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Research Paper

Sustainable Finance in the EU: Macroeconomic Influences on Green Bond Issuance.

Amanda Zetzsche *
Elif Göksu Öztürk **
Cristina Lopes ***

ABSTRACT

This study investigates how macroeconomic indicators, inflation, interest payments, and unemployment rate, and financial market indicators, access, debt, and effectiveness influence green bond issuance by corporates and governments across EU countries. Since the European Investment Bank issued the first "Climate Awareness Bond" in 2007, the green bond market has grown significantly, with Poland and France pioneering sovereign green bonds and private sector participation increasing in 2013. Using panel data, the research examines the relationship between these key economic indicators and the issuance of the green bond in the market at the country level over 10 years. The findings highlight how financial and macroeconomic conditions shape Europe's green bond instruments within the context of the influence of the European Green Deal and the EU's carbon neutrality goals for 2050.

Keywords: Green bonds, Macroeconomic Indicators, Europe, Sustainable Finance, Panel Data

* CEOS.PP, ISCAP, Polytechnic of Porto, Portugal. E-mail: azetzsche@iscap.ipp.pt
** CEOS.PP, ISCAP, Polytechnic of Porto, Portugal. E-mail: elif@iscap.ipp.pt
*** CEOS.PP, ISCAP, Polytechnic of Porto, Portugal. E-mail: cristinalopes@iscap.ipp.pt

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1. INTRODUCTION

According to Yang et al. (2020), government intervention is vital and essential in promoting green development, leading to ample relevant studies. The European Green Deal (EGD) is a bold initiative to secure Europe's sustainable and prosperous future by addressing climate change and environmental degradation. Creating the Sustainable Development Goals (SDGs) aims to preserve and enