhibit a similar distribution pattern, with the United States and Europe playing a leading role in this market. This expectation is grounded in the institutional theory, which highlights the importance of institutional variables in shaping market dynamics and fostering the growth and expansion of financial markets (Zucker, 1987).

The priority theory is especially helpful for this study since "it states that which economic agent makes every effort to achieve sustainable finance goals in a country or region is a true reflection of the priority given to the sustainable finance agenda" (Wilson, 2010, p19). In this context, the EU taxonomy and Chinese Green Finance Strategy serve as independent variables that signal the

priority of sustainable finance, while green bond issuances act as the dependent variable. Hence, it is expected that countries with stronger sustainable finance priorities will have more bond issuances (Kuhn, 2020).

The priority theory of sustainable finance suggests that Europe and China would have a robust green bond market due to its strong policy framework and commitment to sustainable finance (Krauss, Krüger & Meyer, 2016). Also, Bansal (2022) highlighted the barriers in India to the green bond market, while Elliott and Zhang (2019) presented the policy innovations in China to steer capital into the green bond market. Conversely, if the sustainable finance agenda is not an agent's top priority, they will not put significant effort into achieving sustainable finance goals during that period.

Prioritizing sustainable finance comes with consequences and may involve costly trade-offs, which could lead some agents, such as developing countries focused on meeting economic development needs, to deprioritize sustainable financial goals. It should be noted that prioritizing sustainable finance goals does not guarantee that a particular agent will achieve its goals (Ozili, 2022).

5. Methodology

This study employed a quantitative approach to analyze the green bond database, encompassing green bonds issued between 2015 and 2021. The research was conducted through a review of existing literature and data analysis, including descriptive tests and test statistic. The data was retrieved from the Climate Bonds Initiative (CBI) in 2021. The data gathered from CBI includes 8111 green bonds and other debt instruments.

In this research, the following variables related to each bond were recorded: Issuer Name, ISIN Number, Amount Issued in Local Amount and Amount Issued in USD, Currency, Issue and Maturity Date, Country Name, External Reviewer, Issuer Type, Bond Region, Use of Proceeds Summary.

In the next section, the data selection and recording methodology by Climate Bonds Initiatives are presented.

Descriptive analysis was completed using various tools such as Excel, Microsoft Power BI, and Statistical Package for the Social Sciences (SPSS). Descriptive analysis in used through this research to compare regions, countries, and types of issuers between each other, to analyze the country's or region's profile, determine the trends, over and underperformances.

For the second part of the research, SPSS was used to determine whether observed differences within and between regions and countries. Crosstabs were used to compare the expected vs. actual number of green bonds issued, thereby highlighting the concentrations and underperformance of the sectors type of issuers in what regions and countries. Analysis of Variance (ANOVA) was also used to understand whether there is a statistical difference in the average bond size among regions and countries.

5.1 Data

The Climate Bond Initiative's Green Bond Database (the database) is a screening of eligible self-labelled bonds and similar debt instruments (Climate Bonds Initiative, 2020). CBI's database was used in this research.

The screening references Climate Bonds Taxonomy and the EU Sustainable Finance Taxonomy, where CBI Taxonomy is not applicable. There are three overarching prerequisites to be listed in the database:

1. Debt Instrument includes but is not limited to bonds, asset-backed securities, and loans.
2. Self-Labelled, the instrument must have been self-labelled in order to be screened.

Unlabelled climate-friendly debt is not included in the database. Climate Bonds Initiative (2020) acknowledged that any climate-related asset, project, or activity might support climate goals; however, by not pursuing to have a self-green label, the issuer does not commit to disclosing the instrument's details. Thus, CBI could not include these instruments since the confirmation is simply unavailable.

3. Public Disclosure allows the financed assets/projects/activities to be ''green'' and the inclusion of debt instrument— amount outstanding/closing and settlement confirmation (issue date).

After presenting these three overarching pre-requirements, the following section presents details about the data used for this research.

Identification of Green Bonds

The identification process starts with the issuer. The debt instrument issuer must declare that the bond will be used for environmentally beneficial projects/assets/activities. Therefore, self-labelling is the first step to being listed in the database.

The most used label is ‘’green’’; however, CBI accepts all labels including but not limited to climate awareness, solar, wind, renewable energy, energy efficiency, Property assessed clean energy (PACE), GreenStar (Build America Mutual), Environmental, social and governance (ESG), Water bond and similar, Blue, Marine conservation and similar, Energy Transition, Sustainable Transition, Sustainable Development Goals (SDG), Climate action, Transition.

The label should be declared in a company’s public document, such as press releases, bond issuance documents, bond framework, external review, or green bond assessment. The label must be visible in the description of the bond.

Climate Bond Initiative (2020) states that they will consider all debt instruments with a defined amount. As stated before, unlabelled bonds will not be considered in the database. Besides self-labelling, CBI recommends its best practice for issuers. This includes:

- External review at issuance
- Commitment to post-issuance reporting
- Impact Reporting (Highly Encouraged by CBI and increasingly demanded by investors. Also, impact reporting is required under the proposed EU Green Bond Standard.) Issuers should define relevant metrics and baselines, the scope of assessment, and methodologies for impact reporting

Screening

After the three prerequisites are met, CBI screens the debt instruments to determine if they are eligible for further evaluation for the database. The screen is happening in two major areas—*sector eligibility* and *use of proceed eligibility*. The eligibility of proceeds and sectors will be presented in the next section, but before this, three areas that eligible bonds fall under will be explained.

1. **Climate Bond Certification**: A CBI-certified and publicly available debt instrument is listed in the database. Please note that some CBI-certified instruments are not publicly available and are listed in the confidential deal list, not the database.
2. **Green Labelled Bond**: If self-green labelled bonds meet the CBI Green Bond requirements, they are listed in the database.
3. **Other Labels**: As it has seen under the identification section, these bonds might be labelled with other names. In this case, CBI lists these bonds under the database if all proceeds are for green purposes and meet the CBI Green Bond requirements. Please note that these different labelled bonds could be included in more than one listing, e.g., CBI Green Bond Database (the database) and CBI Social and Sustainability Bond Database

The database used for this research combines these three screening processes. Nevertheless, there are further evaluations after this screening process.

Hereafter, more details will be presented about the screening and evaluation processes to make the readers clear about the database.

Details of Screening the Sectors

In this part, the eligibility of the potential assets under each sector will be explained. Please see Appendix A, which is retrieved from Climate Bond Initiatives Methodology Document (Climate Bonds Initiative, 2020). This appendix shows which assets could pass the screening, which need further review, and which are ineligible and, therefore, could not be listed in the database.

Going Further in Screening

Every bond that passes the sector screenings (please see Appendix A) is also being screened based on their use of proceeds. CBI focuses on climate change mitigation, adaptation, and resilience. CBI states that if a debt instrument wants to be listed in the database, the bonds must allocate all net proceeds to aligned projects/assets/activities (Climate Bonds Initiative, 2020). Therefore, even though the bond is identified as green in the previous screenings, CBI wants to ensure that the project/asset to be financed/refinanced is green. Climate Bond Initiative (2020) recommends having an external review for self-labelled bonds; however, this is not required if

the issuer discloses equivalent information to be included in the database. CBI also acknowledge that most issuers now link their frameworks to Green Bond Principles (GBP) / Green Loan Principles (GLP).

Also, obtaining an external review or link to the debt instrument to GBP / GLP does not guarantee that it will automatically be listed in the database. CBI state that if one of the following situations occurs, they will exclude the bond from the database:

- If the use of proceeds or expected proceeds to be used in social projects, general corporate purposes, working/operating capital, and training expenses that are not part of an acceptable program,
- Early-stage R&D when the outcome could not be defined or quantified yet
- Fossil fuel power and any process, product, asset, or improvement,
- Vague categories without reference to a specific sector/assets/projects
- Lack of information about the debt instrument
- After post-issuance reporting for the bonds that the proceeds are not aligned with CBI's taxonomy

As noted, CBI wants to be safe and exclude early-stage R&D bonds from the database. This exclusion does not mean that CBI does not support research and development, but they want to be sure about the sector of the project and quantified possible benefits for climate change mitigation and/or adaptation; therefore, they state that late-stage R&D is better defined and could have more chance to be listed in the database. Countries want to fund eligible early-stage R&D projects at the sovereign level. To accommodate sovereign plans, CBI includes the sovereign bonds in the database if their use of proceeds for early-stage R&D do not exceed 10% of the total bond amount— if a sovereign fund an eligible R&D project, they do not have a limit. They can use up to 100% of their amount to fund eligible R&D projects(Climate Bonds Initiative, 2020).

CBI will assess these bonds case by case for adaptation and resilience bonds to determine if they should be included in the database. CBI also keep the right to re-classify a listed debt instrument if they find a non-aligned activity or in case of changing the methodology.

6. Results

This chapter presents the descriptive and statistical test results. In the first part, several graphs and tables were used to summarize the data as well as present the similarities and differences between regions and countries; show the overperforming and underperforming regions, countries, and types of issuers; point out the trends; breakdown the regions, types of the issuers, countries' profiles; analyze the external reviewers.

In the second part, the results of significance tests and crosstab comparisons will be presented.

6.1 Descriptive Results

Green bond markets aim to promote the role of financial markets to positively contribute to the solutions for environmental problems (ICMA, 2021b). To achieve this goal, the European Investment Bank (EIB) issued the first green bond in 2008. Since the first issued green bond, the market has multiplied. Between 2015 and 2021, green debt grew exponentially in Europe, Asia-Pacific, and North America—the LAC region gained momentum in recent years but was far from the top three regions. Even though the Africa region increased its total amount, it is still small compared to the other regions. On the other side, supranational organizations were strong in the green market in 2015; despite their efforts, supranational organizations were not able to increase the total amount they issued to the same extent as the top regions in the following six years. As shown in Table 3, Europe is the clear leader in the green debt market; Asia-Pacific and North America compete for second place.

Table 3 Overview of the green bond market by regions (2015-2021)[4]

Total			Africa	Asia-Pacific	Europe	LAC	N. America	Supra.
2015	252	N	0	14	60	2	108	68
	44,725.8	SUM (Million $)	0	3,947.3	18,582.2	1,063.7	12,846.7	8,285.7
	177.4	Avg (Million $)	0	281.9	309.7	531.8	118.9	121.8
		St. Dev (Million $)	n/a	170.7	362.0	31.8	222.7	200.5
	Total		**Africa**	**Asia-Pacific**	**Europe**	**LAC**	**N. America**	**Supra.**
2016	392	N	2	58	85	7	186	54
	83,973.3	SUM (Million $)	166.9	26,626.0	24,424.2	1,628.5	20,929.9	10,197.4
	214.2	Avg (Million $)	83.4	459.0	287.3	232.6	112.5	188.8
		St. Dev (Million $)	33.5	755.8	378.0	184.8	228.7	294.5
	Total		**Africa**	**Asia-Pacific**	**Europe**	**LAC**	**N. America**	**Supra.**
2017	1565	N	3	113	155	16	1238	40
	156,714.7	SUM (Million $)	257.8	35,466.8	58,455.3	4,025.8	48,968.5	9,540.2
	100.1	Avg (Million $)	85.9	313.8	377.1	251.6	39.5	238.5
		St. Dev (Million $)	49.8	367.8	739.7	274.2	97.2	366.8
	Total		**Africa**	**Asia-Pacific**	**Europe**	**LAC**	**N. America**	**Supra.**
2	1603	N	4	180	164	16	1187	52

[4] Authors, using data from Climate Bonds Initiative (CBI,2021).

	171,472.1	**SUM** (Million $)	150.9	49,976.2	67,353.7	1,564.5	39,681.1	12,745.5
	106.9	**Avg** (Million $)	37.7	277.6	410.6	97.7	33.4	245.1
		St. Dev (Million $)	34.1	490.5	710.9	88.9	104.2	289.7
	Total		**Africa**	**Asia-Pacific**	**Europe**	**LAC**	**N. America**	**Supra.**
2019	1862	**N**	7	264	346	33	1152	60
	268,372.5	**SUM** (Million $)	898.0	66,933.6	121,224.6	4,846.0	60,104.7	14,365.4
	144.1	**Avg** (Million $)	128.2	253.5	350.3	146.8	52.1	239.4
		St. Dev (Million $)	181.0	360.9	573.4	293.0	124.5	268.4
	Total		**Africa**	**Asia-Pacific**	**Europe**	**LAC**	**N. America**	**Supra.**
2020	1734	**N**	4	310	535	42	772	71
	296,968.1	**SUM** (Million $)	1,216.5	56,053.4	156,257.5	8,488.1	61,459.6	13,492.9
	171.2	**Avg** (Million $)	304.1	180.8	292.0	202.0	79.6	190.0
		St. Dev (Million $)	266.8	233.4	634.1	304.1	191.2	274.6

In this table, SUM, Avg, and St. Dev values are in USD ($).
N represents a numerical value and describes the number of bonds issued in a specific year.
SUM is the total value of all the bonds issued in a specific year.
Avg is the average value of a bond in a specific year. Avg is calculated by dividing the SUM by N.
St. Dev (Standard Deviation) measures how dispersed the data is in relation to the mean.

The average bond size of the top three regions is summarized in Figure 1. The average size of a green bond in the Asia-Pacific region has gradually decreased since 2016. In Europe, the average size increased between 2016 and 2018; however, it retreated to the 2016 level in 2020. North American green bonds had the smallest average size among the top regions. The average bond

size was about USD 33.5 million in 2015. Since 2018, the average size of North bonds has increased to USD 79.6 million in 2020.

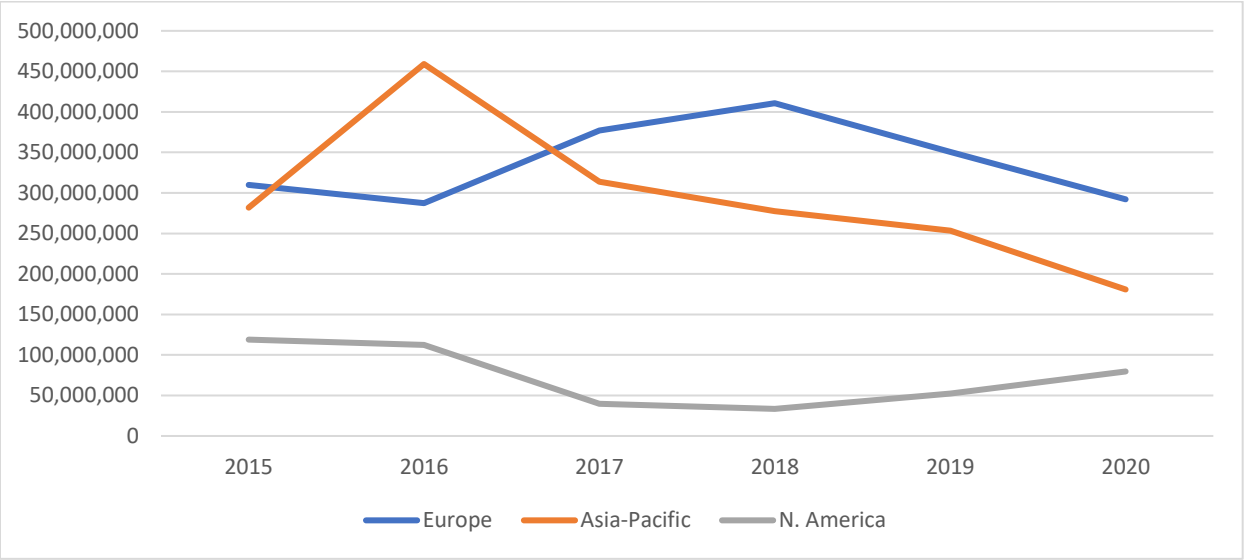

Figure 1 Average bond size of the top three regions

Figure 2 explains the share of each reach in the global green bond market. As it has seen in this figure, the supranational organization's strong start did not last. Their share in the growing market shrunk. On the other hand, Europe dominated the market. Even though the LAC region gained momentum in the last year, its total share in the global picture did not change significantly. Asia-Pacific's share picked up in 2015, and North America kept its share throughout these six years. Africa's presence was not visible in the global market.

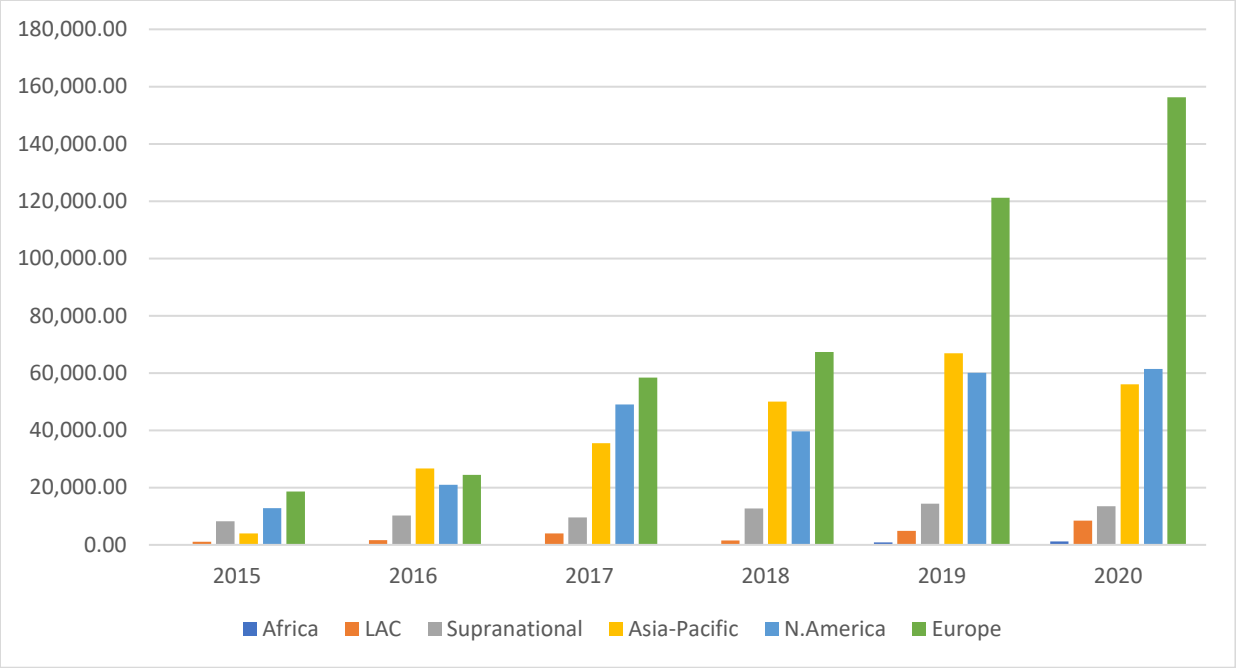

Figure 2. Distribution of total raised capital between regions. (Million $)

Developed countries experienced the highest growth rate in the green bond market from 2015-2020. After 2016, the gap between developed countries and emerging countries widened. Emerging countries' share in the market is significantly low. In Figure 3, the blue line representing emerging countries also includes China. If we subtract China's share from this line, the remaining portion represents the rest of the emerging countries, excluding China. This portion is significantly lower compared to that of developed countries.

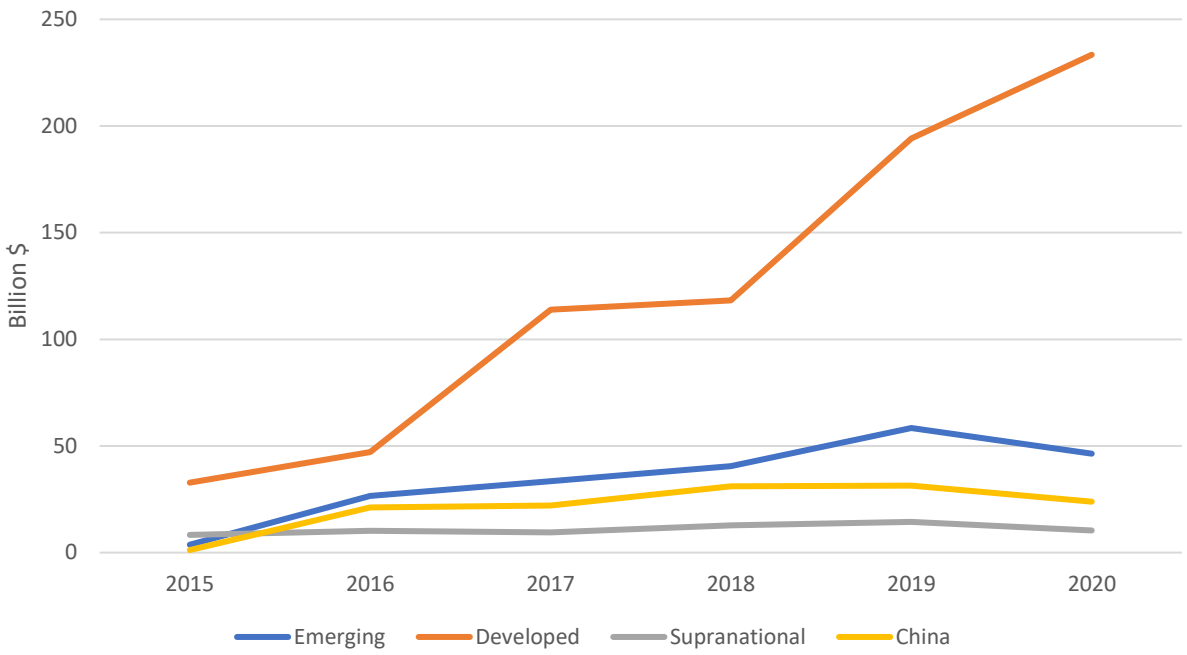

Figure 3. Total amount issued between 2014 to 2021 by emerging and developed countries and supranational organizations.

6.1.1 Geographical Review of Green Bonds (2015-2021)

The amount of green bonds has exponentially grown since 2015; however, not every geographical region has experienced this growth equally. In this section, a break down by geography reveals what countries and/or regions benefited most and least.

The regional breakdown was undertaken by the Climate Bond Initiative. The exact breakdown could be seen in Table 4.

Table 4 Geographical regions and their boundaries[5]

Region	**Included Countries**
Africa	South Africa, Egypt, Morocco, Nigeria, Ghana, Kenya, Seychelles, and Namibia.
Asia-Pacific:	China, Japan, Australia, India, Singapore, Hong Kong (China), South Korea, Indonesia, UAE, Philippines, Taiwan, Saudi Arabia, New

[5] Authors, using data from Climate Bonds Initiative (CBI,2021).

	Zeeland, Thailand, Malaysia, Qatar, Vietnam, Lebanon, Turkey, Fiji, and Kazakhstan.
Europe:	France, Germany, Netherlands, Sweden, Spain, Italy, Norway, the UK, Denmark, Belgium, Finland, Ireland, Portugal, Luxembourg, Switzerland, Austria, Hungary, Greece, Russia, Lithuania, Iceland, Guernsey, Ukraine, Georgina, Latvia, Slovenia, and Estonia.
Latin America and the Caribbean:	Chile, Brazil, Mexico, Peru, Argentina, Colombia, Costa Rica, Panama, Ecuador, Uruguay, and Barbados.
North America	The United States of America and Canada.
Supranational:	The database has three hundred forty-five (345) green supranational bonds. Multinational development banks issued three hundred twenty-eight, or 95.07% of all supranational bonds. A single government-backed entity issued the remaining 4.92%.

Africa

Morocco initiated issuing green bonds in the African region, and they were one of the leading players for the first three years; however, they failed to issue any bonds in 2019 and 2020. On the other hand, South Africa showed consistency by issuing bonds for four consecutive years and became the region's most consistent country. Ghana, Kenya, Namibia, and Seychelles issued green bonds only in one year between 2015 and 2020. Nigeria was able to issue in two different years.

Figure 4 shows Egypt joined these countries in 2020 by issuing the region's first sovereign bond worth $750 million. Egypt's first bond could be seen as a positive sign, but the region has shown

signs of instability in issuing bonds over the last five years; therefore, Egypt's progress should be monitored for the following years.

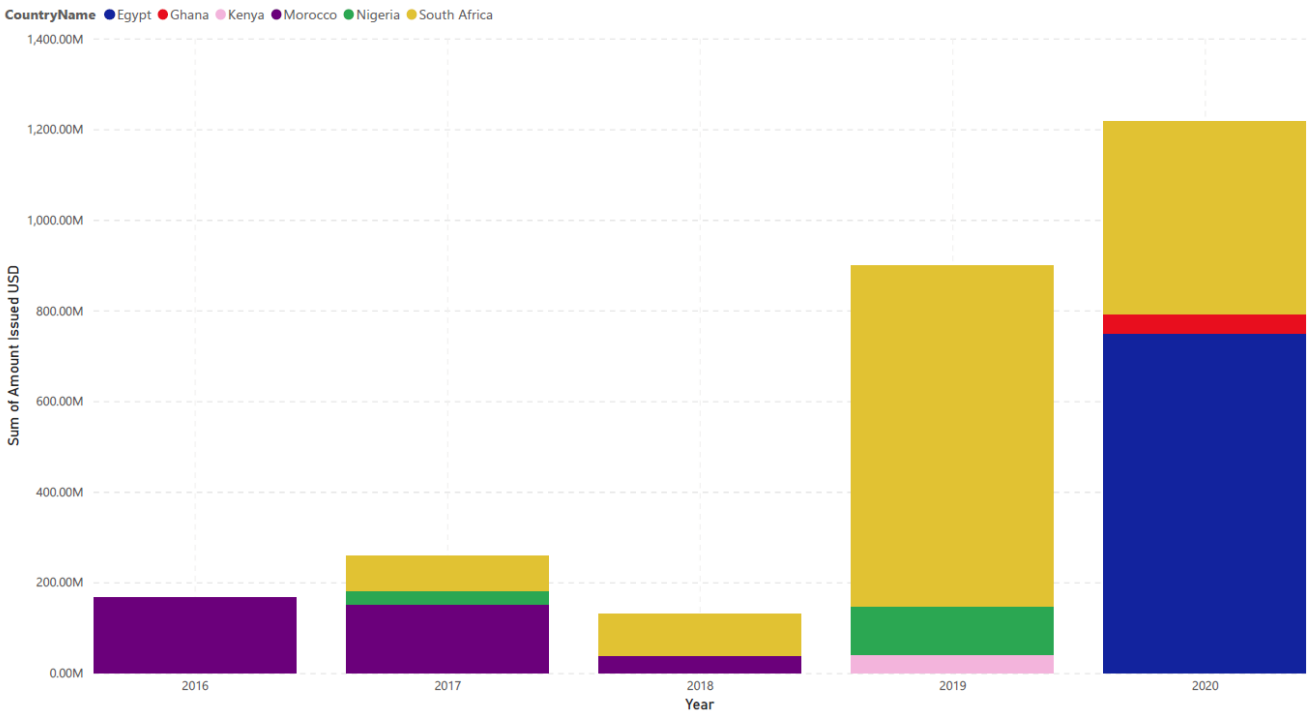

Figure 4 Total amount issued in Africa by countries.

Asia-Pacific:

Asia-Pacific is among the most diverse and leading regions in issuing green bonds. The region exponentially increased its total amount of issuance in 2016, and a steady increase followed until 2019; the region experienced its only decrease in 2020.

Between 2015 and 2021, China dominated the region by issuing more than half of the total amount, precisely 54.75%. India underperformed by issuing 4.99% of the total amount of the region. Japan issued 10.8% of the amount and became a big player in the region.

In Asia-Pacific, Australia, Hong Kong (China), South Korea, the Philippines, and New Zeeland were among the countries that consistently contributed to the total amount for these six years; 6.18%, 3.89%, 3.75%, 1.23%, and 1% respectively.

Qatar, Saudi Arabia, Thailand, and Vietnam were among the countries that recently joined in issuing green bonds. Turkey entered the database in 2020 with a $50 million bond; this $50 million bond issued only 0.02% of the total amount over the last six years. The small amount could also result from a need for more integration into the Climate Bond Initiative in Turkey. Either way, Turkey was one of the underperformed countries in this database. However, as a country start issuing green bonds, it should be watched for the coming years.

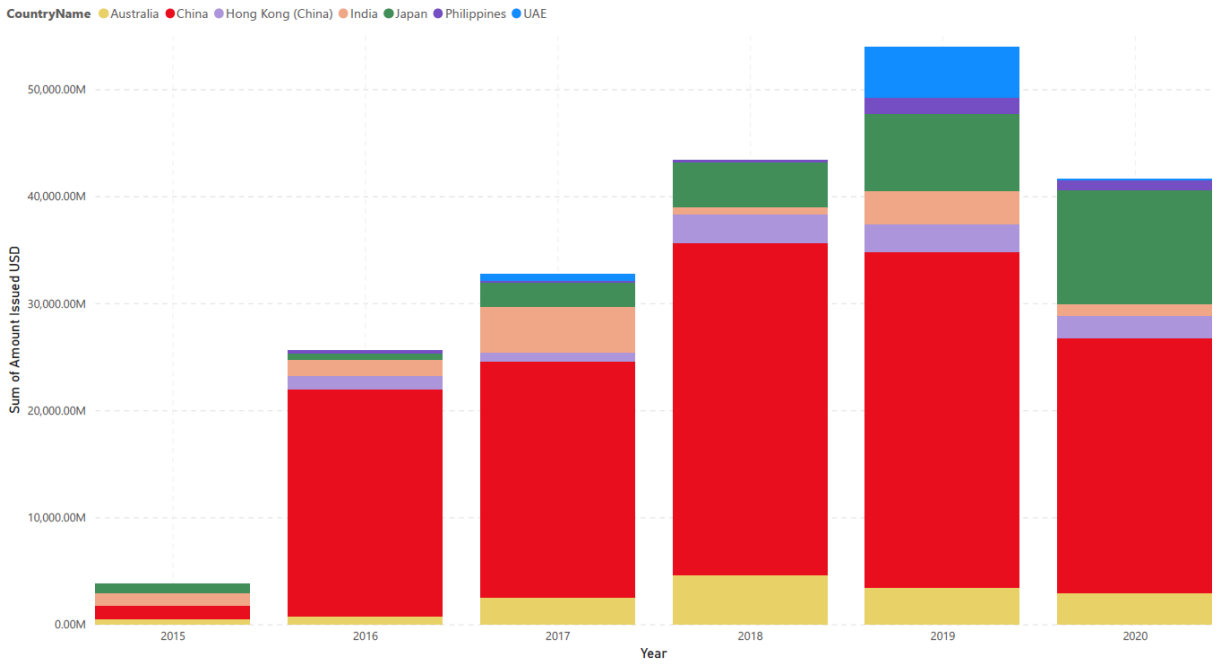

Figure 5. Total amount issued in Asia-Pacific by countries.

Europe:

Europe was the most diverse and robust region in the world. The total amount issued had firmly increased over the six years. In the last six years, the region saw three big jumps in 2017, 2019, and 2020. France (113bn in USD), Germany (88bn), the Netherlands (53bn), Sweden (40bn), Spain (34bn), Italy (18bn), Norway (15bn), the UK(14bn), Denmark (11bn), and Switzerland (4bn) were the top ten countries, respectively (CBI, 2021). Over the six years, France, Germany, and the Netherlands took the lead in the region. Among these countries, Germany had the most

aggressive growth in their amount, placing it as the second green bond issuer in Europe. Overall, the region experienced steady growth over the years.

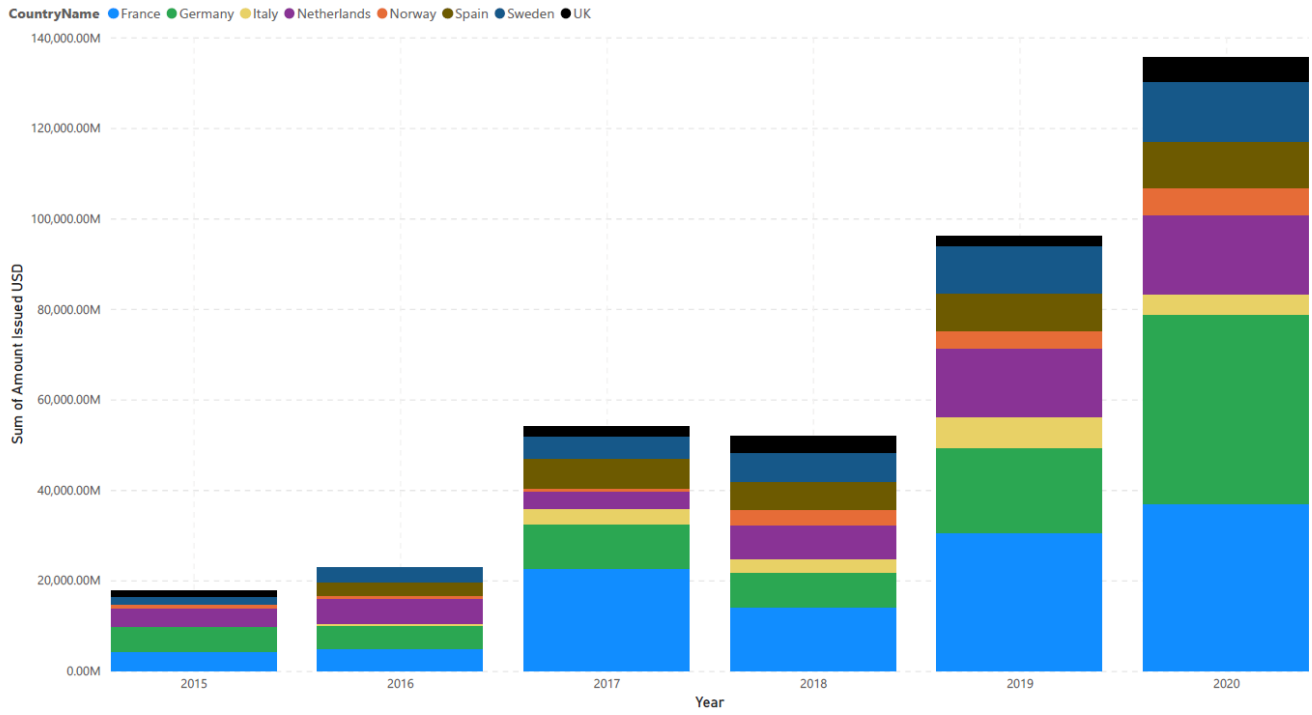

Figure 6. Total amount issued in Europe by countries.

The Caribbean and Latin American Region:

Brazil became a major player in the region and did not miss a year in issuing green bonds in the last six years. Chile's presence in the market started in 2017, but it has significantly improved its total issuing amount in the last two years. Chile was the biggest issuer in 2019 and 2020. Mexico is following these Brazil and Chile. Also, other countries like Peru, Argentina, and Colombia issued green bonds occasionally but not as significantly as the other three countries. Despite the region's momentum in the last two years, they failed to catch the leading regions in total USD amount issued between 2015-2021.

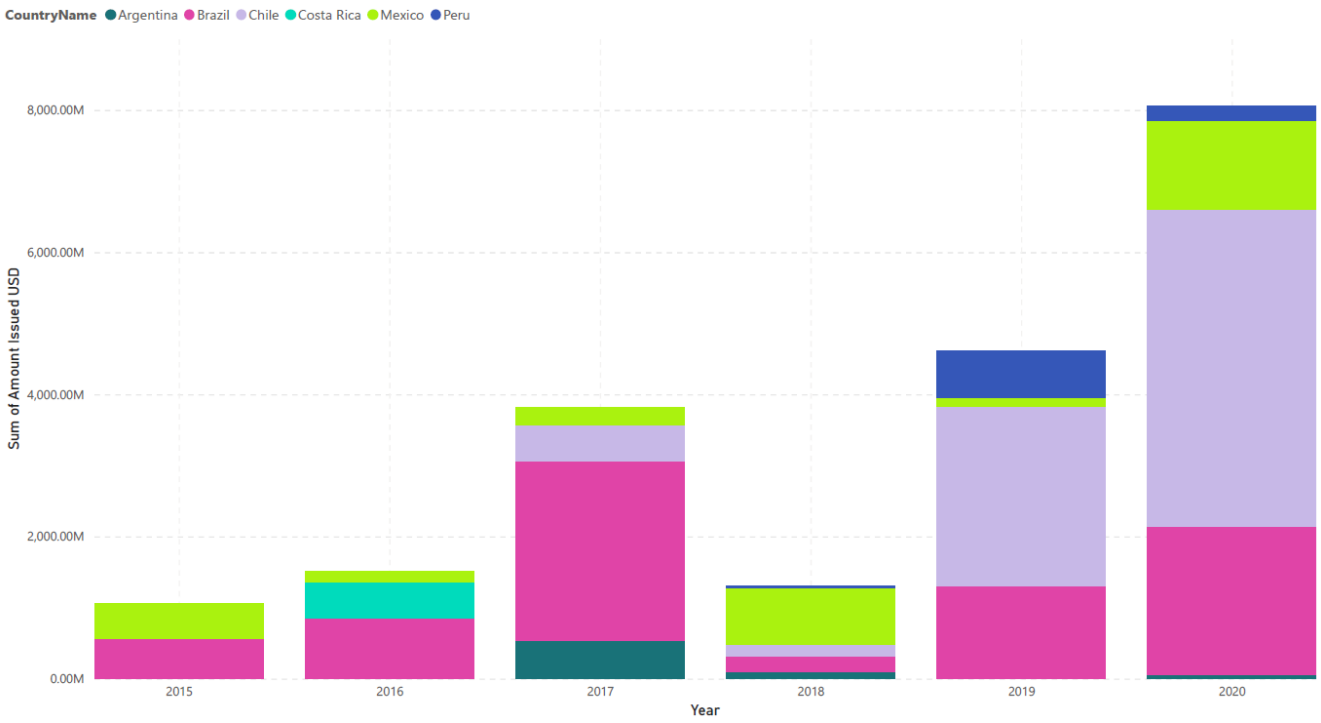

Figure 7. Total amount issued in The Caribbean and Latin America by countries

North America

Climate Bond Initiative includes Canada and the United States under North America; the two countries significantly increased their total amount issued over the last five years. The United States managed to increase its total amount yearly except in 2018. Canada experienced a significant decrease in 2016 but strongly recovered in the next year and increased to nearly $9.5 billion in 2020. Between 2015 and 2020, Canada had around 10% share in the region—10%, 2.5%, 8.9%, 10.9%, 11.9%, and 15.2%, respectively. Collectively, the region saw a substantial increase in the last five years.

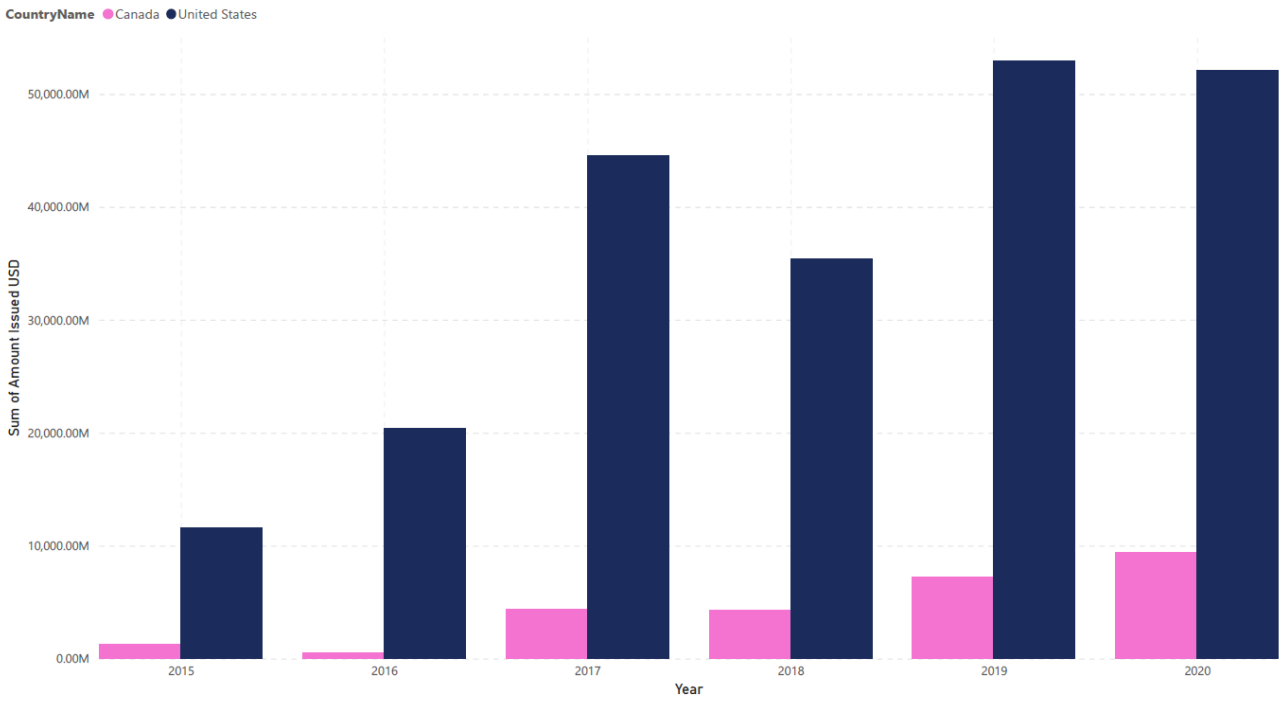

Figure 8. Total amount issued in North America by countries

Supranational

From 2015 to the end of 2020, three hundred forty-five (345) green supranational bonds were recorded in the CBI's database. Three hundred twenty-eight (328) or 95.07% of all supranational bonds were issued by Multinational Development Banks. The remaining bonds, seventeen (17) or 4.92%, were issued by a single Government-Backed Entity: EUROFIMA, an organization specialized in financing railways across Europe and was established in 1956.

Table 5 Amount issued by Supranational organizations in USD[6].

	Issuer Name	Million $		Issuer Name	Million $
2015	ADB	512.12	2018	EBRD	114.27
	AfDB	500.00		EIB	5,475.19
	EBRD	149.22		EUROFIMA	570.50
	EIB	4,372.60		IFC	1,073.27
	IFC	595.27		NIB	597.90
	NIB	687.55		NADB	125.84
	WB (IBRD)	1,469.00		WB (IBRD)	2,295.82
2016	ADB	1,300.00	2019	ADB	2,402.46
	AfDB	176.02		AfDB	134.96
	CABEI	74.00		CABEI	375.00
	EBRD	706.27		CAF	830.03
	EIB	4,085.86		EBRD	2,210.75
	IFC	1,252.48		EIB	4,346.90
	NDB BRICS	447.93		EUROFIMA	548.64
	NIB	854.41		IFC	1,044.06
	WB (IBRD)	1,300.50		NIB	771.23
2017	ADB	1,296.31		WB (IBRD)	1,701.38
	AfDB	49.98	2020	ADB	436.20
	EBRD	500.00		Africa Finance Corp	162.55
	EIB	4,747.38		CAF	412.15
	EUROFIMA	100.00		EBRD	1,220.61
	IFC	1,627.07		EIB	7,311.28
	NIB	795.56		EUROFIMA	2,529.04
	WB (IBRD)	423.99		IFC	191.11
	ADB	1,760.27		NIB	714.74
	AfDB	600.00		NADB	350.60
	CAF	132.49		WB (IBRD)	164.63

[6] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).
ADB: Asian Development Bank
AfDB: The African Development Bank Group
CAF: Development Bank of Latin America
EBRD: European Bank for Reconstruction and Development
EIB: European Investment Bank
EUROFIMA: EUROFIAM is a railway financing organization operating in Europe
IFC: International Financing Corporation – World Bank Group
NIB: Nordic Investment Bank
NADB: North American Development Bank
WB (IBRD): World Bank – International Bank for Reconstruction and Development

According to CBI (2021) data, over six years, $68,627,375,048 worth of green bonds was issued by thirteen supranational organizations. Table 5 shows the distribution of issued amount by the supranational organization; Asian Development Bank (ADB), Development Bank of Latin America (CAF), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), EUROFIMA, International Financing Corporation – World Bank Group (IFC), Nordic Investment Bank (NIB), and World Bank – International Bank for Reconstruction and Development (WB-IBRD) were among the top issuers.

EIB has shown leadership in issuing green bonds since the beginning of 2015. The European railway financing organization, EUROFIMA, has significantly increased its issuing amount.

Asia-Pacific region's decrease in 2020 is also reflected in ADB's performance in 2020. The bank had a strong performance from 2015 to 2019, but in the last year, this performance weakened. Over the six years, supranational organizations issued only $2.02 bn in these currencies: BRL, CNY, COP, HUF, IDR, INR, KZT, MXN, MYR, PHP, PLN, RUB, TRY, and ZAR. Figure 9 illustrates the distribution of $2.02bn. At the same time, these supranational organizations issued $66.60 bn in USD, EURO, CAD, AUD, GBP, NOK, NZD, SEK, DKK, HKD, and CHF. Even though our data cannot say in what region the development banks are using the money, it could be said that the supranational development banks failed to issue significant amounts in developing countries' currencies. This could be further questioned in another research effort.

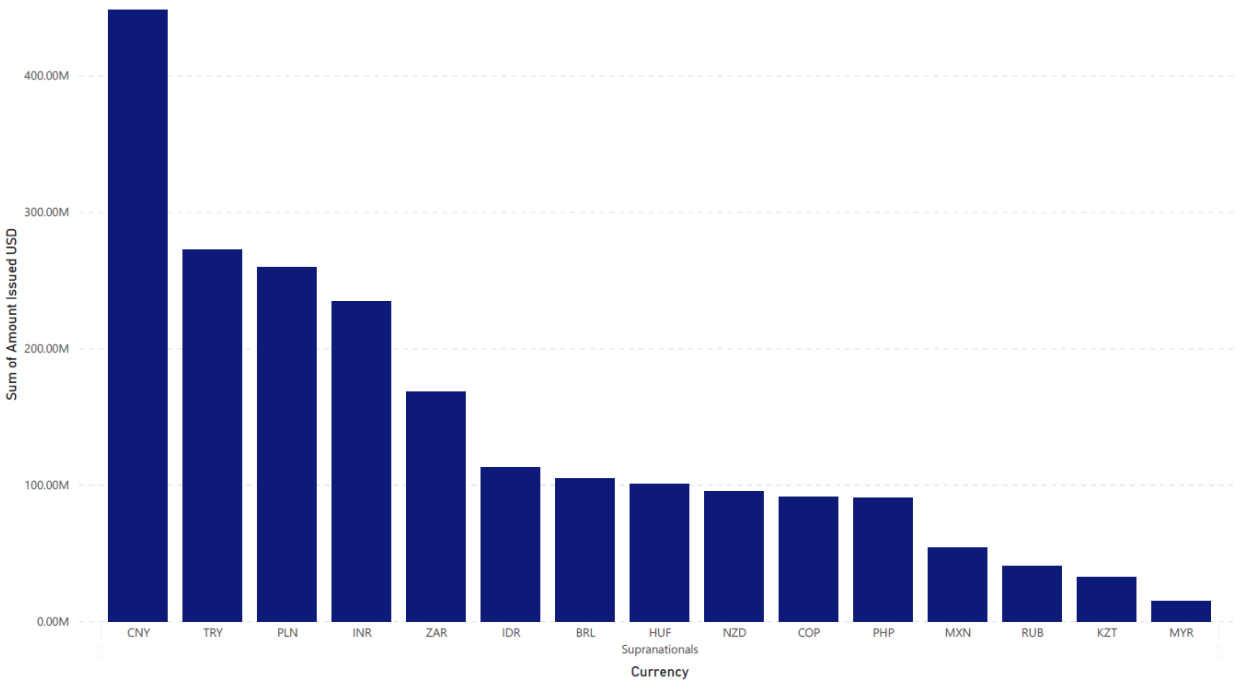

Figure 9. Total amount (USD) issued in local currencies by Supranational organizations.

Among emerging countries, China, Turkey, Poland, and India got a higher share than the other countries. However, as seen in the graph, none of these emerging countries had funding from supranational institutions for six years in a row. These institutions did not issue a substantial amount in emerging countries' currencies; about nighty-seven percent of the total amount issued by supranational institutions was in developed countries' currencies.

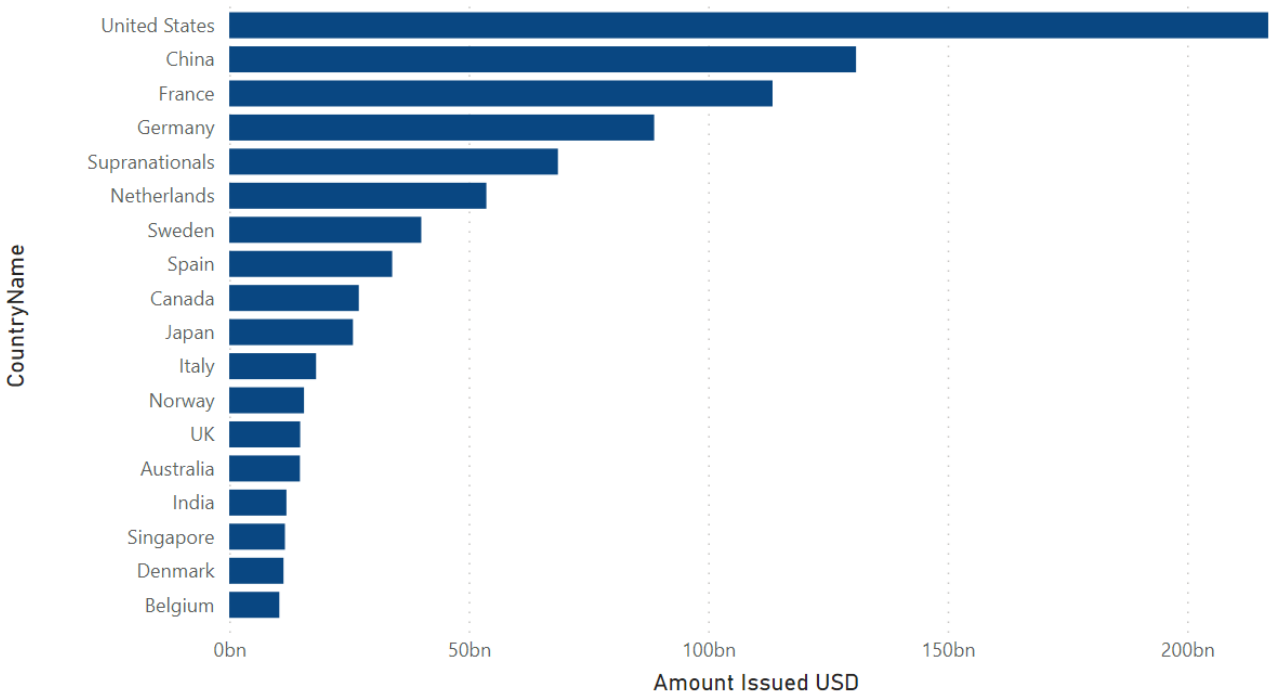

Figure 10. Top issuer countries

In the last six years, the United States, China, and France have led their regions in North America, Asia-Pacific, and Europe, respectively. It can also be seen in Figure 10, presented above. While European countries dominated the top issuing countries list, Canada and Japan could place their names between European countries. Even though supranational institutions could not expand their limits for the last six years, they could place themselves fifth thanks to their consistency since 2014.

6.1.2 Analysis of External Reviewers

External reviewers in the green bond market play an important role. They provide a final report about the issued green bond. The issuer could use this report to explain the bonds, including but not limited to its stakeholders, regulator and green bond certificate providers. These second-party opinions reduce information asymmetry and lower the environmental risk of green bonds (Simeth, 2022).

Table 6 Top external reviewers[7]

Reviewer Name	Total Reviewed Amount in USD (Million $)
CICERO	245,554.32
Sustainalytics	166,994.20
Vigeo Eiris	104,265.49
ISS-ESG	63,827.65
DNV GL	21,548.40
Lianhe Equator	5,851.80
Zhongcai Green Financing	2,786.97
Sitawi	2,643.15
The iGreen Bank	1,947.12
Carbon Trust	1,744.45
R&I (Japan)	1,471.34
CECEP	1,399.65
Syntao Green Finance	1,367.71
CCXI	945.00
Kestrel Verifiers	839.69
China Bond Rating	631.54
Shanghai BrillianceÂ Credit Rating	568.48
JCRA	447.50
Golden Credit	384.81
Turner & Townsend	313.04
CCX	231.54
GIB	150.88
RFU	133.83
Harris Group	117.20
RAEX	94.19
Pengyuan	71.20
First Environment	32.20
Glitre Energi	31.64
IMUG	30.27
TUV Nord	23.62
RAM Holdings (Malaysia)	3.88
Bureau Veritas	3.52
CIPA	3.50
AIFC Green Finance Center	0.47

[7]Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

Between 2015 and 2021, approximately 246 billion dollars worth of bonds were externally reviewed by Cicero, $167 billion by Sustainalytics, $104 billion by Vigeo Eris, $64 billion by ISS-ESG, and $22 billion by DNV GL. These external reviewers were the top five reviewers. Table 6 illustrates their dramatic domination in the green bond market.

Even though Cicero reviewed more bonds in terms of total amount (in USD) over the six years, Sustainalytics' share in the market increased consistently, and they overtook Cicero in total amount (in USD) in 2020. It was also evident that the market for external reviewers expanded drastically over the six years.

Table 7 Top external reviewers by region[8]

(Million $)	Africa	Asia-Pacific	Europe	LAC	N America	Supranational
CICERO	-	16,346.50	100,939.12	50.00	97,334.44	30,806.12
Sustainalytics	-	34,324.01	81,690.85	6,978.85	38,856.23	5,144.25
Vigeo Eiris	799.90	6,068.76	97,016.37	176.45	204.01	-
ISS-ESG	-	459.70	63,133.40	-	72.00	162.55
DNV GL	-	2,875.87	16,054.86	-	2,617.67	-

It can be also seen in Table 7 that supranational issuers chose Cicero as their first choice when they wanted to get their bonds reviewed. Europe stands out as the biggest market for external review organizations. Sustainalytics has the most significant share of the Asia-Pacific market, while Cicero dominates the rest. Vigeo Eiris ($97 bn) reviewed almost the same amount of bonds Cicero ($101 bn) reviewed in Europe—it can be indicated that Vigeo Eiris was a strong

[8] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

player in Europe. Table 8 shows that the top four reviewers had a 92.69% market share. This is another example of market concentration in green bonds.

Table 8 Concentration of external reviewing market[9]

Cicero (39.19%)	Sustainalytics (26.66%)	Vigeo Eiris (16.65%)	ISS-ESG (10.19%)
Cicero + Sustainalytics = 65.85%			
Cicero + Sustainalytics + Vigeo Eiris = 82.5%			
Cicero + Sustainalytics + Vigeo Eiris + ISS-ESG= 92.69%			

6.1.3 Analysis of Green Bond Issuance (2015-2021)

Table 9 groups the bond issuer types for the top three regions to show what currencies were used in these regions particularly.

Table 9 Amount issued by issuer type and currency.[10]

	Europe		Asia		North America	
Issuer Type	**Original Currency**	**Converted Amount in USD** (Million $)	**Original Currency**	**Converted Amount in USD** (Million $)	**Original Currency**	**Converted Amount in USD** (Million $)
Asset Backed Security	EUR	3,243.38	CNY	13,326.72	USD	104,661.97
	USD	3,000.00	EUR	350.51		
Development Bank	EUR	21,375.13	CNY	15,369.39	USD	2,876.42
	USD	8,900.00	USD	4,450.00		
			EUR	2,638.43		
Financial Corporate	EUR	74,347.10	CNY	38,895.47	USD	21,318.30
	USD	4,694.33	USD	21,215.00	EUR	9,367.44
			EUR	13,561.97		
Government-Backed Entity	EUR	79,344.37	CNY	14,294.06	USD	11,198.95
	USD	9,750.00	USD	10,887.00	EUR	891.75

[9] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

			EUR	2,177.27		
Sovereign	EUR	74,245.02	USD	3,750.00		
Non-Financial Corp.	EUR	86,748.73	USD	23,217.60	USD	32,395.59
	USD	4,555.00	CNY	8,199.55	EUR	3,450.90
			EUR	2,459.93		
Local Government	EUR	1,706.94	CNY	2,152.62	USD	37,571.73

Table 9 above reveals that Euro has been predominantly used in green bonds. Federal government presence in North America was yet to be visible. Corporations are major players in leading green bond markets. Even though the previous analysis showed that asset-backed securities (ABS) are one of the major players in green bond markets, this market was highly dependent on one single entity: Fannie Mae. This was once again proven in Table 9. This single entity issued the vast majority of the bonds under ABS. This creates a question about the market structure of ABS in the database. It was also seen in more detail that the Chinese Yuan, Euro, and United States Dollar dominated Asia-Pacific, Europe, and North America, respectively. Remarkably, USD was the primary currency in non-financial corporations in Asia-Pacific; this may need further investigation.

Another finding was Latin America, the Caribbean, and Africa had yet to be able to develop strong green bond markets in their regions. At the same time, it was observed that international collaboration had not matured yet— only development banks issued supranational bonds. Moreover, government-backed entities and sovereign bonds were not seemed to invest in supranational projects.

Furthermore, In the analysis it was observed that even though the least developed countries are struggling with some of the worst environmental problems, the world's attention to these regions with green bonds is questionable. The amount issued in other than developed countries and China is insignificantly low. Moreover, the supranational organizations and development banks' presence was also insignificant.

Based on CBI (2021) data, the least developed regions were not ready to utilize the green bond markets in their regions; therefore, this doubts the effectiveness of these bonds in these regions. This also needs further studies to explore.

Among all the issuer types, (1) sovereign bonds, (2) government-backed entities, and (3) local governments were considered as direct government investments as. These three combined have massive potential and capacity to move the market, but only some governments are involved in green bond markets. Indeed, very few significant involvements were observed. In the last six years, considerable government involvements were from France, the USA, the Netherlands, Germany, and China.

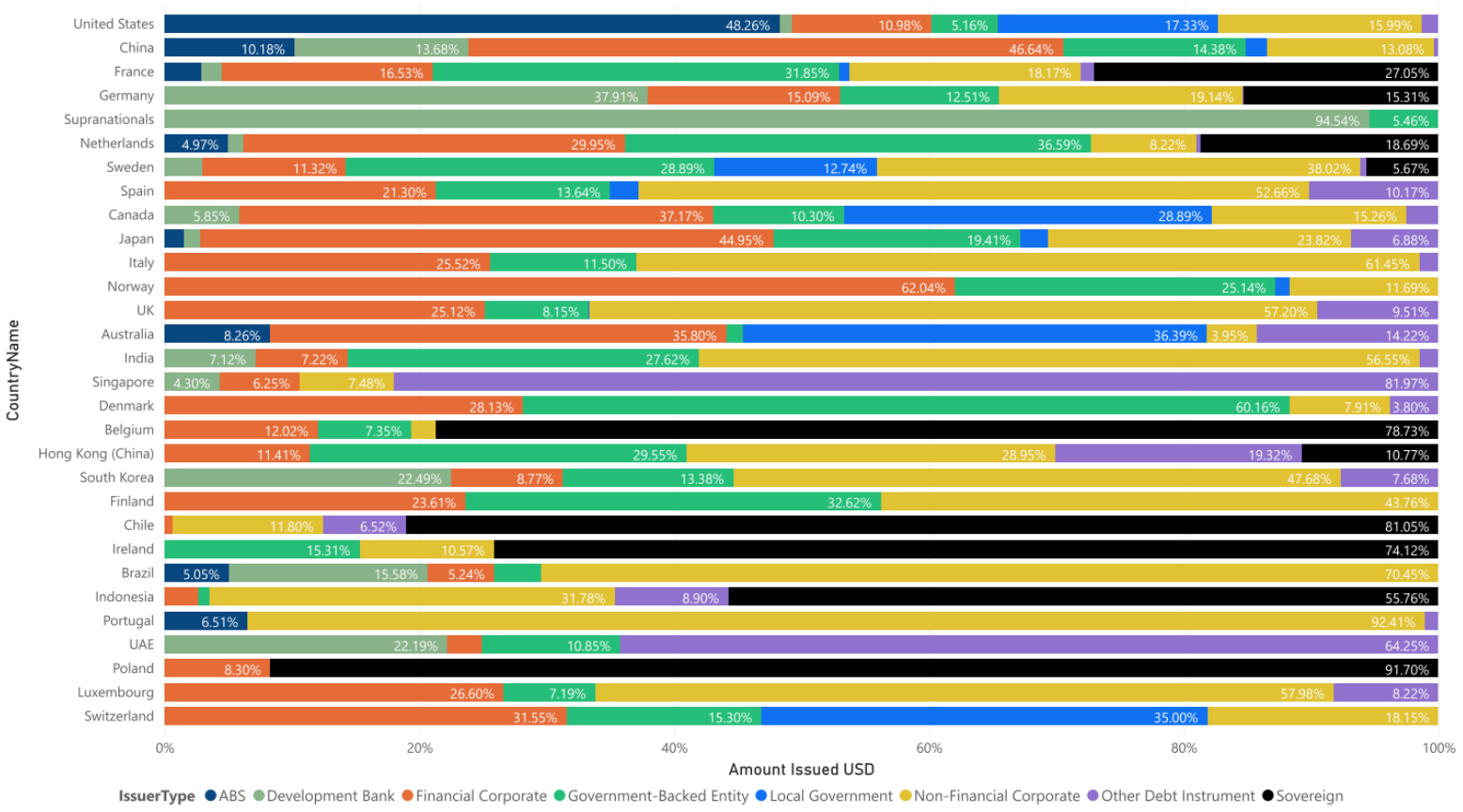

Figure 11. Top countries' issuer profiles

Countries in Figure 11 are sorted by the total amount issued in USD. United States, China, and France were the top three issuers in the world. At the same time, we can see top issuers' profiles and characteristics. While corporations dominate in China, green bond markets are led by non-corporation entities in the United States, France, and Germany.

Two third of the top 29 countries did not issue a sovereign bond— this alone may show the lack of direct government involvement. Sovereign bonds were concentrated in Europe. As previously mentioned, it was noted that the Asset-Backed Security market in the USA was predominantly dominated by a single major player. However, the graph has revealed that the issuer profile of the United States also lacks diversity. Fannie Mae issued almost half of the total amount issued in the USA. This one issuer-type domination also appears in China's green market, as 46 percent of the total amount was issued by financial corporations. China's market fragility will be reviewed in more detail in the following sections.

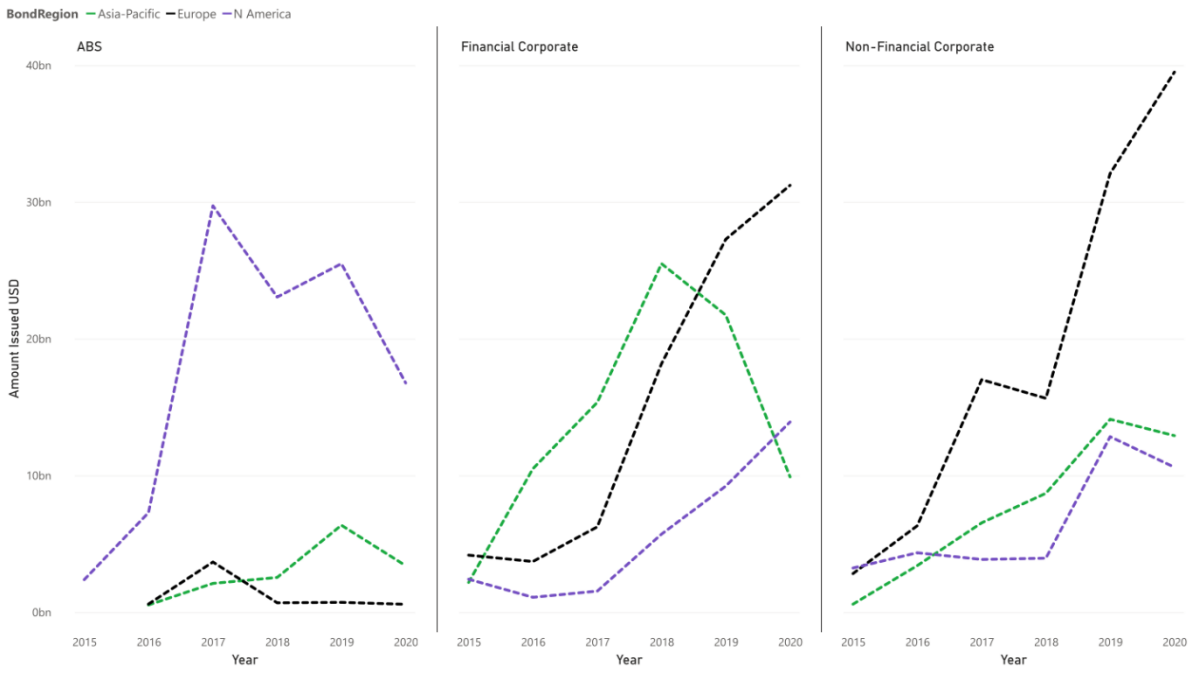

Figure 12. Top regions by non-governmental issuers

It can be seen in Figure 12 that the major issuer types -Financial Corporations & ABS- were losing their momentums in Asia-Pacific. In addition to this lost momentum, the most dramatic decrease

happened in Asian-Pacific financial corporations. It peaked in 2018 and decreased by almost 60% in the annual total amount in three years.

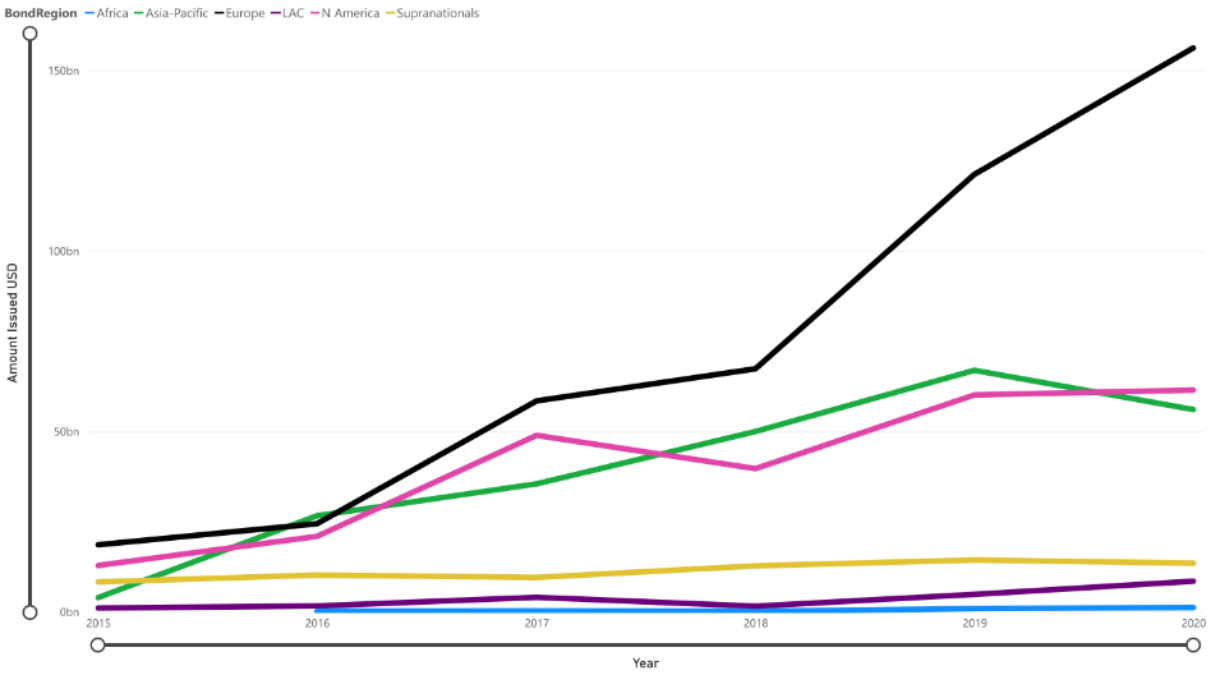

Figure 13. Total amount by regions

If a bigger picture is taken, it can be seen that Europe's presence has significantly increased, while Asia-Pacific and North America struggled to match their total amount with Europe. Even though supranational kept their total amount issued, they failed to increase their performance over the years. LAC had a slight momentum in the last three years. Africa's involvement is negligible.

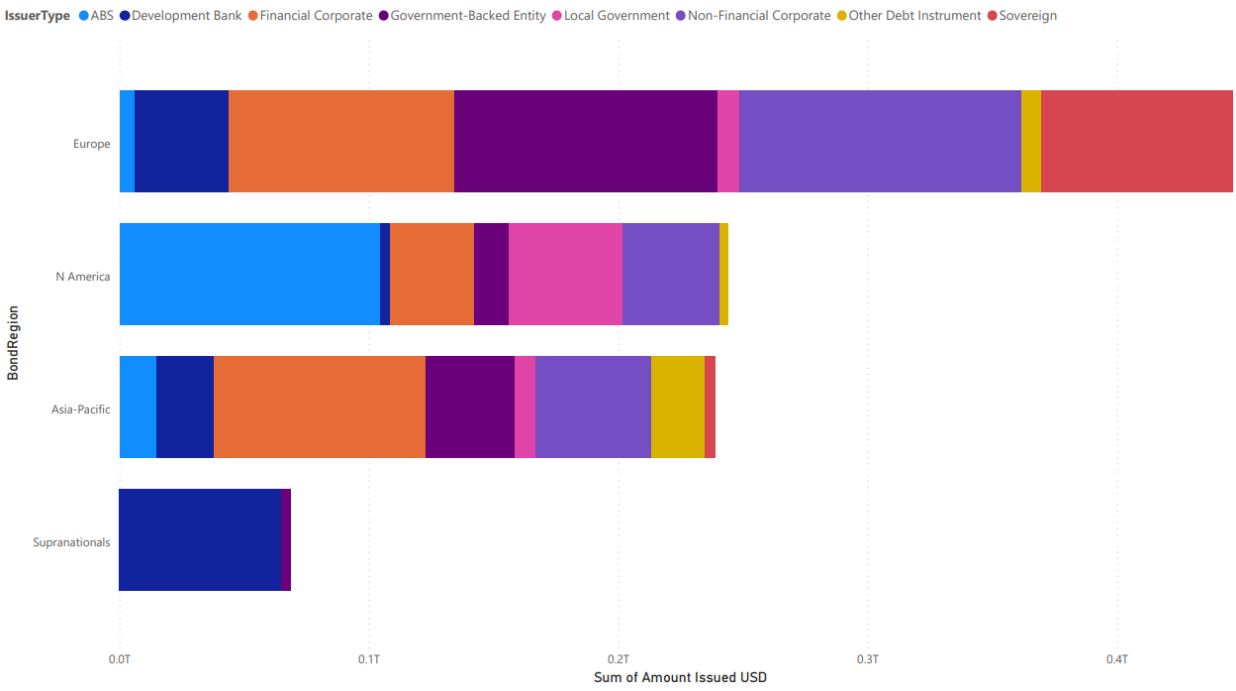

Figure 14 Top regions by issuer types

Among the leading three regions, North America was missing the strong presence of financial and non-financial corporations and development banks. On the other hand, local government and asset-backed securities are more robust than in other regions. The sovereign bond issuance was not visible in North America and was very weak in Asia-Pacific. At the time when our research was being conducted, an inaugural sovereign green bond issuance had been announced by Federal Government of Canada; the bond will be worth 5 billion Canadian Dollars. (Canada, 2022).

Government involvements also occurred via different channels; in Europe, the sovereign bond presence is significant, while this is lacking in other leading regions. In North America, local government involvement is massive corresponding two third of total issuance in government. However, in Asia-Pacific, leading issuers are government-backed entities. The main reason for this government participation difference between these two regions could be a good research question for other researchers.

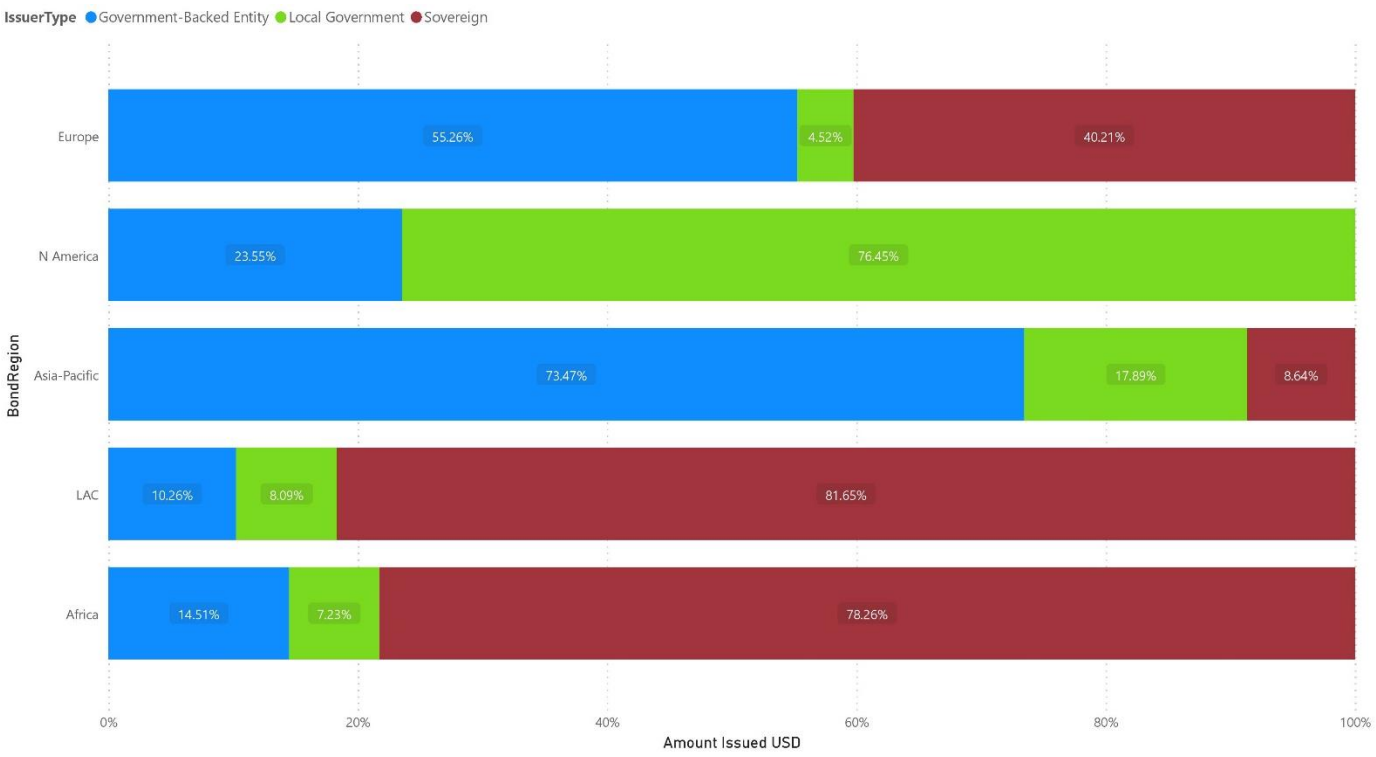

Figure 15. Distribution of governmental issuers by region

Particular countries dominate leading regions; North America, Europe, and Asia-Pacific were leading regions, and they are dominated by the USA, France-Germany, and China, respectively. This domination can be interpreted as a lack of diversity in regions; the regions are tied to one or two major players. Also, several top issuers are not diverse in their market— the regional markets depend on a big player or one significant issuer type. This pattern could also be seen in the world map. Only a couple of countries are leading the entire world.

To illustrate this better, the research included the top ten issuing countries by region. Europe seems to be the most diverse region, while North America and Asia-Pacific were significantly led by one country.

The top ten countries issued 73.4% of the total amount in USD; the top five countries issued about 58% of the total amount; the top three countries issued around 44% of the total amount; and the top two countries almost 33% of the total amount. This may illustrate that the green

market was concentrated in particular countries rather than having a diverse market. Concentration looks like a common characteristic of the green bond market.

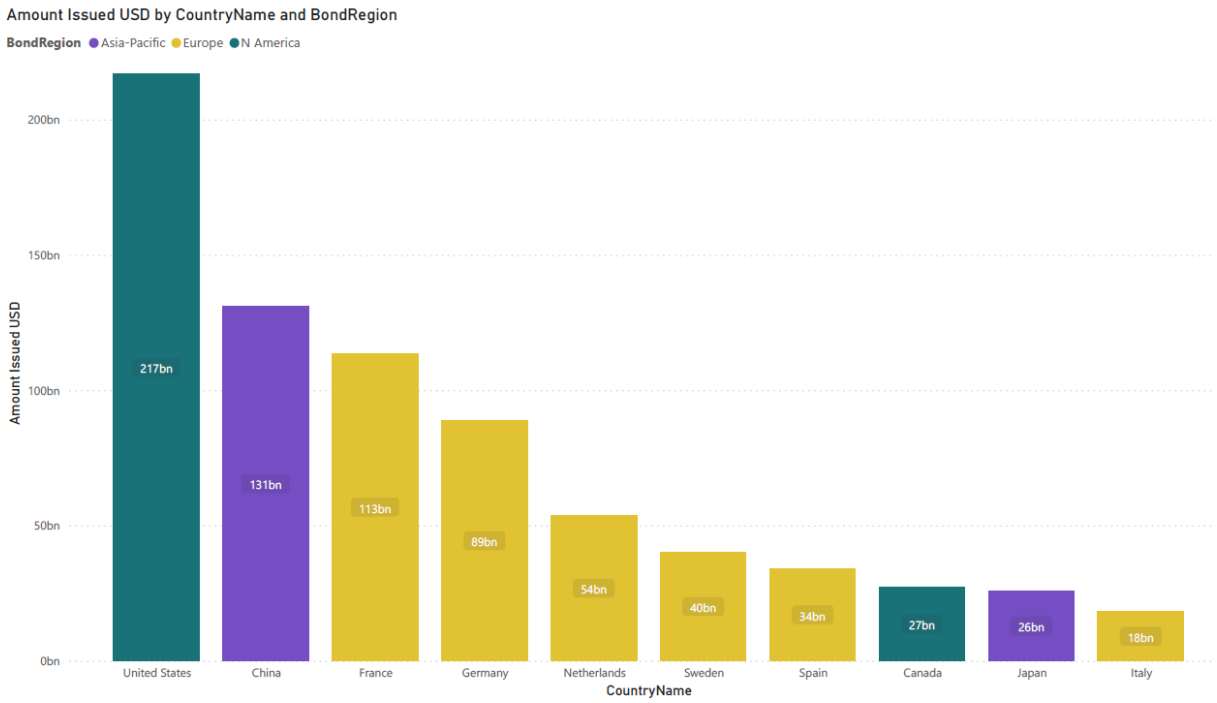

Figure 16. Market domination of top ten countries

Figure 17 on the next page shows the top use of proceeds and their type of issuers. Sovereign bonds tend to be more general by having a wide range of use of proceeds. It can be said that almost all types of investors are attracted by energy and building.

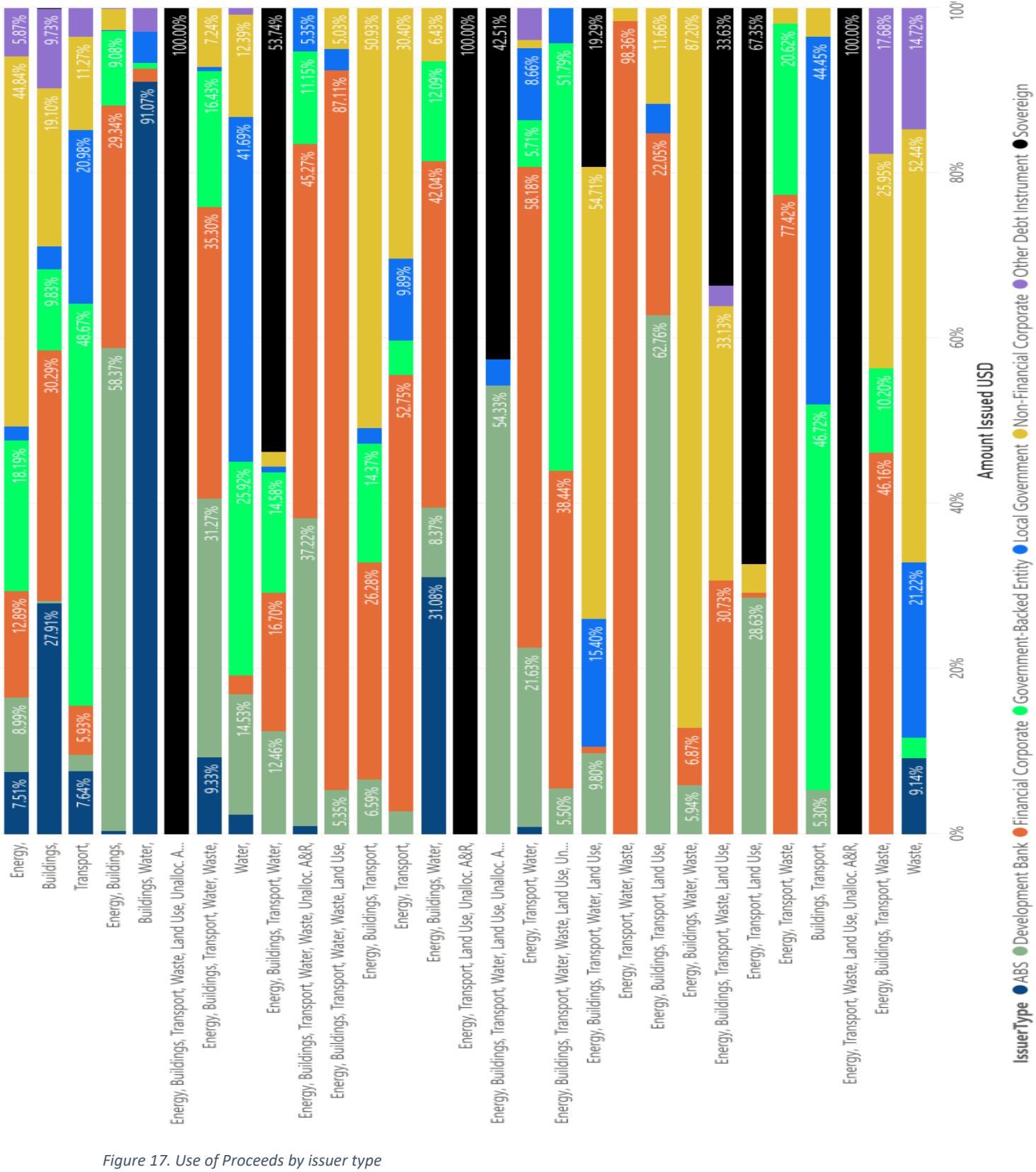

Figure 17. Use of Proceeds by issuer type

The database has ten sectors where the raised money could be used: Energy, Building, Transport, Water, Waste, Land Use, Unallocated A&R, Industry, and Information Communication and Technology (ICT). In the graph above, issuers may use the issued money in only one sector or divide the issued money between sectors. As you can see in Figure 17, there are use of proceeds that combine more than one sector. The exact proportion of the money distribution is not available for the researchers. Therefore, it will not be possible to determine how much money was allocated to a specific sector if the issued money was used in more than one sector.

(Energy), (Building), (Transport), (Energy and Building), (Building and Water), (Energy, Building, Transport, Waste, Land Use), (Energy, Building, Transport, Water, and Waste), (Water), and (Energy, Building, Transport, Water) were the top use of proceeds, respectively.

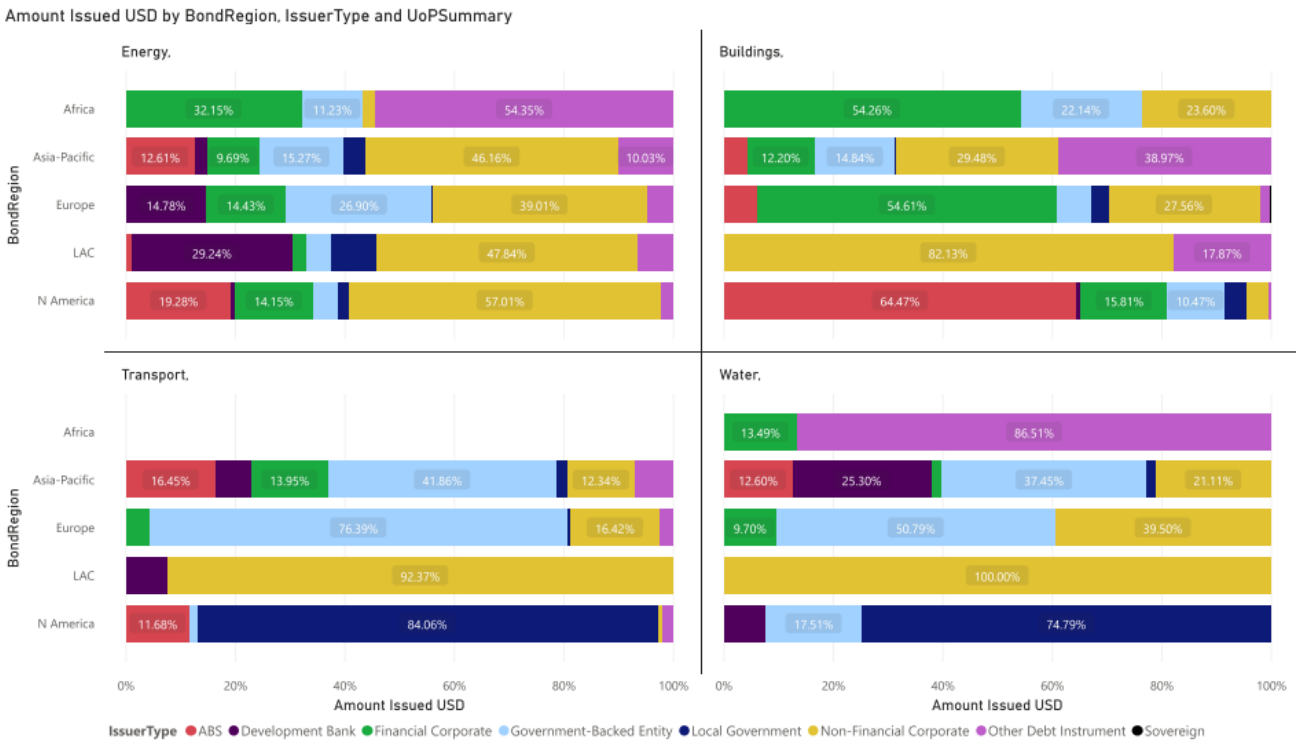

Figure 18. Top Use of Proceeds by regions and issuer types

Before the top duos and trios are investigated, the top four single sectors in the use of proceeds will be looked at. (1) Energy, (2) Buildings, (3) Transport, and (4) Water. As figure 18 shows, the energy sector was driven by non-financial corporations, and government presence in water and transport is visible. Major regions have similar investor types for energy, transport, and water; however, the building sector has shown differences in issuer types.

Figure 19 and figure 20 show the top two and three sectors that issuers partnered with; energy and buildings stand out as favoured partners for other sectors. The energy and Buildings couple got the most investments by issuers. The energy was part of all top trio investments. Buildings were also an important partner of other sectors.

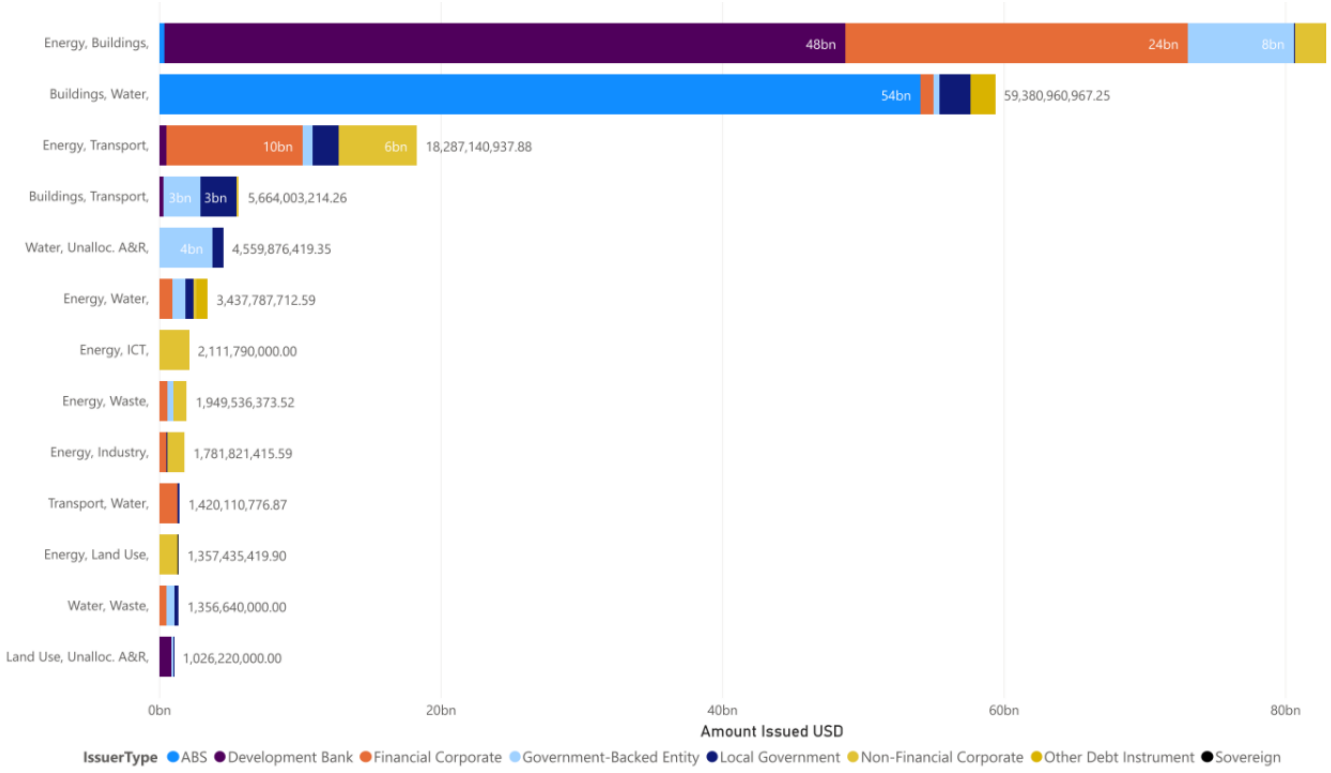

Figure 19. Top duo of Use of Proceeds by issuer type

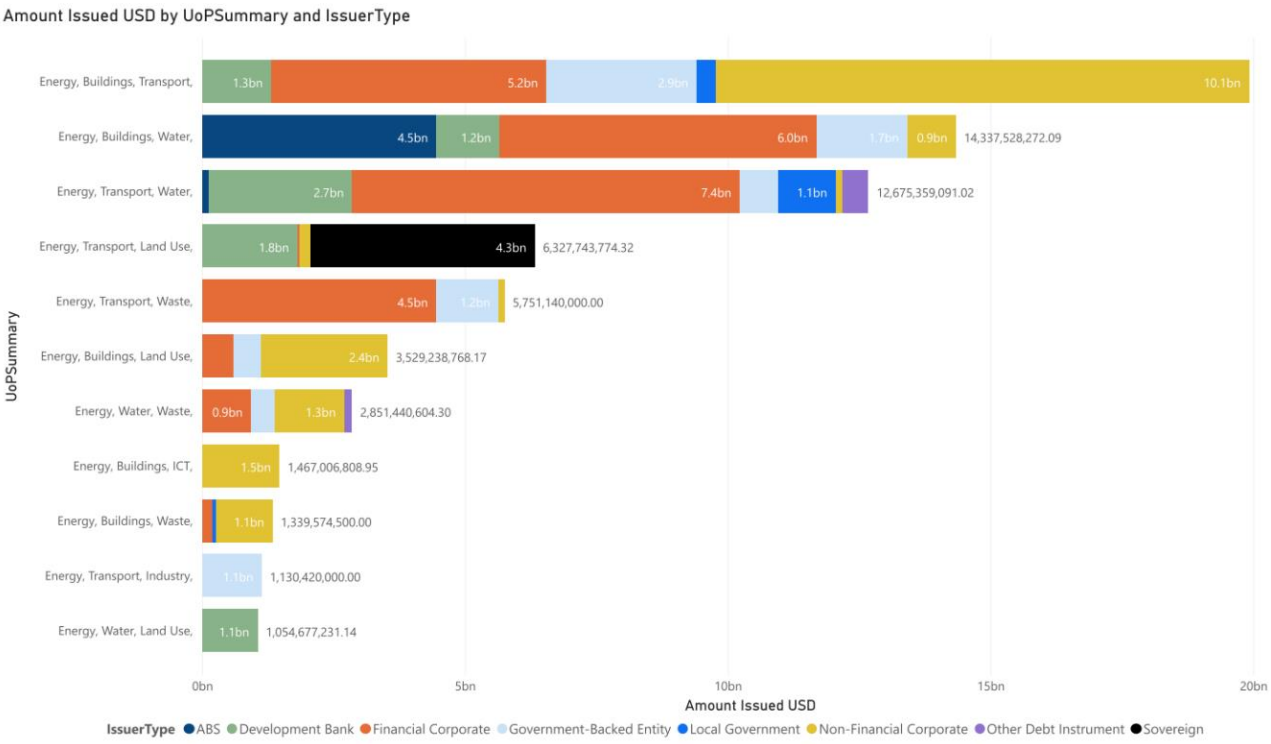

Figure 20. Top trio of Use of Proceeds by issuer type

6.1.4 The USA vs China: Highlights of the top two

China exponentially increased its issuance amount in 2016, and another visible increase occurred in 2018. However, China lost its momentum in the last years. On the other hand, the USA had a better starting position than China in 2015 and managed to grow substantially. Only one setback was observed in 2018, but the USA recovered quickly. Their performance is summarized in figure 21.

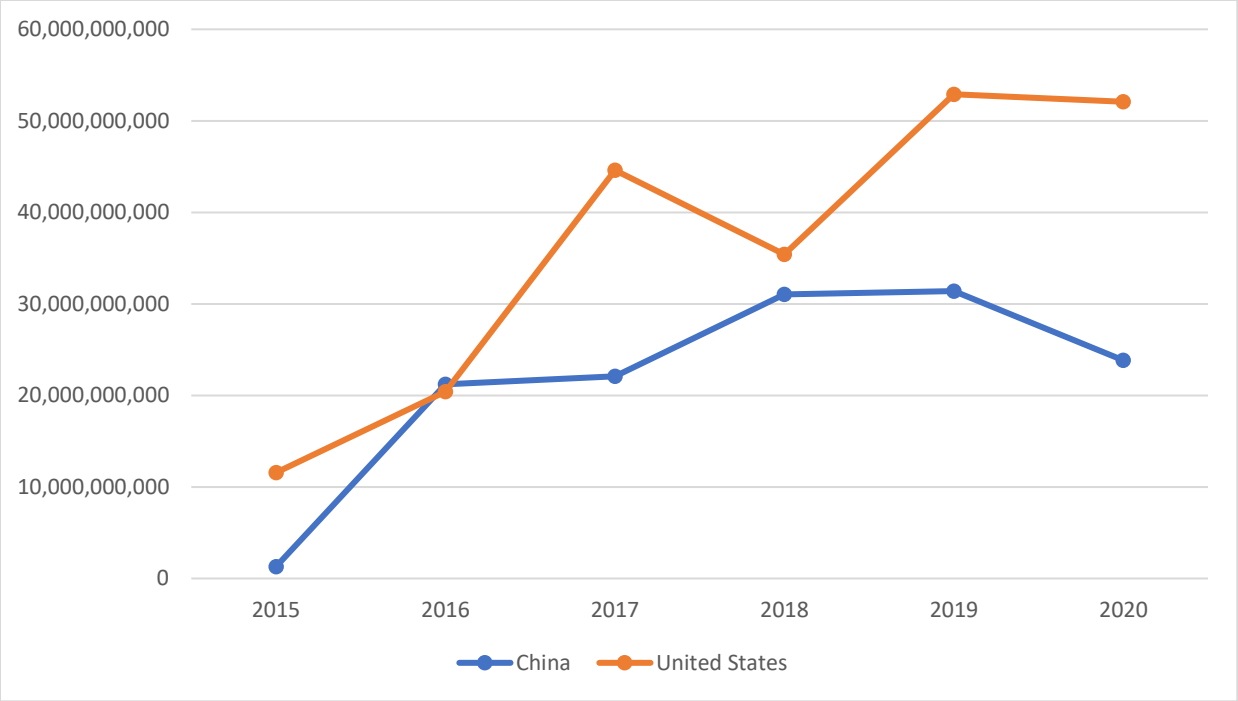

Figure 21. The USA vs China in total amount (USD) by year

The number of unique issuers was 310 in the USA and 207 in China. The USA had an overwhelmingly higher number of total bonds issued; however, this was because of Fannie Mae's large number of bonds. Thus, it was determined that examining the number of unique bond issuers is more significant than examining the total number of bonds issued. In this case, Fannie Mae was counted only once as a unique issuer. As a result, the USA (310) had a higher number of unique issuers than China (207).

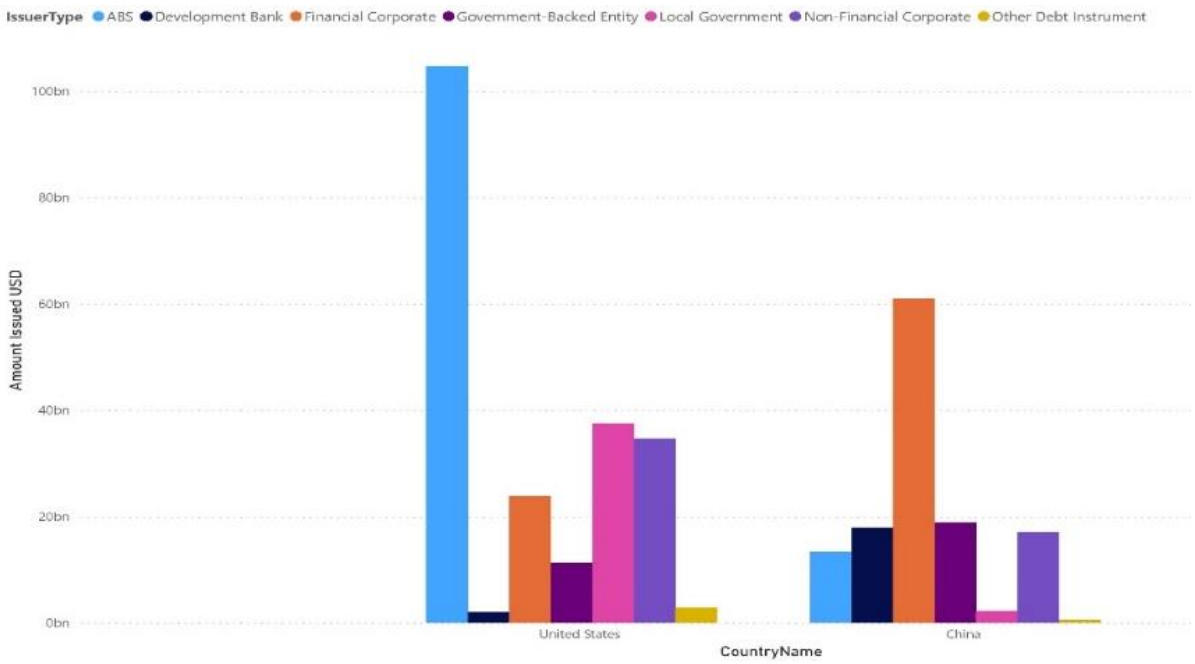

Figure 22. The USA vs China by issuer type

In the issuer-type comparison, figure 22, the USA's ABS stands out thanks to Fannie Mae. Local governments, non-financial corporations, and financial corporations followed ABS in the USA. Development banks' presence was almost invisible, and government-backed entities fell behind. In China, Financial Corporations distinguished themselves among other types. However, the local government's existence in the green bond market in China was not noticeable. Tables 10 and 11 show the top 100 issuers from the USA and China.

Table 10 The United States of America's top 100 issuers[11]

The United States of America's top 100			
Issuer Name	**Amount Issued USD (Million $)**	**Issuer Name**	**Amount Issued USD (Million $)**
Fannie Mae	87,411.8	Power Authority of The State Of New York	791.6
New York MTA	10,851.5	Metropolitan Life Global Funding	750.0
Digital Realty Trust	4,154.7	Pattern Energy	700.0
MidAmerican Energy	3,900.0	City And County Of San Francisco	658.3
Bank of America	3,850.0	DTE Energy	650.0

[11] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

Xcel Energy	3,275.0	Host Hotels & Resorts	650.0
Southern Power Company	3,144.1	PNC Financial Services Group	650.0
Toyota	2,850.0	Sunrun	637.0
Renovate America	2,830.8	Johnson Controls	625.0
Citigroup	2,711.1	Mill City Solar Loan	621.1
San Francisco Public Utilities	2,560.7	Arizona State University	580.5
AES Corporation	2,508.3	Dividend Finance	571.6
Apple INC	2,500.0	Ameren Corp	550.0
NY State HFA	2,401.0	Goldman Sachs	500.0
Duke Energy	2,300.0	Morgan Stanley	500.0
Los Angeles County MTA	2,246.0	Welltower	500.0
Apple	2,206,8	California Pollution Control Finance Authority	461.0
Prologis	2,088.3	Owens Corning	450.0
Verizon	2,000.0	City of Aurora, CO	437.0
San Francisco BART	1,994.0	East Bay Municipal Utility District	421.5
Ygrene Energy Fund	1,984.3	District of Columbia Water	404.0
Solar Mosaic	1,974.4	Duke Realty	400.0
Boston Properties	1,850.0	Equity Residential	400.0
Hannon Armstrong	1,785.1	Federal Realty Investment Trust	400.0
Indiana Finance Authority	1,750.2	NSTAR Electric	400.0
Tesla	1,696.0	Pinnacle West Capital	400.0
Massachusetts Water Resources Authority	1,652.2	SunStrong	400.0
Sunnova	1,644.8	Tenaska	400.0
Ibank, CA	1,393.8	New Jersey Infrastructure Bank	384.5
Equinix	1,350.0	California Infrastructure And Economic Development Bank	372.6
Central Puget Sound Transit Authority	1,342.8	American Municipal Power	370.2
Iowa Finance Authority	1,272.0	Los Angeles County Public Works Financing Authority	363.2
TerraForm Power	1,250.0	Dominion Energy	362.0
City of Los Angeles	1,129.7	Hastings Campus Housing Finance AuthorityÂ	360.7
Interstate Power and Light	1,100.0	Southern California Public Power Authority	355.5
Vivint Solar	1,057.5	City and County of Honolulu	353.6
Alexandria Real Estate Equities	1,000.0	Commonwealth of Massachusetts	350.0
JP Morgan	1,000.0	UDR INC	350.0

Massachusetts Clean Water Trust	998.3	Westar Energy Inc	350.0
Freddie Mac	985.0	San Diego Association of Governments	335.0
Kaiser Foundation Hospitals	983.3	OPIC	332.8
Illinois Finance Authority	950.0	State of Michigan	328.7
NYS EFC	948.4	Georgia Power Company	325.0
State of Connecticut	909.8	The Regents Of The University Of Colorado	314.6
Calpine Corporation	900.0	Maryland State Economic Development	313.0
Renew Financial	882.6	Piedmont Office Realty	300.0
Loanpal	877.3	Tucson Electric Power	300.0
Clearway Energy Operating	850.0	San Diego County Water Authority	283.4
Kilroy Realty LP	825.0	Transbay Joint Power Authority	271.2

Table 11 People's Republic of China's top 100 issuers[12]

People's Republic of China's top 100			
Issuer Name	**Amount Issued USD (Million $)**	**Issuer Name**	**Amount Issued USD (Million $)**
Industrial Bank	13,356.1	Bank of Changsha	444.6
ICBC	10,315.7	Qigndao Rural Bank	443.2
Bank of China	8,290.2	Chongqing Three Gorges Bank	436.9
SPD Bank	7,889.0	ABC financial Leasing	434.1
China Development Bank	7,498.3	Beijing Rail Transit Daxing	433.2
Bank of Beijing	4,456.2	Yalong River Hydropower Development Company, Ltd.	432.2
Bank of Communications	4,355.1	Bank of Ningbo	432.0
China Construction Bank	3,970.8	Chongqing Rail Transit (Group) Co.,Ltd.	425.4
Modern Land	2,630.0	Guizhou Water Investment Group Co., Ltd.	409.7
Wuhan Metro	2,558.2	Zheijiang Geely	400.0
CGN	2,447.9	Huarong Xiangjiang Bank	395.7
Agricultural Development Bank of China	2,368.8	Guiyang Public Transport	384.6
Beijing Jingneng Clean Energy	2,110.7	SPIC Ronghe Financial Leasing	376.1
China Three Gorges Corp	1,969.0	Qingdao Guoxin Development	368.7

[12] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

Bank of Jiangsu	1,491.3	Concord New Energy Group Ltd	336.0
Beijing Infrastructure Investment	1,427.8	Bank of Dongguan	306.3
Huaxia Bank	1,413.6	Chongqing Rural Commercial Bank Co Ltd	302.8
Longyuan Power	1,321.5	Beijing Capital Polaris Investment	300.0
Agricultural Bank of China	1,213.6	Capital Environment Holdings	300.0
Nanjing Metro	1,200.2	China Everbright Bank	300.0
State Power Investment Corporation Limited	1,184.1	CIFI Holdings	300.0
Guangzhou Metro	1,170.4	Envision Energy Overseas Capital	300.0
Bank of Guiyang	1,158.4	Jiangxi Provincial Water Conservancy Investment	300.0
Beijing Enterprises Water Group	1,139.1	Shui On Land	300.0
CECEP	1,037.1	Yuzhou Group Holdings	300,0
China Merchants Bank Co., Ltd.	940.4	China Datang Corp	298.8
Sichuan Railway Investment	884.3	Bank of Lanzhou	297.9
Huishang Bank	777.3	Wuxi Communication Industry Group	296.8
China Longyuan Power Group	770.7	Sichuan Province Airport Group	296.7
Beijing Capital	746.2	Huadian Fuxin Energy	295.4
Guangdong Huaxing Bank	745.1	Huarong Financial Lease	291.8
Chengdu Rail Transit	737.8	Bank of Dalian	290.3
Bank of Nanjing	725.3	Bank of Zhengzhou	289.4
Harbin Bank	724.5	Guilin Bank	288.5
Bank of Guizhou	723.8	Chengdu Rail Transit Group Co.,Ltd	286.6
Xinjiang Goldwind	719.5	Ningbo City Rail Trans	285.0
China Zheshang Bank	701.9	Harvest Capital	281.3
ICBC Leasing	600.0	Tus-Sound Environmental Resources	275.9
Beijing Enterprise Holdings Limited	582.2	Qingdao International Shipping Building Management	270.1
Jiangsu Financial Leasing	570.8	Yango Justice International	270.0
Huaneng Tiancheng Financial Leasing	570.7	GD Power Development Co.,Ltd.	268.0
Zhenro Properties Group Ltd	550.0	China Kangfu International Leasing	267.2

Beijing China Oversea Plaza Business Development Co., Ltd.	522.9	State Power Investment Corp	258.5
BYD	521.4	China Resources Leasing Co.,Ltd.	258.4
Fudian Bank	511.3	China Jinmao Holdings	250.0
Rongshi Intl	500.0	Zhongyuan Bank	237.0
Huadian Fuxin Energy Corporation Limited	499.0	Chouzhou Commercial Bank	234.6
Tianjin Rail Transit	491.5	Zhuhai Huafa Comprehensive Development	229.8
Bank of Rizhao	447.4	Nanjing Pukou Construction	229.7

6.1.5 Country Rankings

The practice of recording bond market data has a long and rich history that spans across the development of financial markets and their respective instruments. In contrast, the green bond market, a relatively recent phenomenon, has seen rapid growth in recording practices and data availability.

As of August 2020, ICMA estimates that the overall size of the global bond markets in terms of USD is approximately $128.3tn (ICMA, 2020). United States (≈ 26%), China (≈ 21%), and Japan (≈11%) were the top three global conventional bond market, respectively (ibid.).

CBI (2022) estimates that the green bond market has cumulatively raised, as of September 2022, US $1.95tn.

Table 12 Country Rankings[13]

	Top Green Bond Countries CBI (2021)	Top Environmental Performance Index (EPI) (2022) *	Top Environmental Performance Index between 2012-2022 (EPI) (2022) *
1	United States	Denmark	United Kingdom
2	China	United Kingdom	Finland
3	France	Finland	United Arab Emirates

[13] Source: Authors, using data from (CBI,2021), (SIFMA, 2021), (EPI, 2022).

4	Germany	Sweden	Sweden
5	Netherlands	Austria	Kuwait
6	Sweden	Switzerland	Denmark
7	Spain	Netherlands	Mexico
8	Canada	France	Kazakhstan
9	Japan	Germany	China
10	Italy	Australia	Australia
*Countries under four million population and GDP under fifty billion dollars are excluded from the Top Environmental Performance Indexes by the author.			

6.2 Test Statistic

A series of crosstabs will be shown to the readers in this part to compare the number of issued bonds between regions, issuer types, and use of proceeds. An ANOVA test will also be run to compare each region's average size of the bond. The statistically significant differences in the tables will be highlighted as well.

There is a significant difference ($df = 5$, $p < 0.001$) in the ANOVA test for the average size of the bond between regions. Readers can also reference Table 12 to see the results in detail. There is no significant difference in the size of the average bond between Africa and other regions. An average bond issued in Asia-pacific is significantly bigger than in North America but smaller than in Europe. The average bond size in Europe is significantly bigger than in other regions except Africa. Latin America and the Caribbeans' average bond size is significantly bigger than the average size of the bond in North America. In North America, the average bond size is significantly smaller than in every region except Africa. Lastly, the average bond size of Supranational organizations is significantly bigger than in North America.

Table 13 Statistical difference of average bond size between regions.[14]

Region		Mean Difference (I-J)	Std. Error	Sig.
Africa	Asia-Pacific	-121281295.35	76735347.23	0.777
	Europe	-196278173.39	76505551.42	0.254
	LAC	-54520427.36	82255619.22	0.994
	N America	81388852.73	76166963.08	0.950
	Supranational	-63417804.25	77944428.43	0.985
Asia-Pacific	Africa	121281295.35	76735347.23	0.777
	Europe	-74996878.03*	13598152.56	<0.001
	LAC	66760867.99	33133023.52	0.541
	N America	202670148.09*	11541950.42	<0.001
	Supranational	57863491.10	20177816.49	0.144
Europe	Africa	196278173.39	76505551.42	0.254
	Asia-Pacific	74996878.03*	13598152.56	<0.001
	LAC	141757746.03*	32597287.17	<0.01
	N America	277667026.13*	9899621.36	<0.001
	Supranational	132860369.14*	19285490.96	<0.001
LAC	Africa	54520427.36	82255619.22	0.994
	Asia-Pacific	-66760867.99	33133023.52	0.541
	Europe	-141757746.03*	32597287.17	<0.01
	N America	135909280.10*	31794496.34	<0.01

[14] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

	Supranational	-8897376.89	35844353.20	1.000
N America	Africa	-81388852.73	76166963.08	0.950
	Asia-Pacific	-202670148.09*	11541950.42	<0.001
	Europe	-277667026.13*	9899621.36	<0.001
	LAC	-135909280.10*	31794496.34	<0.01
	Supranational	-144806656.99*	17895167.73	<0.001
Supranational	Africa	63417804.25	77944428.43	0.985
	Asia-Pacific	-57863491.10	20177816.49	0.144
	Europe	-132860369.14	19285490.96	<0.001
	LAC	8897376.89	35844353.20	1.000
	N America	144806656.99	17895167.73	<0.001

Table 13 shows issuer types and the top ten country profiles (Chi2 -test: df = 568, p <0.001). A statistical test was run among all countries, and a significant difference was found between the number of expected bonds and the actual number of unique bonds issued. However, the top ten countries were picked to present a detailed table. In the United States, the number of issued bonds by ABS and Local Government Bonds is significantly higher than the expected number.

In China, the number of bonds issued by Financial Corporations, Government-Backed Entities, and Non-Financial Corporations is higher than the expected count. In France, the number of bonds issued by Financial Corporations, Government-Backed Entities, Non-Financial Corporations, and Sovereigns is higher than the expected number. In Germany, the number of bonds issued by Development Banks, Financial Corporations, Government-Backed Entities, and Sovereigns is higher than the expected number. Among Supranational organizations' bonds, only Development Banks issued more individual bonds than expected count. In the Netherlands, the number of issued bonds by Financial Corporations, Government-Backed Entities, Other Debt Instruments, and Sovereigns is higher than the expected number. In Sweden, the number of

issued bonds by Government-Backed Entities and Non-Financial Corporations is higher than the expected number. In Spain, the number of issued bonds by Financial Corporations, Non-Financial Corporations, and Other Debt Instruments is higher than the expected number. In Canada, the number of issued bonds by Financial Corporations, Government-Backed Entities, Non-Financial Corporations, Other Debt Instruments, and Local Governments is higher than the expected count. In Japan, the number of issued bonds by Financial Corporations, Government-Backed Entities, Non-Financial Corporations, and Other Debt Instruments is higher than the expected number. In Italy, the number of issued bonds by Financial Corporations, Government-Backed Entities, Non-Financial Corporations, and Other Debt Instruments is higher than the expected number.

Earlier in the research, it was concluded that the main government involvement came from France, the USA, the Netherlands, Germany, and China. However, the approach from governments varied. North American countries, Canada & the USA, overperformed in local government issuance but underperformed in sovereign bond issuance. In the meantime, France and the Netherlands, from Europe, were the only countries that issued more sovereign bonds than expected count. Government-backed entities were generally popular among top issuer countries. Please reference Table 13 to see over and under-performed issuer types among top countries.

Table 14 SPSS Crosstabs Table. Issuer Type x Top 10 Countries[15]

		N.America	Asia-Pacific	Europe	Europe		Europe	Europe	Europe	N.America	Asia-Pacific	Europe
		United States	**China**	**France**	**Germany**	**Supra.**	**Nether.**	**Sweden**	**Spain**	**Canada**	**Japan**	**Italy**
ABS	Count	4231	76	2	0	0	4	0	0	0	4	1
	Expected Count	2628.1	232.6	127.8	147.0	208.0	44.9	239.0	54.0	40.6	120.3	23.0

		United States	**China**	**France**	**Germany**	**Supra.**	**Nether.**	**Sweden**	**Spain**	**Canada**	**Japan**	**Italy**
Dev. Bank	Count	24	24	2	59	371	2	15	0	4	1	0
	Expected Count	319.3	28.3	15.5	17.9	25.3	5.5	29.0	6.6	4.9	14.6	2.8

[15] Authors, using data from Climate Bonds Initiative (CBI,2021).

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Financial Corps	Count	46	110	128	56	0	32	18	12	23	87	8
	Expected Count	433.9	38.4	21.1	24.3	34.3	7.4	39.5	8.9	6.7	19.9	3.8

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Gov.-backed Entity	Count	130	95	49	128	18	30	52	7	7	35	5
	Expected Count	430.2	38.1	20.9	24.1	34.1	7.4	39.1	8.8	6.7	19.7	3.8

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Local Gov.	Count	335	2	4	0	0	0	57	1	19	8	0
	Expected Count	280.0	24.8	13.6	15.7	22.2	4.8	25.5	5.8	4.3	12.8	2.4

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Non-Financial Corps	Count	105	126	38	28	0	10	303	66	19	71	27
	Expected Count	676.3	59.9	32.9	37.8	53.5	11.6	61.5	13.9	10.5	31.0	5.9

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Other Debt Instru.	Count	44	2	3	2	0	2	1	15	4	19	2
	Expected Count	110.9	9.8	5.4	6.2	8.8	1.9	10.1	2.3	1.7	5.1	1.0

		United States	China	France	Germany	Supra.	Nether.	Sweden	Spain	Canada	Japan	Italy
Sovereign	Count	0	0	13	2	0	4	1	0	0	0	0
	Expected Count	35.8	3.2	1.7	2.0	2.8	0.6	3.3	0.7	0.6	1.6	0.3

A Chi^2 test resulted in significant differences between regions with respect to issuance type ($df=40$, $p < .001$) (Table 14, in many ways, supports the findings from the previous crosstabs. These findings may also prove the leading countries' influence on their regions. ABS securities outperformed in North America thanks to Fannie Mae; Development Banks stand out among

Supranational Organizations; Financial Corporates' involvement was significantly higher than the expected number of bonds in all regions except North America and Supranational Organizations. Governments' approaches to issuing bonds differed between regions. North America relied on Local Government bonds; however, the number of Sovereign bonds was higher than expected in Europe and Asia-Pacific.

Table 15 SPSS Crosstabs: Issuer Type x Regions[16]

		Africa	Asia-Pacific	Europe	LAC	N.America	Supranational	Total
ABS	**Count**	0	92	8	6	4231	0	4337
	Expected Count	10.7	561.4	825.6	62.6	2668.7	208.0	4337.0
Development Bank	**Count**	0	39	79	10	28	371	527
	Expected Count	1.3	68.2	100.3	7.6	324.3	25.3	527.0
Financial Corporate	**Count**	8	266	347	26	69	0	716
	Expected Count	1.8	92.7	136.3	10.3	440.6	34.3	716.0
Government-Backed Entity	**Count**	2	190	360	3	137	18	710
	Expected Count	1.8	91.9	135.2	10.2	436.9	34.1	710.0
Local Government	**Count**	1	31	71	5	354	0	462
	Expected Count	1.1	59.8	87.9	6.7	284.3	22.2	462.0
Non-Financial Corporate	**Count**	2	325	607	58	124	0	1116
	Expected Count	2.8	144.5	212.4	16.1	686.7	53.5	1116.0
Other Debt Instrument	**Count**	3	96	33	3	48	0	183
	Expected Count	0.5	23.7	34.8	2.6	112.6	8.8	183.0
Sovereign	**Count**	4	10	39	6	0	0	59
	Expected Count	0.1	7.6	11.2	0.9	36.3	2.8	59.0
Total Count		20	1050	1544	117	4991	389	8111

[16] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

A Chi^2 test resulted in significant differences between regions with respect to the use of proceeds (df=635, p < .001). There were more than 100 different types of use of proceed combination; however, only the top ten use of proceed were chosen-which covers about 70% of the market- in terms of the total amount issued in USD. In Table 15, it was broken down the top ten use of proceeds by region and compare the expected number with the actual number of bonds issued.

In North America, the number of green bonds issued to use in buildings and water was more than the expected count. This is likely because of the overwhelming amount of bonds issued by Fannie Mae: The Federal National Mortgage Association.

In the meantime, countries in Asia-Pacific issued more bonds than the expected number in Transportation and Energy. Energy got the highest share of use of proceeds for African countries.

In Europe, it was found a diverse market. Almost in all top sectors, the region issued more than expected number.

Table 16 SPSS Crosstabs. Top 10 Use of Proceeds x Regions[17]

		Africa	Asia-Pacific	Europe	LAC	N America	Suprana-tional
Energy	Count	6	328	351	54	202	4
	Expected Count	2.3	122.3	179.9	13.6	581.5	45.3
Buildings	Count	3	218	353	4	1633	0
	Expected Count	5.5	286.2	420.9	31.9	1360.5	106.0
Transport	Count	0	139	80	2	55	18
	Expected Count	0.7	38.1	56.0	4.2	180.9	14.1
Energy, Buildings	Count	1	28	170	4	19	78
	Expected Count	0.7	38.8	57.1	4.3	184.6	14.4
Buildings, Water	Count	0	3	1	0	2678	0
	Expected Count	6.6	347.2	510.5	38.7	1650.3	128.6
Energy, Buildings, Transport, Waste, Land Use, Unalloc. A&R	Count	0	4	13	0	0	0
	Expected Count	0.0	2.2	3.2	0.2	10.5	0.8

[17] Source: Authors, using data from Climate Bonds Initiative (CBI,2021).

Energy, Buildings, Transport, Water, Waste,	Count	0	11	65	1	7	46
	Expected Count	0.3	16.8	24.7	1.9	80.0	6.2
Water	Count	3	57	26	4	237	6
	Expected Count	0.8	43.1	63.4	4.8	204.9	16.0
Energy, Buildings, Transport, Water	Count	0	4	36	8	5	38
	Expected Count	0.2	11.8	17.3	1.3	56.0	4.4
Energy, Buildings, Transport	Count	0	9	80	2	0	4
	Expected Count	0.2	12.3	18.1	1.4	58.5	4.6

At last, A Chi^2 test resulted in significant differences between issuer types with respect to the use of proceeds (df=1016, $p < .001$). As seen in Table 16, almost all issuer types are interested in issuing bonds in the energy sector. The building sector also attracted many green bonds following the energy sector.

The reason sovereign issuers issued zero green bonds in the energy sector might be because of the range of their bonds. Sovereign bonds tend to cover a broader range of industries instead of issuing only for a single sector, such as energy or building.

ABS issued more than the expected number of bonds in the building sector thanks to Fannie Mae.

The transportation sector attracted more government-backed entities than the expected amount. Local governments issued green bonds in water-related investments ten times more than expected count; this might show the interest of local governments in water. Readers can also reference table 16 to analyze the actual number of bonds issued in the top ten use of proceeds by issuer type versus expected count.

Table 17 SPSS Crosstabs. Top 10 UoP x Issuer Types[18]

		ABS	Development Bank	Financial Corporate	Government-Backed Entity	Local Government	Non-Financial Corporate	Other Debt Instr.	Sovereign
Energy	Count	93	54	116	157	23	450	52	0

[18] Authors, using data from Climate Bonds Initiative (CBI,2021).

	Expected Count	505.3	61.4	83.4	82.7	53.8	130.0	21.3	6.9
Buildings	Count	1528	3	170	103	40	295	68	3
	Expected Count	1182.2	143.7	195.2	193.5	125.9	304.2	49.9	16.1
Transport	Count	29	6	24	125	52	46	12	0
	Expected Count	157.2	19.1	26.0	25.7	16.7	40.5	6.6	2.1
Energy, Buildings	Count	3	115	63	94	1	23	1	0
	Expected Count	160.4	19.5	26.5	26.3	17.1	41.3	6.8	2.2
Buildings, Water	Count	2638	0	3	3	3	0	35	0
	Expected Count	1434.1	174.3	236.8	234.8	152.8	369.0	60.5	19.5
Energy, Buildings, Transport, Waste, Land Use, Unalloc. A&R	Count	0	0	0	0	0	0	0	17
	Expected Count	9.1	1.1	1.5	1.5	1.0	2.3	0.4	0.1
Energy, Buildings, Transport, Water, Waste	Count	1	51	45	21	3	9	0	0
	Expected Count	69.5	8.4	11.5	11.4	7.4	17.9	2.9	0.9
Water	Count	6	15	5	82	192	31	2	0
	Expected Count	178.1	21.6	29.4	29.1	19.0	45.8	7.5	2.4
Energy, Buildings, Transport, Water	Count	0	38	18	10	1	14	0	10
	Expected Count	48.7	5.9	8.0	8.0	5.2	12.5	2.1	0.7
Energy, Buildings, Transport	Count	0	4	15	7	4	65	0	0
	Expected Count	50.8	6.2	8.4	8.3	5.4	13.1	2.1	0.7

7. Overall Result Finding

The data showed that the green market grew in all regions, with Europe having the most robust growth, while Asia-Pacific and Supranational organizations saw a decrease in their market share recently. Europe, North America, and Asia-Pacific were the top three regions dominated by developed countries. USD and Euro were strong currencies, with the Chinese Yuan being dominant in Asia-Pacific.

Europe was the most robust and diverse region, with France (113bn in USD), Germany (88bn), the Netherlands (53bn), Sweden (40bn), and Spain (34bn) being the top five countries. The United States of America's annual share in North America fluctuated between 97% to 85% over the six years. China was the clear leader in Asia-Pacific. It dominated the region by issuing more than half of the total amount, precisely 54.75%; however, the most dramatic decrease happened in Asian-Pacific's financial corporations. Their total annual issuance, in USD, peaked in 2018 and decreased by almost 60% in three years. Japan issued 10.8% of the amount and became another big player in the region.

Other developing countries and Africa had poor performance, and Supranational organizations saw slight improvement in annual total amount issued, but their market share declined. Latin America and the Caribbean's performance had been poor; however, after 2018, the LAC region gained momentum and put the region in competition with Supranational organizations.

In Asia-Pacific, the average size of the bond peaked in 2016 ($459 million) and decreased to $180.8 million in 2020. In Europe, the average size peaked in 2018 ($410 million) and decreased to $292 million in 2020. For North America, the graph was the opposite; the average bond size dipped in 2017 ($39.5 million) and increased to $79.6 million in 2020.

Over the six years, statistical results showed that the size of the average bond in North America was significantly smaller than in other regions except Africa. The average bond size in Europe is significantly bigger than in other regions except Africa. No significant difference was found in the average bond size between Africa and other regions.

The number of sovereign bonds issued by France and the Netherlands was statistically more than the expected count. Local governments in the United States and Canada statistically issued more bonds than expected count. The number of bonds issued by development banks was significantly more than the expected count in Germany and Supranational Organizations. Among leading countries, only in the United States, the number of ABS types of bonds was significantly more than the expected count.

Energy, transport, and building sectors stand out as the primary use of proceeds. Statistically, the number of bonds issued in the building sector was higher than the expected count in North America, and the number was significantly higher in the energy sector in Asia-Pacific and Europe.

8. Discussion

The analysis of the database presented in this research serves as a significant contribution to the ongoing discussion surrounding the structure and dynamics of the green bond market. As highlighted in this study, there is a considerable degree of uncertainty about the green bond market, making it essential to present a comprehensive and reliable database to facilitate further exploration and understanding. By systematically analysing and presenting the data on green bond issuances, this research lays the foundation for future studies to investigate and test common theoretical assumptions about the green bond market.

One of the key aspects of this database is its novelty, as it offers a detailed market expansion structure for researchers and policymakers interested in the green bond market. This unique feature enables the database and the analysis to be used as a valuable tool for evaluating the role of green bonds in promoting sustainable development and mitigating climate change. Furthermore, the study sets up the capacity to address the critical question of whether the green bond market is genuinely "green" by providing a solid foundation for examining the relationship between green bond issuances and the actual reduction of greenhouse gas emissions.

A key insight was presenting the leading countries in green bond market: the United States, China, France, Germany, the Netherlands, Sweden, Spain, Canada, Japan, and Italy were identified as the top ten countries, respectively. Europe, North America, and Asia-Pacific were clear leaders among the regions. Among the top issuers, the European region positively distinguished after 2018. On the other hand, Asia-Pacific slightly lost its momentum in 2019, and North America's total amount was stagnant in the last two years. The European region stood out as the main driver of the market expansion between 2015 and 2021 based on our analysis.

The test statistic unveiled several noteworthy results. One of which was the average bond size. The average bond size in Europe was significantly bigger than the other top regions. On the other hand, our research indicated that the average size of bonds in North America is significantly smaller compared to other major regions. This is mainly due to the fact that Fannie Mae has issued too many small green bonds in North America, leading to a significant difference in the

average bond size in this region. Based on the tests run by country and the issuer types, this research concludes that regional proximity might affect the approach of the countries while issuing green bonds. Closer proximity countries showed similar characteristics when issuing green bonds. In the use of proceeds, energy outperformed in every region except North America. Building proceeds outperformed only in North America. At the same time, the energy sector attracted many issuer types, buildings capital mainly raised by asset-backed securities thanks to Fannie Mae. Government involvement in the transportation sector was notable as well.

Climate Bond Initiative (2021) and European Investment Bank (2022) argued that the green bond market expanded significantly in the last six years; our detailed analysis supports this. Furthermore, this analysis reveals the details of this expansion. Contrary to the findings of CBI (2021) and EIB (2022), our research suggests that the expansion in the green debt market did not bring benefits to a large number of countries, especially developing countries. Instead, it was primarily benefited by a select few, primarily developed, nations. We called this "*concentration.*"

The concentration of the market around several big players raised questions about the market's diversity and robustness. This study shows that there has been a lack of diversity in the green bond market. Only a limited number of countries prioritized green bond issuance; therefore, the top ten countries- the United States, China, France, Germany, the Netherlands, Sweden, Spain, Canada, Japan, and Italy, respectively- raised almost 75% of the total green bond capital. Likewise, capital distribution was uneven among the top ten countries as well. The top 5 countries issued around 58%, and the top two issued about 33% of the total green bond capital between 2015-2021. Concentration not only happened between countries but also occurred within the countries. Fannie Mae dominated the US green market, and financial corporations were almost half of the China green bond market. Our findings about China's strong performance also align with Elliott and Zhang's (2019) claims. They indicated that China's green bond market is steered by the People's Bank of China. Our results present another significant concentration in the green bond market. The top four external reviewers- Cicero, Sustainalytics, Vigeo Eiris, and ISS-ESG, had about 93% market share in the opinion market between 2015 and 2021.

The findings in this study support our assumptions based on institutional theory and priority of sustainable finance theory. Building upon the institutional theory framework adopted in this research, the findings of this study confirm our initial assumptions regarding the leadership role of North America and Europe in the green bond market. The data analysis revealed that these regions, characterized by their strong financial infrastructure, regulatory frameworks, and established market norms, have indeed dominated the green bond market. This outcome aligns with the institutional theory, which emphasizes the impact of institutional factors in shaping market dynamics.

The other theory this study support is the priority theory. This theory suggests that how much an economic agent works towards achieving sustainable finance goals in a region reflects how important the sustainable finance agenda is considered. (Wilson, 2010; Ozili, 2022). Our study demonstrates that the countries in Europe region prioritizes their green bond agenda more than other regions. In light of this theory, China also overperformed among developing countries. China prioritized green bond issuance significantly more than other developing countries. On the other hand, other developing countries performed poorly, and the African region's total capital issuance was almost invisible in the market.

Banga (2018) suggested that multilateral development banks could be an intermediary in the green bond market; however, our research showed that supranational organizations failed to expand their effect in the market. Their performance was stagnant over the six years, and their total share in the market shrunk. Laskowska (2019) and Cheng (2022) pointed out that sovereign bonds have had a rapid increase in recent years. Our research not only confirmed their findings but also highlighted the European region’s leadership in issuing sovereign bonds. Furthermore, Bansal (2022) emphasized that India had several obstacles in green bond markets. Our analysis aligns with Bansal’s statement. Between 2015 and 2021, India’s share in the Asia-Pacific was just under five percent. In this research, it was highlighted that the LAC region had gained momentum in the last years and put the region in competition with Supranational organizations. This statement supports Bernabé Argandoña’s (2022) findings claiming that green bonds are gaining more and more importance in Latin America and the Caribbean (LAC).

This study has shown that the green bond market has expanded over the years; however, it did not bring benefits to a large number of countries or regions. Especially in recent years, the expansion was driven by several countries in Europe. The concentration of the market was visible on many occasions, creating a lack of diversity in the overall market. Also, our research indicated that supranational organizations failed to be intermediary agents to raise capital within these six years.

8.1 Limitations

Unique challenges were brought about by working with a large dataset. Therefore, our research will be concluded by presenting the main limitations and questions that could be asked by future researchers.

First, the dataset was extensive and comprehensive, having 8111 bonds and another debt instrument, each having twelve different variables to analyze. Our time was indeed limited to analyzing this dataset. Therefore, only some noteworthy occasions were presented in this research.

The other limitation of the present research is that the database utilized in this study focuses solely on self-labeled bonds, including but not limited to green, sustainable, and ESG bonds. Therefore, it may fail to capture bonds that issuers allocate toward environmentally friendly projects without explicitly labeling them as green. In many cases, issuers might choose not to obtain the green label for their bonds, as obtaining third-party verification can increase the cost of issuance. This decision may stem from a desire to avoid the additional expense while still allocating the funds raised toward climate change mitigation efforts. Therefore, it is important to acknowledge that the database's scope may not fully capture the true extent of the market expansion, as it potentially excludes bonds that contribute to environmental sustainability without bearing the green label. This limitation should be taken into account when interpreting the findings and drawing conclusions about the overall expansion of the green bond market.

The use of proceeds was another limitation. It was known where the issued money was used or would be used, but the exact portion of the money used in a specific sector was not known. For

instance, if $1 million was issued to be used for Energy, Buildings, and Transportation, the exact distribution of the money among sectors was not known due to the limitation to reaching more data.

Also, the researchers were not involved in collecting and recording the dataset; they relied on Climate Bond Initiative's work to collect, screen, and record the data. They cannot say that CBI screened, collected, and recorded each eligible green bond issued between 2015-2021, or they cannot say each recorded bond was eligible as a green bond. They did not get involved in this data collection process. However, CBI's data collection methodology was extensively explained in the methodology section. Furthermore, having an extensive dataset does not mean that CBI was able to record every eligible bond during this period. Especially collecting data could be more complex for developing and non-developed countries due to a lack of infrastructure and resources.

CBI's exchange rate to convert the local currency to USD was based on the bond's issuance date. If the bond was issued on June 12th, 2019, CBI took the rate on this date to convert the issuance amount into USD.

At last, the data used in this research covers until the end of 2020; therefore, other researchers could use this research to compare the market's performance after Covid-19. Since this research does not have the data for 2021, 2022, and 2023, this will be a question for another research.

8.2 Further Questions

Several questions were left unanswered in our research due to the lack of resources. These questions could be a good area for researchers to explore.

The first future question would be about the effectiveness of the green bonds. How can this comprehensive database and analysis of green bond issuances provided in this study be utilized to assess the effectiveness of the green bond market in driving genuine environmental improvements and reducing greenhouse gas emissions?

The other future research could be about government involvement. Different levels of government are involved in government involvement in the regions. For example, local governments were found to be more active in North America than in other regions, but in Europe, it was noticed that Sovereign bond issuance was more influential than in North America. The reasons for this difference and how it affects the efficiency of the issued money are to be explored.

The other question that was raised was about China. In the last years, leading issuer types lost their momentum, and it was wondered if China would be able to maintain leading the Asia-Pacific market. What caused the loss of momentum in China and how this would affect the global green bond market if China could not keep the momentum are also to be explored.

Another question was raised for the United States of America—the total issued amount heavily depends on Fannie Mane. How does this dependence possibly affect the sustainability and resiliency of the green bond market in the USA?

A broader question was raised regarding the green bond market's concentration. On several occasions, it was demonstrated that the market depends on particular players, and there are questions about the market's resiliency in general. It is to be explored whether the failure of one of the influential players could create a global domino effect for the entire market.

9. Conclusion

This research was timely because the green market exponentially expanded in the last decade, and this research will work as an extensive summary of the second part of the decade in the literature. Working with a large dataset, which both increased the research's credibility and our limitations. At the same time, our analyses contributed to the literature by pointing out the regions and countries' momentums, strongness, and weaknesses in the green bond market. Policymakers, researchers, and sustainable finance professionals could use our research to understand the green bond markets better to develop future policies and strategies.

9.1 Comprehensive and Novel Database

The presenting this comprehensive and reliable database on green bond issuances is essential for facilitating further exploration and understanding of the green bond market's structure and dynamics. It lays the foundation for future studies to investigate and test common theoretical assumptions.

9.2 A Highly Concentrated Market

Another significant comment was that the overall market drastically expanded between 2015-2021; however, this increase overwhelmingly happened in several developed countries.

As stated earlier in the research, the green bond market was concentrated in developed countries, raising questions about tackling the complex environmental problems in developing and undeveloped countries. Europe was the fastest growing region in total amount (in USD) of issued bonds. Africa’s and LAC’s share in total amount was not substantial. Even though developing and undeveloped countries need funding to fix their environmental issues, they are not strongly present in the green bond market at all.

The top ten countries raised about 75% of the total green bond capital. Likewise, capital distribution was uneven among the top ten countries as well. The top five countries issued

around 58%, and the top two issued about 33% of the total green bond capital between 2015-2021.

Moreover, our results presented another significant concentration in the green bond market. The top four external reviewers- Cicero, Sustainalytics, Vigeo Eiris, and ISS-ESG, had about 93% market share in the opinion market between 2015 and 2021.

9.3 Supporting the Theories

The study's findings support the assumptions based on institutional theory and the priority of sustainable finance theory. This highlights the importance of considering institutional factors and policy priorities when examining the green bond market's evolution and potential future trajectory.

9.4 The Role of Supranational Organizations

This research shows that supranational organizations have not been effective as intermediary agents in the green bond market, as their performance has been stagnant, and their market share has shrunk. This indicates a need for a re-evaluation of the role of these organizations in promoting the green bond market and addressing the market's concentration and lack of diversity.

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Appendices

Appendix A

Climate Bonds Initiative's Sector Screening Tables

Table 18 Details of Screening of the Sectors[19]

Energy	
Solar and Wind Energy	• Offshore solar and wind power generation • Onshore photovoltaic and concentrated solar heat & power generation, provided there is no substantial backup generation from fossil fuel sources • Onshore wind power generation, provided there is no substantial backup generation from fossil fuel sources • Dedicated infrastructure, manufacturing (supply chain), storage and transmission
Geothermal	• Geothermal electricity (further considerations apply for some countries – see below) • Dedicated infrastructure, manufacturing (supply chain), storage and transmission
Bioenergy	• Facilities producing biofuel, biomass, biogas from wood industry by-products, waste, or sustainable feedstocks (preferably certified under schemes such as RSB, RTRS, FSC and ISCC Plus or national schemes such as EU RED, UK Renewable Obligation) • Power generation facilities provided biofuel is sourced from sustainable feedstock (excluding timber), for example, biomass power stations, heating/cooling facilities, combined heat and power (CHP) and electricity generation facilities (including those with CCS) • Dedicated infrastructure, manufacturing (supply chain), storage and transmission
Hydro	• Power generation facilities without a reservoir (e.g., run-of-river) or built without adding reservoirs, impoundment, and pumped-storage facilities • Power generation facilities with new reservoirs which have a high-power density (preferably >5W/sqm or higher) or low emissions of electricity generated (preferably up to 100gCO2e/kWh), unless controversial due to loss of habitat/biodiversity and/or displacement of people or with weak social/environmental impact assessment (if publicly available). • Dedicated infrastructure, manufacturing (supply chain), storage and transmission
Marine renewables	• Tidal, wave and other energy generation using ocean thermals, salinity, gradients, etc.

[19] Source: (Climate Bonds Initiative, 2020)

	• Dedicated infrastructure, manufacturing (supply chain), storage and transmission • Marine heating and cooling facilities using ocean thermals (assumed to provide a reduction in gCO2e/kWh compared to fossil fuel alternatives)
Transmission, distribution and storage	• Transmission infrastructure needed to integrate renewable energy or energy efficiency systems and their load balancing (e.g. overhead transmission lines, conductors, insulators, towers) and infrastructure (e.g. buildings, fences, earth mats, busbars) • District heating network fed primarily by renewable energy • Products such as smart systems/meters, smart grid, off-grid power units, home storage batteries, supercapacitors, hydro and thermal heat storage, voltage regulation equipment, transformers, and switchgear • Large-scale energy storage facilities, batteries, Capacitors, compressed air and flywheel plants, supercapacitors, and related manufacturing
	Assets need further review
Geothermal	• Geothermal electricity in Turkey, New Zealand, the USA and Canada, where gas emission levels from extraction typically require further assessment • Geothermal heat pump (GHP) technology
Bioenergy	• Biofuel blending facilities • Biomass power stations if GHG emissions are more than 100gCO2e/kWh • Supply chain facilities related to blending facilities
Nuclear	• Power plants and dedicated supporting infrastructure (excluding uranium mining), but safety and social aspects need to be considered • Uranium mining and supporting infrastructure.
	Ineligible assets
Fossil fuels	• Coal/oil/gas with or without carbon capture and storage (CCS) • Coal/oil/gas-powered combined heat and power (CHP) • Coal/oil/gas mining/extraction, refining, processing, and associated supply chain infrastructure
Energy efficiency	• Efficiency upgrades to GHG-intensive power sources, e.g. so-called “clean coal.” • Energy savings in fossil fuel extraction activities and anything that helps to extend the life of fossil fuel usage
Transmission	• District heating fed primarily by non-renewable energy sources
Bioenergy	• Power generation facilities using timber (except for waste wood) • Traditional biomass use, such as a three-stone fire for heating and cooking in the residential sector
Onshore solar & wind	• Onshore solar generation facilities if more than 15% of the power generation are backed up by fossil fuel sources

Buildings	
Buildings and built environment	• Buildings which are EDGE certified, net zero energy, Passivhaus or Living Building Challenge Certified • Commercial, residential and special-purpose public properties (e.g. hospitals, schools) upgrades/retrofits aiming for a substantial energy performance improvement and/or improving emissions performance • Buildings meeting well-established, widely used building industry certification schemes such as LEED, Miljöbyggnad, BREEAM, DGNB, China Green Building Label, CASBEE, and NABERS), with the lowest level excluded for those that have levels. • Properties achieving a substantial further reduction in energy use compared to the baseline requirements under the domestic building regulations/code • Properties with EPC ratings of D and above in the EU (where A is the highest and G is the lowest rating) and an equivalent level in other locations • Assets and urban policies/regulations directed at climate change mitigation, such as streetlighting upgrades, passive heating/cooling, car-free areas
Technology, products, systems and manufacturing for building efficiency	• Products meeting industry certification schemes such as ENERGY STAR • Manufacture of energy-efficient components (e.g. LED lighting) • Systems which increase overall energy efficiency (e.g. district heating) • Low-carbon and alternative building materials (e.g. alternatives to cement or concrete) • Building, maintaining, or upgrading utility tunnels for cables and pipes, which improve resource and energy efficiency
	Assets need further review
Buildings and built environment	• Commercial, residential, and special-purpose public properties (e.g. hospitals, schools) upgrades/retrofits not aiming for substantial energy performance improvements, provided there are other targets (e.g. water consumption reduction) and/or properties previously subject to significant energy and water performance improvements • Buildings meeting less well-known or local/regional certification schemes
	Ineligible assets
Buildings and built environment	• Buildings meeting only the lowest level of well-established, widely used industry certification schemes with levels (e.g. LEED Certified) • Properties with EPC ratings of E and below in the EU (where A is the highest and G the lowest) and an equivalent level in other locations

Transport	
Private, Public	• Electric vehicles (EVs), hybrids and hydrogen fuel cell vehicles • Bicycle and public walking infrastructure and schemes

and freight land transport	• Passenger trains; urban rail systems such as metro, light rail, cable cars, trams • Freight railways and rolling stock provided <50% fossil fuel transport • Public transport buses and coaches, bus rapid transit (BRT) • Dedicated infrastructure, energy-efficient products (e.g. batteries, charging stations)
Passenger and cargo water transport	• Electric-powered or otherwise low-carbon (sustainable biofuel, ammonia, hydrogen) • Supporting infrastructure
Passenger and cargo aircraft and aviation	• Electric-powered or otherwise low-carbon (sustainable biofuel, hydrogen, solar, etc.) • Supporting infrastructure
	Assets need further review
Passenger and cargo water transport	• LNG and biofuel vessels are factoring in design and operational energy efficiency improvements, level of GHG and total emission reductions, etc.
Transport logistics	• Sorting centres, smart freight logistics, intermodal freight facilities, ports and associated facilities such as power from shore and multi-modal logistics hubs.
	Ineligible assets
Private, Public and freight land transport	• ICE and CNG passenger vehicles and supply chain (components) • Rail lines/operators when fossil fuels account for more than 50% of freight • New roads, bridges and upgrades, parking facilities, fossil fuel filling stations and other assets which prolong the life and/or increase the ease of use of ICE transport
Passenger and cargo water transport	• Oil tankers, LNG carriers and other vessels transporting solely fossil fuels • Heavy fuel vessels • Support vessels such as jack-up rigs, and supply vessels dedicated to the oil and gas industry
Passenger and cargo aircraft and aviation	• Aircraft using fossil fuel

Water	
Water storage and management	• Rainwater harvesting systems, aquatic ecosystems (lakes, wetlands), aquifer storage, groundwater recharge systems, water distribution systems, infiltration ponds • Gravity-fed canal systems, hydrological restoration • Water-efficient agricultural irrigation systems and water-saving technology
Defences and stormwater	• Flood, sea and drought defence, including pumping stations, levees, gates, ecological retention systems,

management	• snowpack management, wetland storage • Rainwater harvesting, constructed ecological retention ponds, erosion control systems, groundwater recharge, • erosion control systems
Water treatment	• Water treatment, including desalination plants using renewable energy • Water recycling, wastewater treatment, sewage, manure and slurry treatment • Natural filtration systems such as wetlands, watersheds, forests and settling systems
Ecological restoration	• Erosion control, hydrological restoration

Waste	
Circular economy activities	• Recycling of metals, plastics, glass, and paper. Facilities for sorting and recovering materials. • Facilities for the re-use of materials (recycled products, refurbishing, repairing, etc.) • Anaerobic digestion facilities produce biogas from green waste. Composting facilities • Waste-to-energy plants for solid waste incineration with energy capture, pyrolysis/gasification, plasma converter, and anaerobic digestion outside the EU • Collection of waste where it is specified that the waste is to be recycled
Waste disposal	• Adding gas capture to existing, closed landfill facilities
Pollution control	• Carbon capture and storage (excluded for fossil fuel energy)
	Assets need further review
Bioplastics and similar	• Bioplastics and similar products that use biomaterials as a substitute for fossil fuels unless these are derived from other waste products (e.g. sawdust, corn husks etc.). This includes related production facilities, as the concern is that bioplastics divert arable land away from food. • Bioplastic assets /supply chains are only included where these are single polymer (e.g. PET) products that can be easily reused or are home-compostable or municipality compostable only where such facilities exist.
Nuclear waste	• Radioactive waste disposal and nuclear power plant decommissioning
	Ineligible assets
Waste management	• Collection of waste that is going to landfill and where it is not specified if the waste is to be recycled or sent to landfill • Landfill without gas capture or if gas capture is used to extend landfill's life • Waste-to-energy plants for solid waste incineration with energy capture, pyrolysis/gasification, plasma converter, and anaerobic digestion in the EU • Waste incineration without energy capture

Land Use and Marine Resources	
Agriculture	• Sustainable agriculture within the categories of growing non-perennial and perennial crops, animal production, mixed farming, and controlled environment agriculture that reduces carbon and GHG emissions increases soil-based carbon sequestration and improves climate resilience • Reduced water and energy use, verifiable reduced fertilizer use • Supply systems for seed production, distribution and access • Storage for agricultural produce • Equipment, intelligent management systems and technology to manage sustainable agriculture
Commercial forestry	• Natural forests and forest plantations certified under internationally accepted sustainability standards such as FSC or PEFC for large-scale forestry and otherwise sustainably managed forests for small-scale forestry • Production facilities using energy- and water-efficient pulping processes, biorefineries, use of recyclates • Storage for sustainable forestry produce • Primary processing for FSC, PEFC and other certified forestry produce • Equipment, intelligent management systems and technology to manage sustainable forestry
Natural ecosystems	• Natural ecosystem land (managed and unmanaged) • Land remediation, afforestation, and re-vegetation that creates habitat appropriate for the location • Reduced emissions from deforestation and degradation (REDD) • Wild fisheries and sustainable fish farms, machinery and equipment to sustainably harvest fisheries, as well as related primary processing and storage facilities • Marine reserves and marine conservation • Equipment, intelligent management systems and technology to manage ecosystems
Resilience infrastructure	• Dedicated infrastructure for climate resilience, including coastal infrastructure
	Assets need further review
Green spaces	• Landscaping of recreational parks/gardens, golf courses and similar green spaces are unlikely to be included unless carbon sequestration impact is significant and/or their preservation/creation protects biodiversity • Sustainable drainage systems should be evaluated
Agriculture & forestry	• Primary processing for agricultural produce • Primary processing for sustainable forestry produce
	Ineligible assets
Agriculture & forestry	• All agricultural production and commercial forestry on peatland • Timber harvesting except for certified and otherwise sustainably managed forests

Industry	
Energy-efficient products and processes	• Facilities and equipment dedicated to manufacturing energy-efficient components, such as motors and automation systems • Facilities and equipment dedicated to manufacturing energy-efficient products, such as household appliances and equipment (particularly white goods) • Eco-efficiency improvements/cleaner production, e.g. related to cement (e.g. reduced clinker content), iron, steel, chemicals and glass production • Related supply chain manufacturing facilities
Non-energy GHG reductions	• Carbon scrubbers • Carbon capture and storage products (except for fossil fuel power generation)
	Assets need further review
Heavy industry	• Manufacture of steel, aluminum, cement, chemicals, etc.
Non-heavy industry	• Manufacturing and processing of other commodities and goods
	Ineligible assets
Energy-efficient products and processes	• Facilities and equipment dedicated to manufacturing polystyrene and other non-recyclable plastics

Information and Communication Technology (ICT)	
Broadband networks, IT solutions	• Teleconferencing, telecommuting software and services • Fibre optic and cable networks and exchanges • Renewable energy-powered data centres or with low to zero energy usage for cooling
Power management	• Dedicated infrastructure, software, and hardware for remote and in situ power management, such as load balancing, energy monitoring and automatic switching off power systems
	Assets need further review
Broadband networks, IT solutions	• Data centres not powered by renewable energy or not cooled naturally and related hardware and supply chain • manufacturing facilities
	Ineligible assets
ODS refrigerant based cooling systems	• ICT facilities that use ODS (Ozone depleting chemicals)

Appendix B

Top Countries' Issuer Profiles

In this appendix, you will see the top issuer's profile between 2015-2021. Graphs visualize the name of the top issuers in each country; the colour of the bar indicates the type of issuer.

Australia

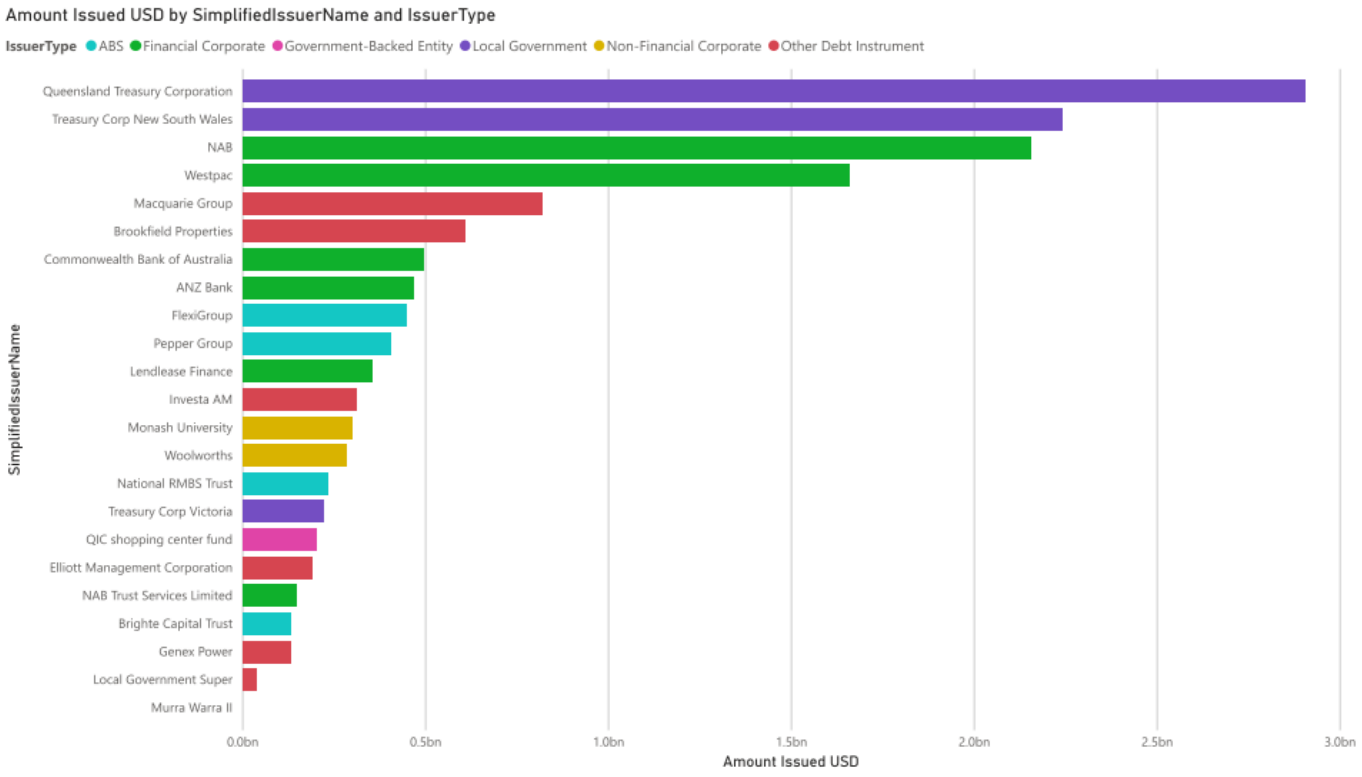

Figure 23. Country profile: Australia

Canada

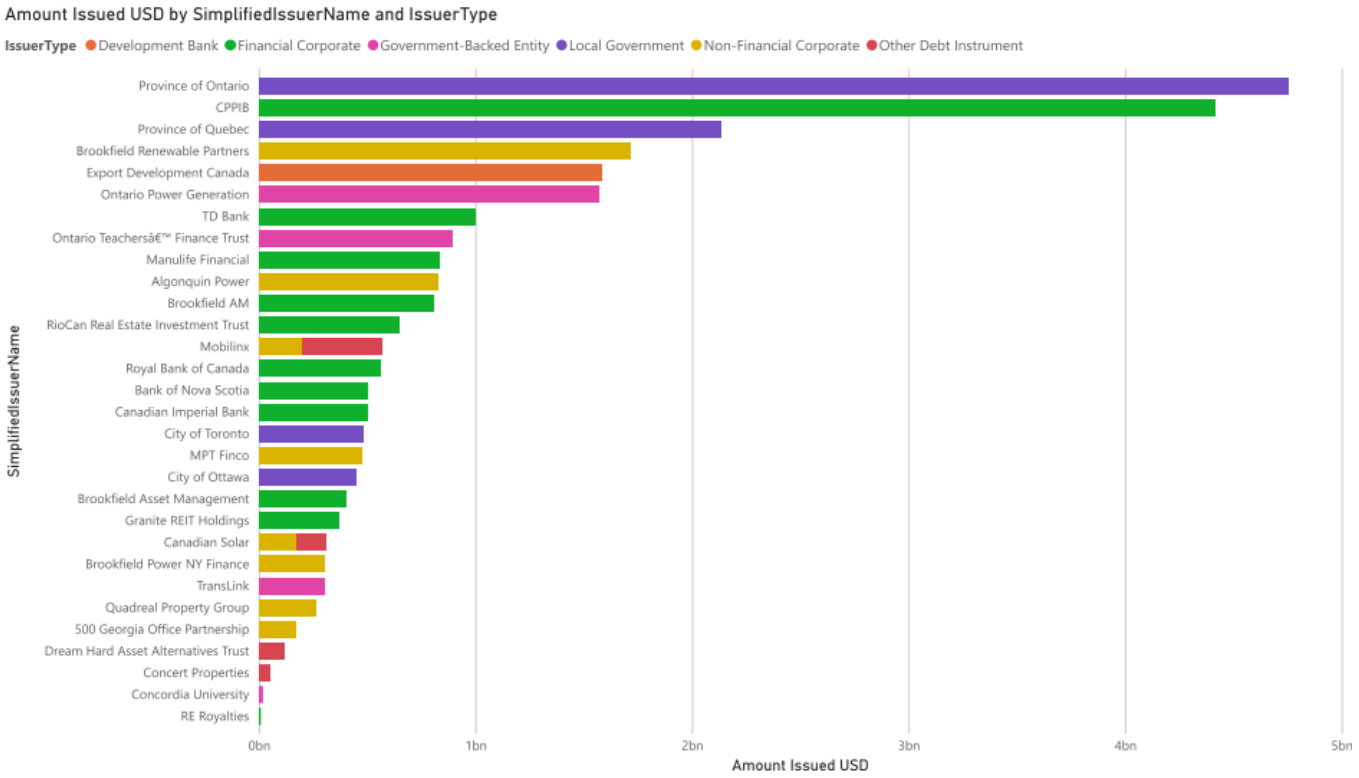

Figure 24. Country profile: Canada

Supranational

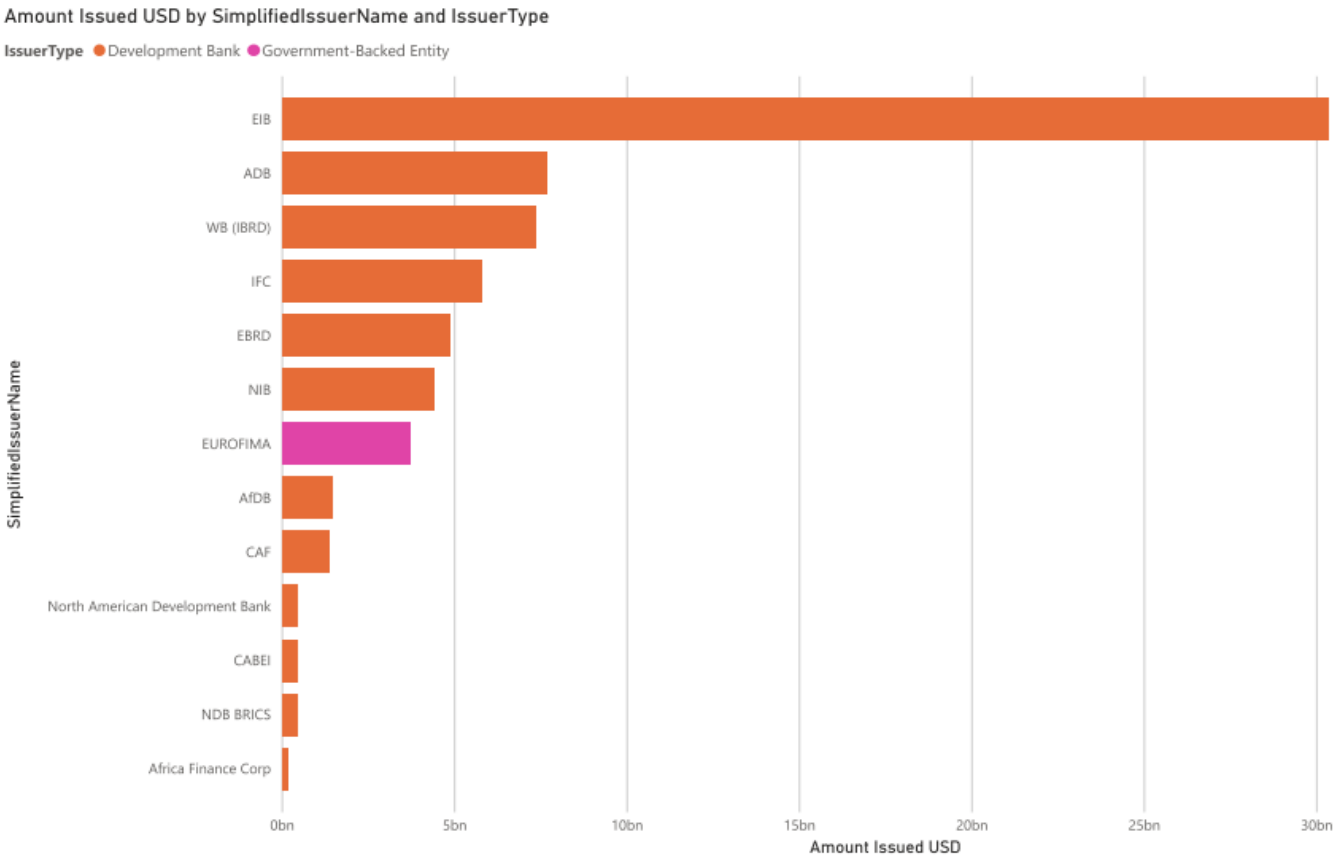

Figure 25. Profile: Supranational

China

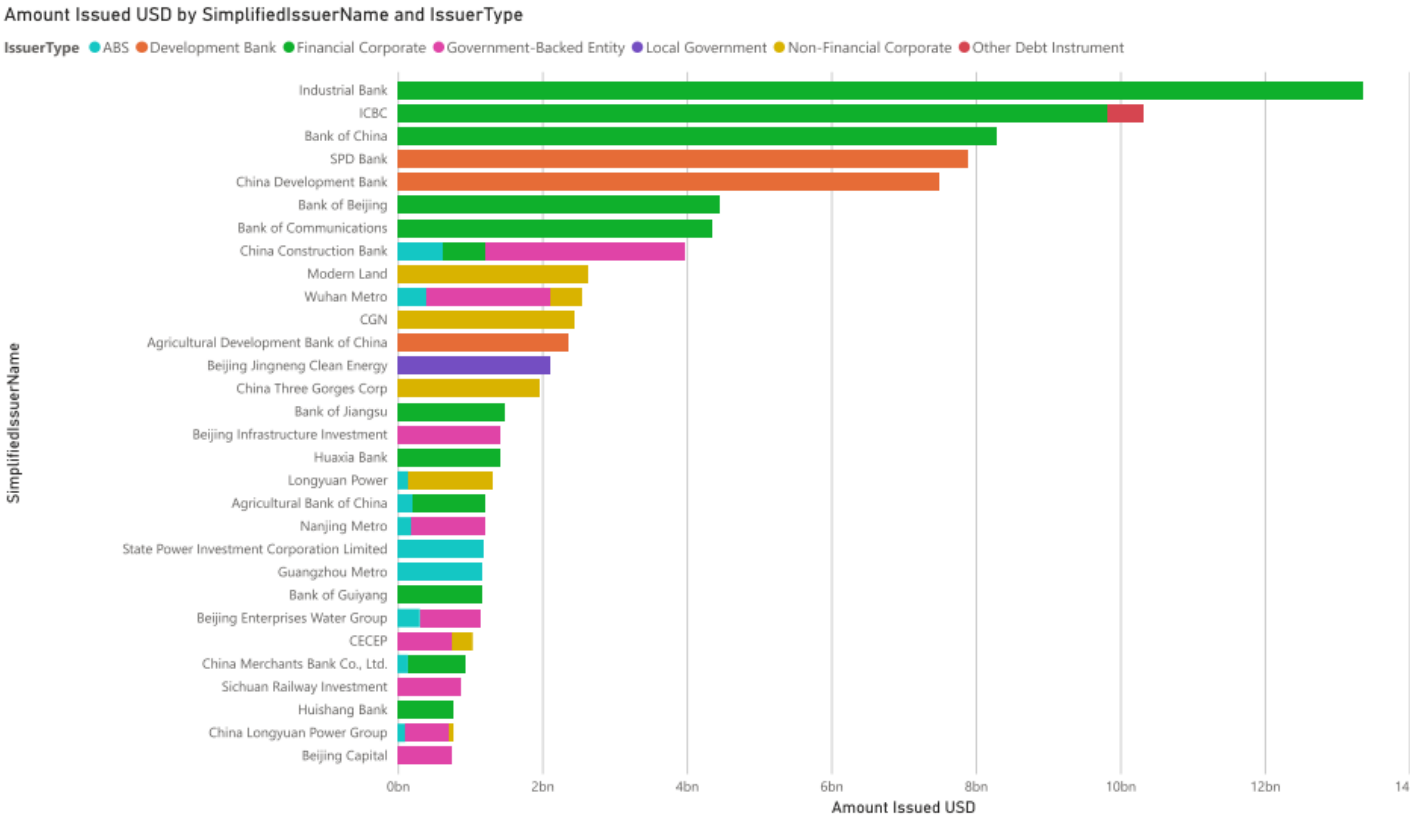

Figure 26. Country profile: China

France

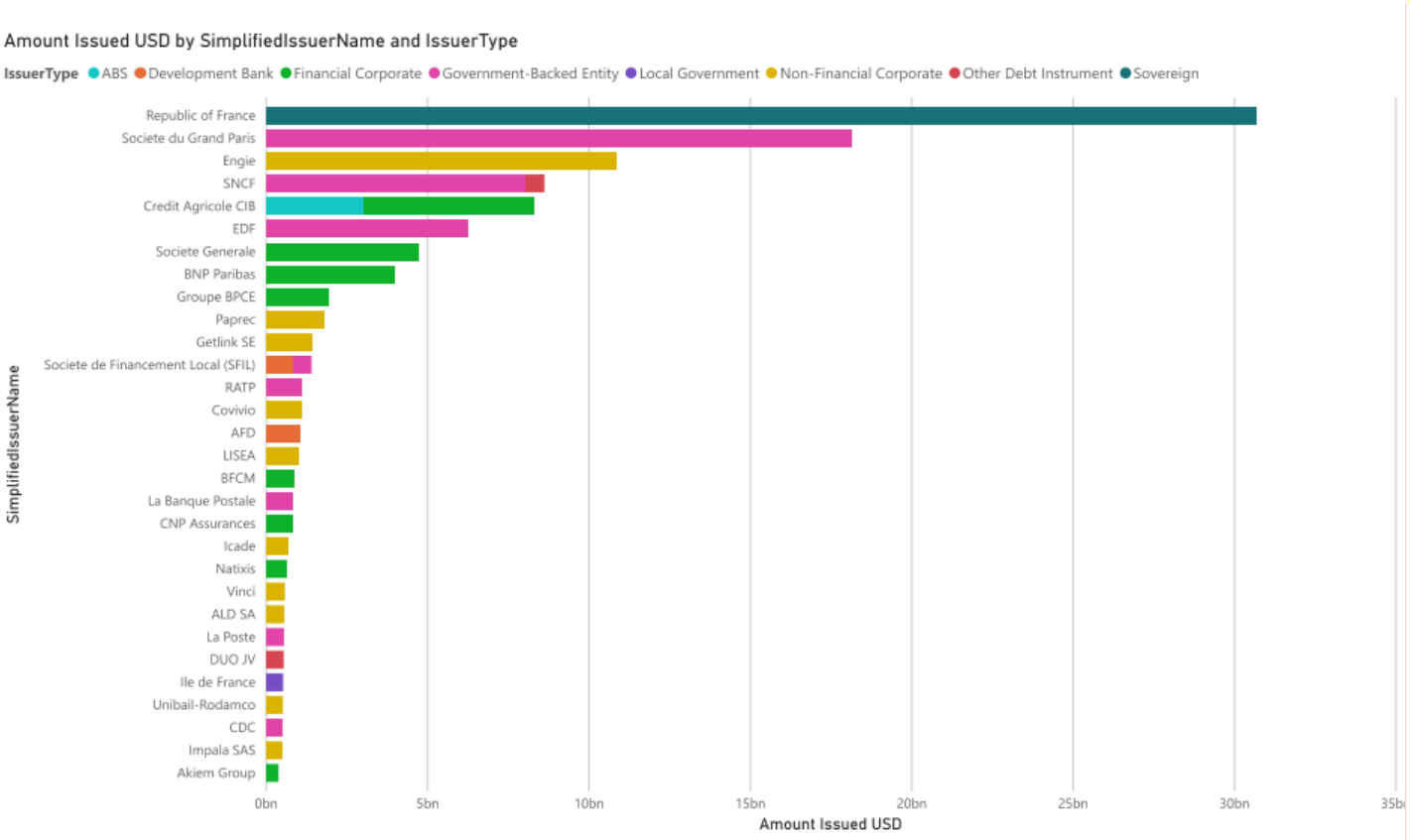

Figure 27. Country profile: France

Germany

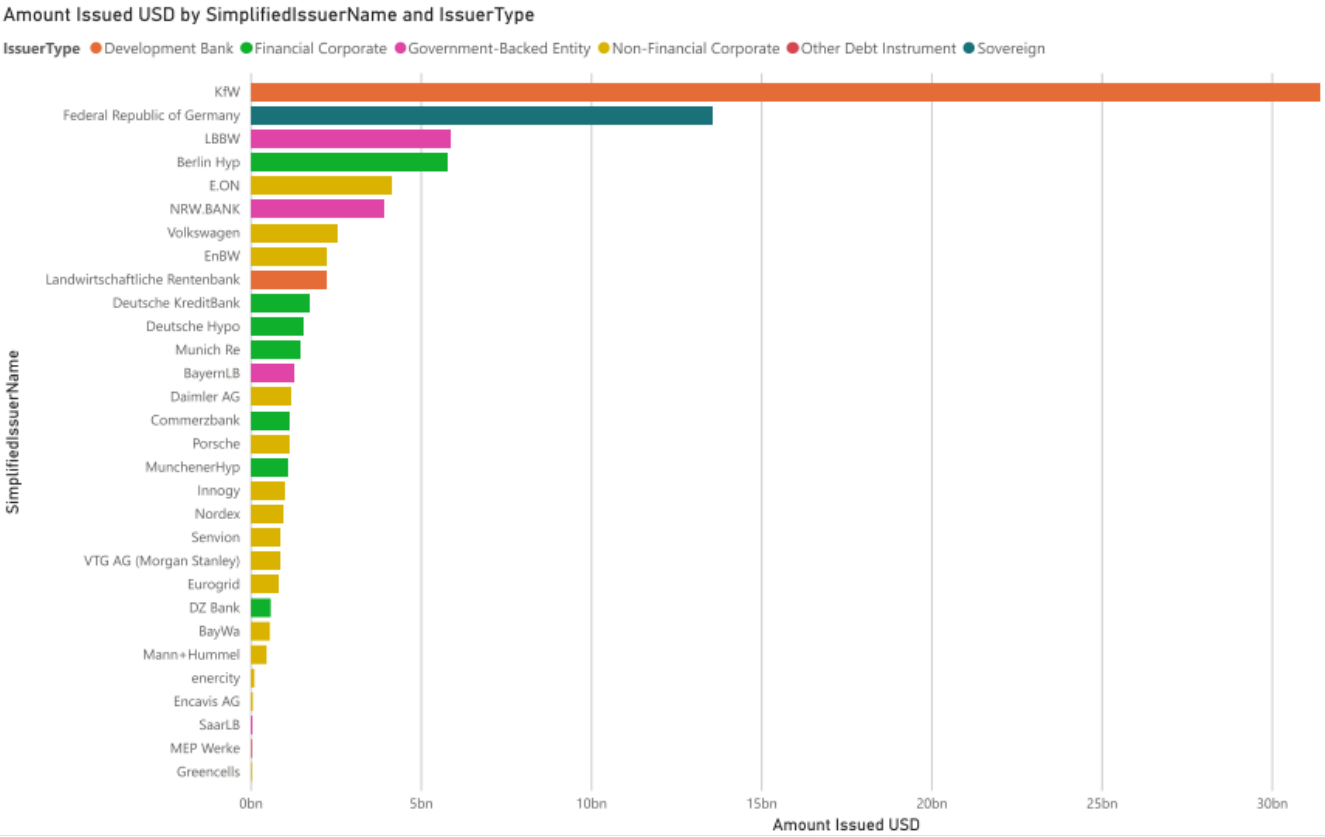

Figure 28. Country profile: Germany

Italy

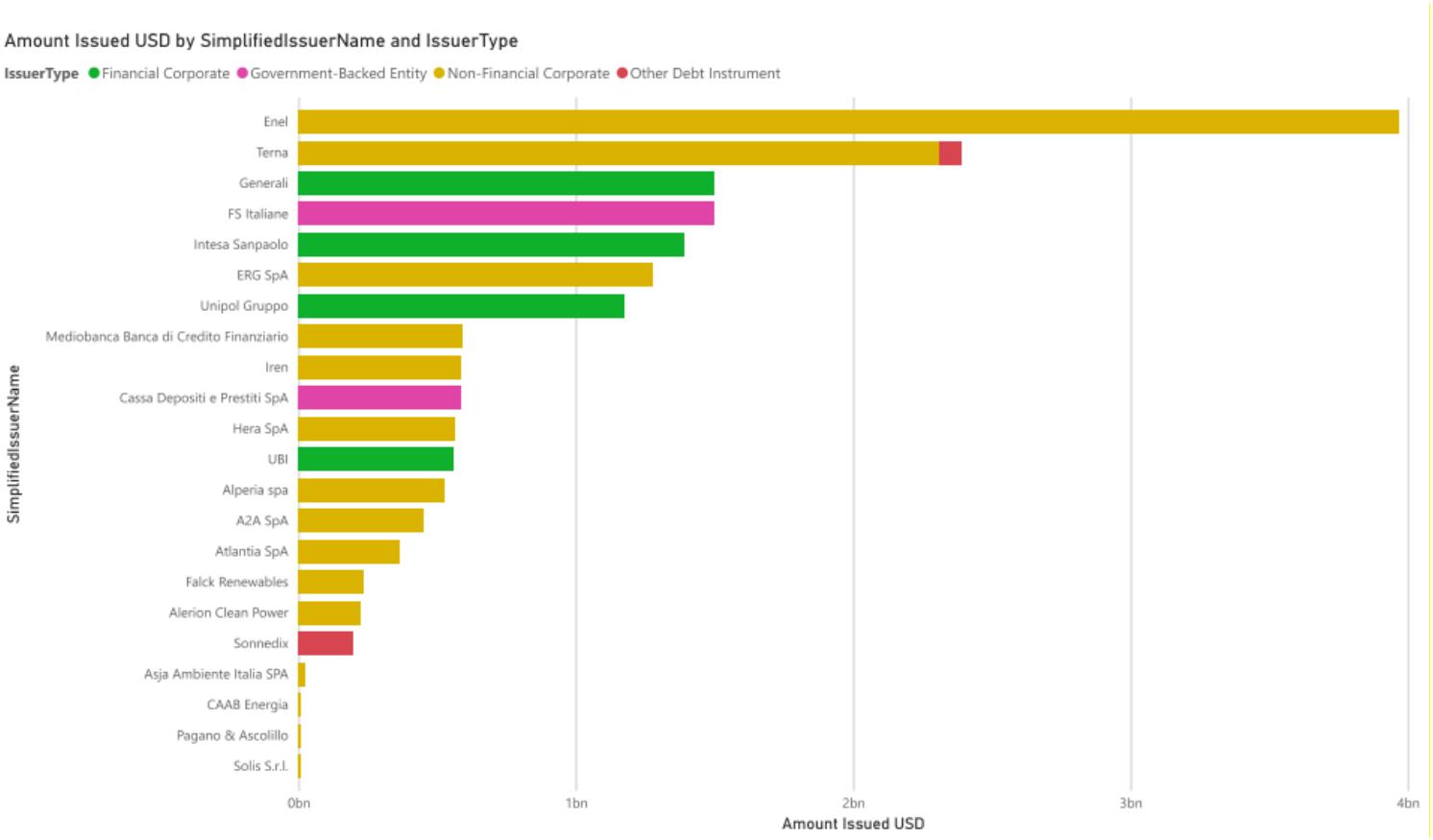

Figure 29. Country profile: Italy

Japan

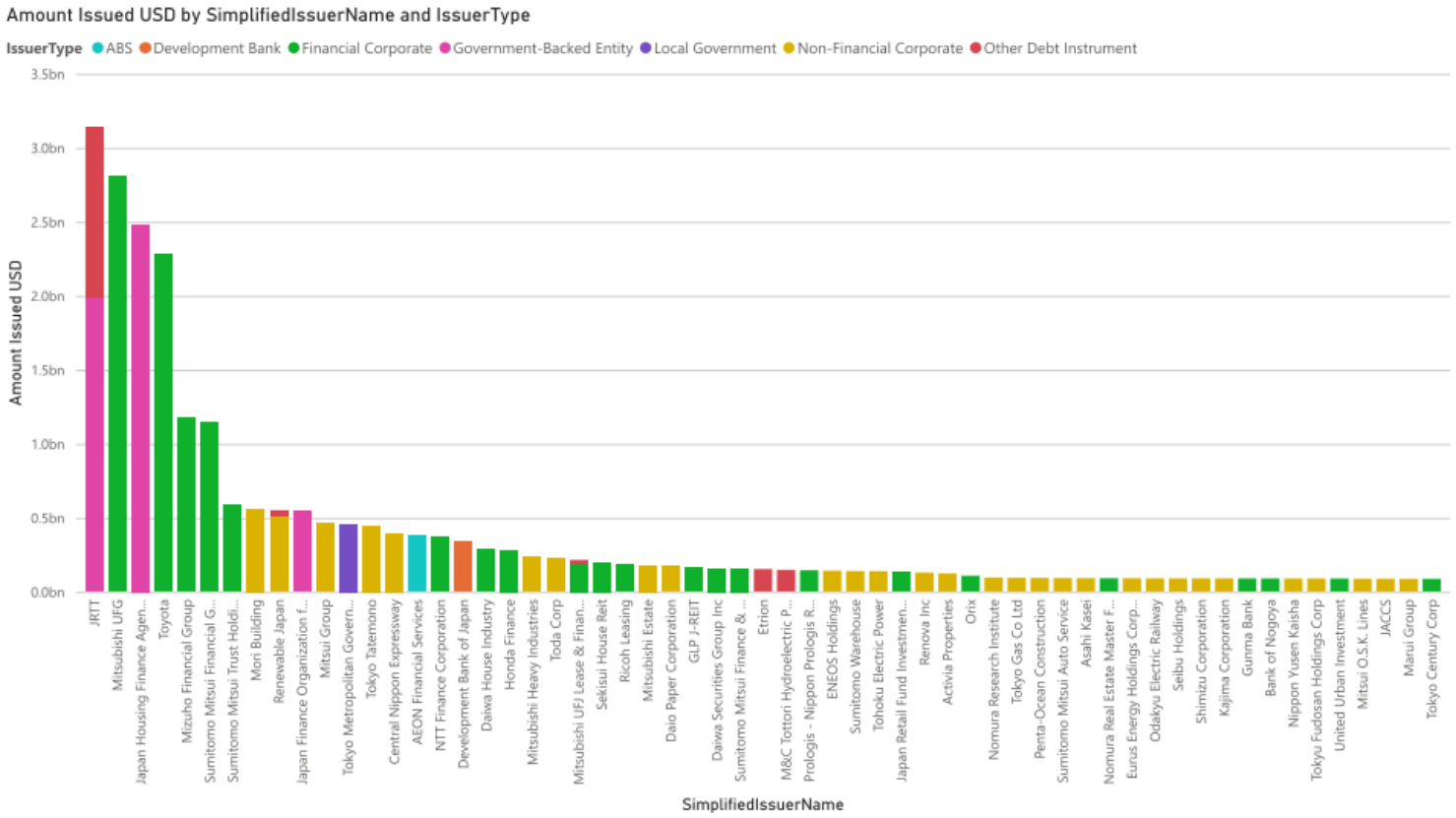

Figure 30. Country profile: Japan

The Netherlands

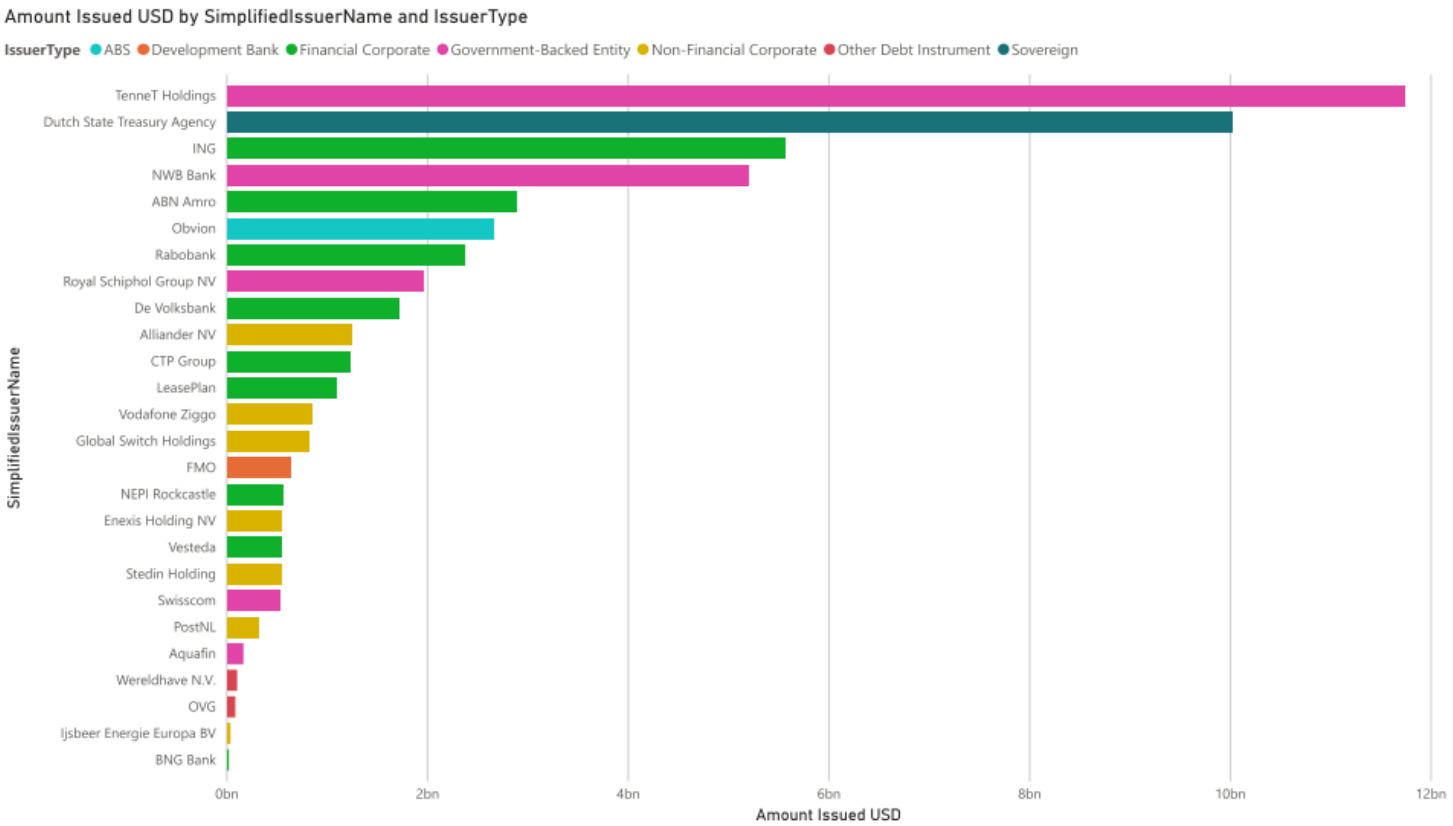

Figure 31. Country profile: The Netherlands

Spain

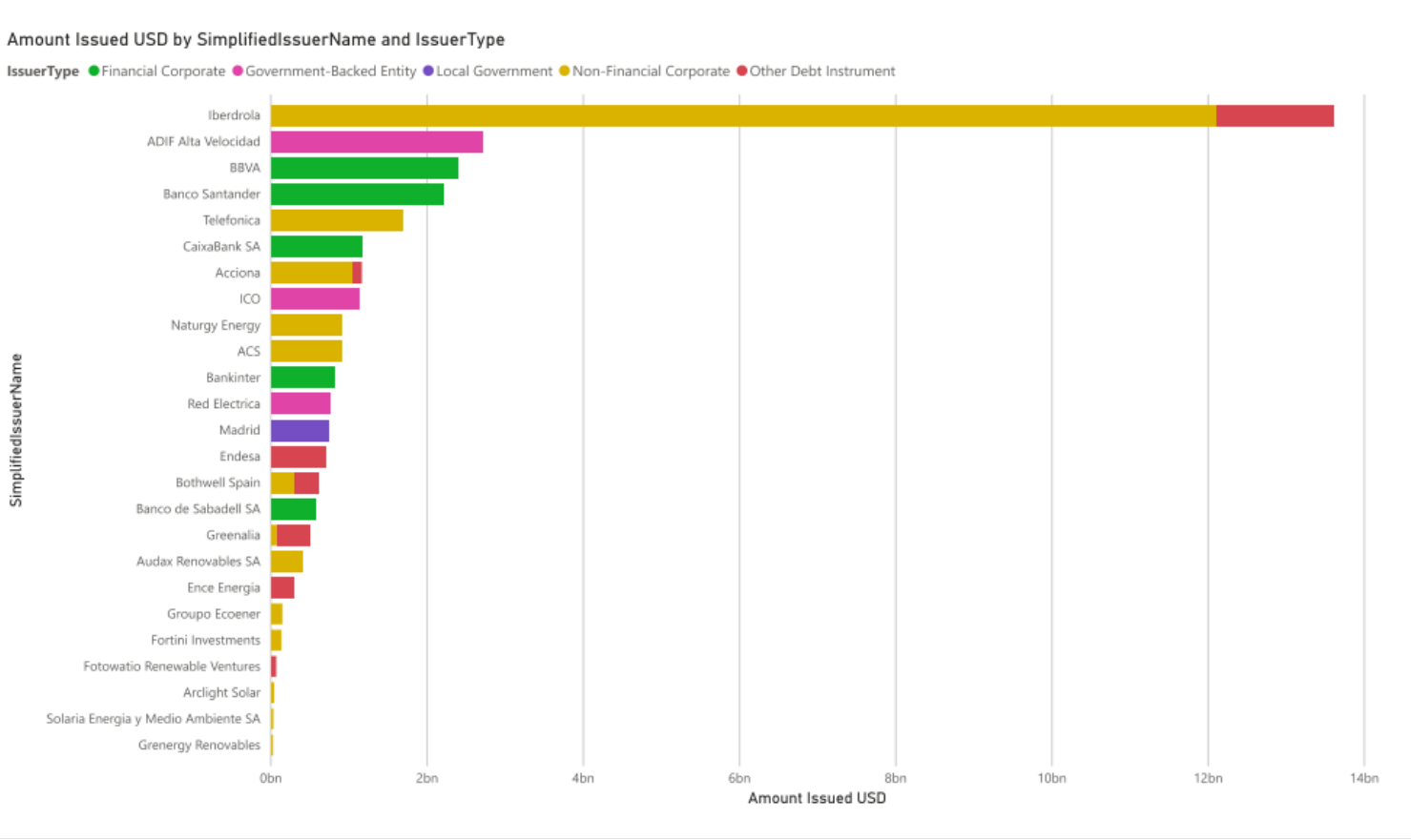

Figure 32. Country profile: Spain

Sweden

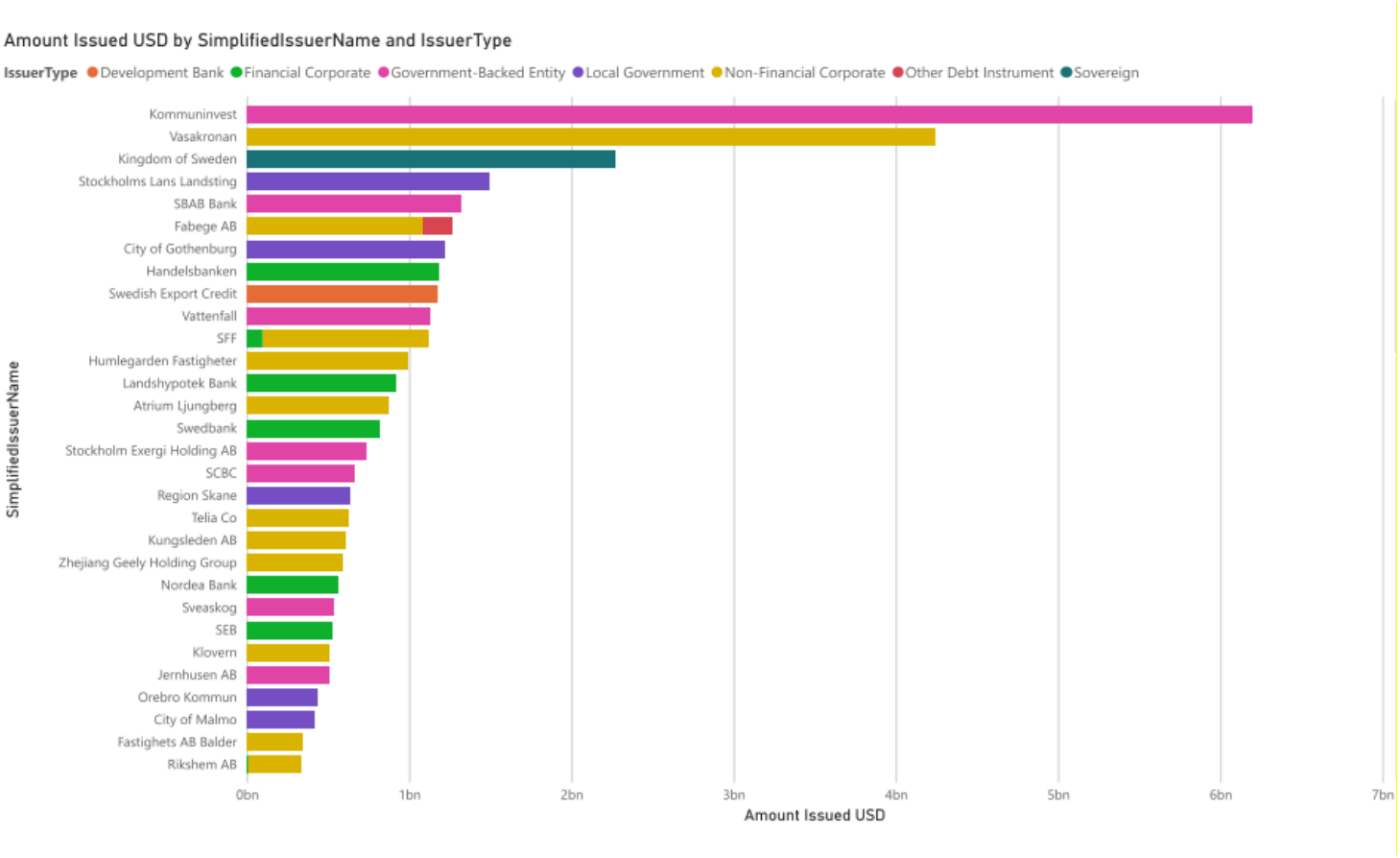

Figure 33. Country profile: Sweden

The USA

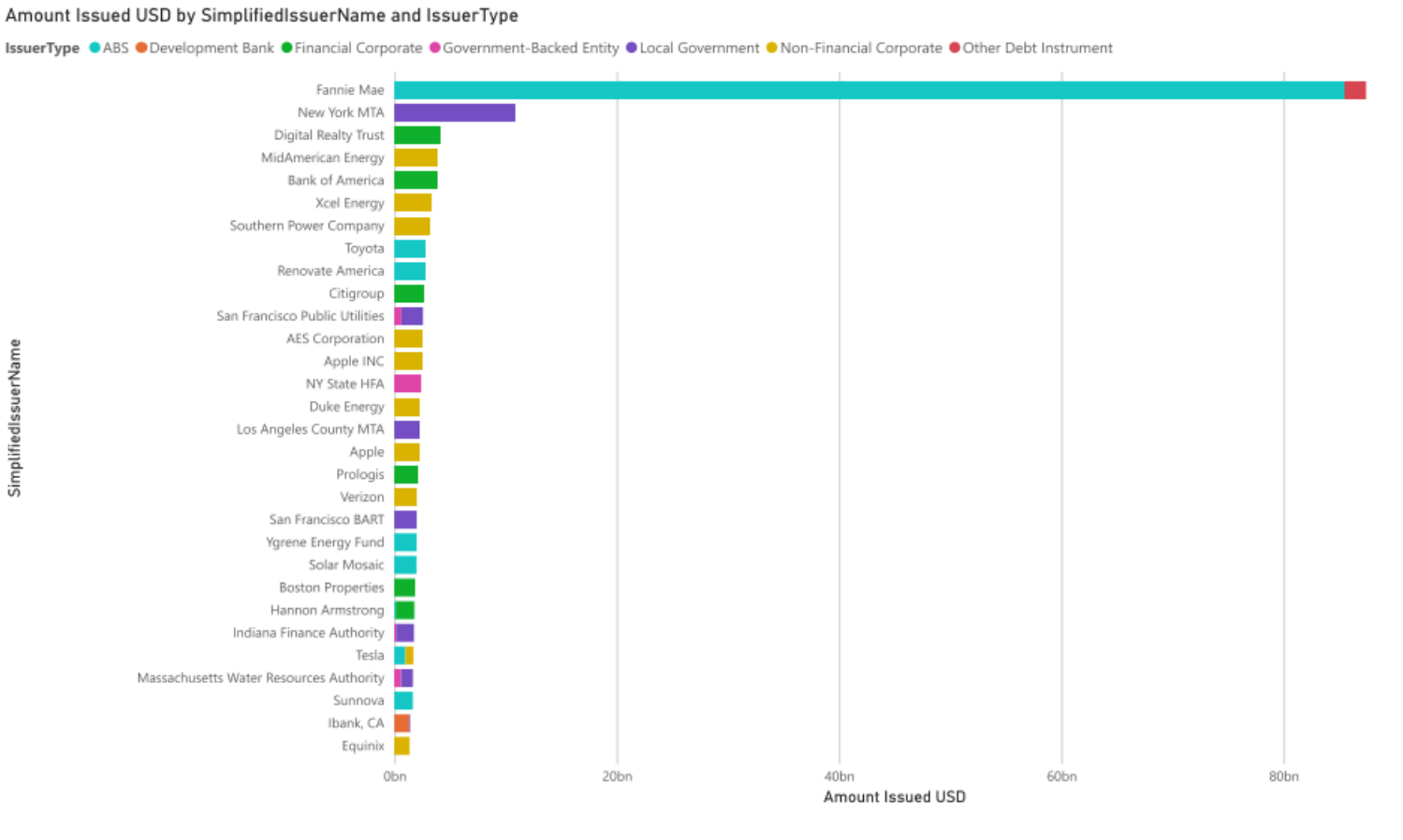

Figure 34. Country profile: The USA

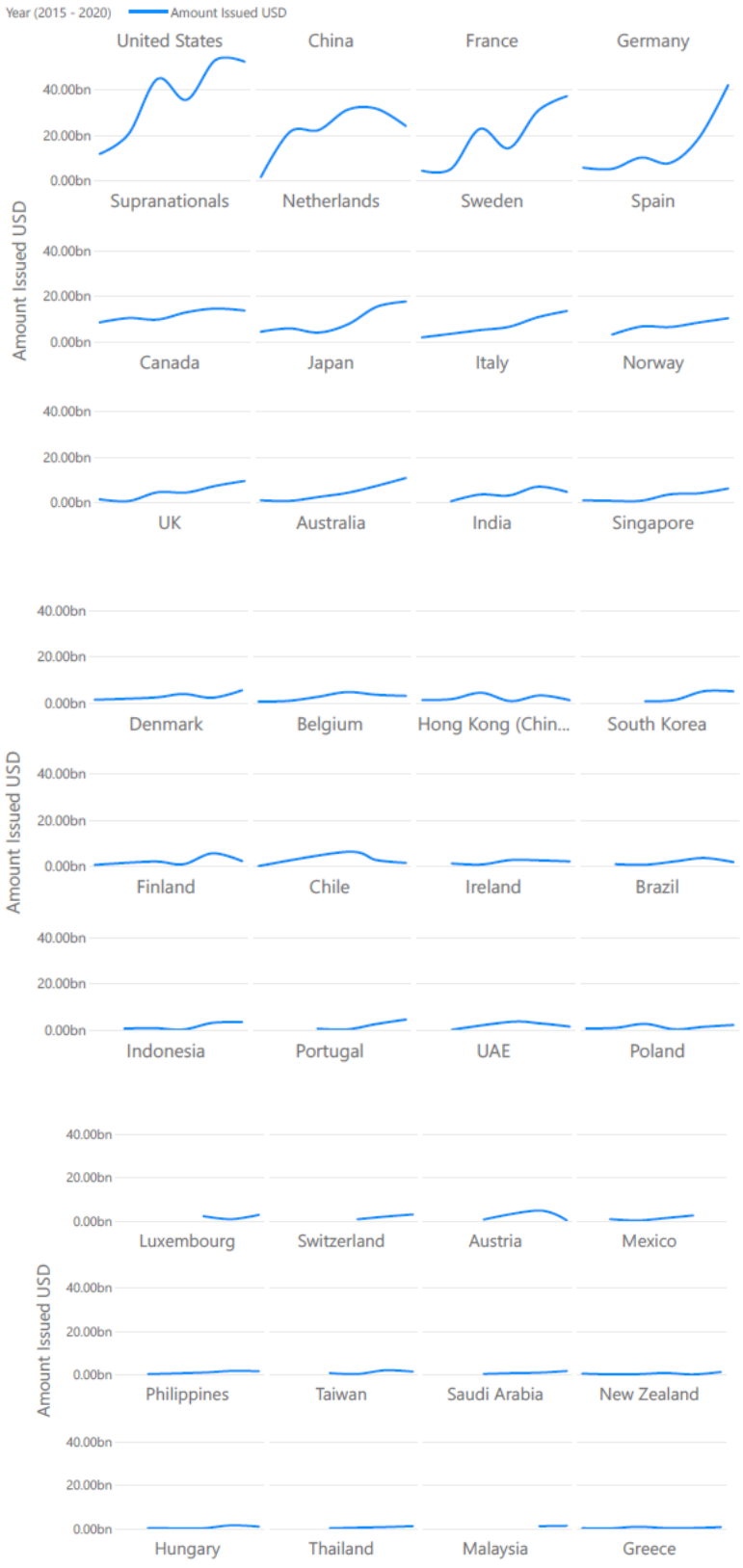

Figure 35. Top countries' performance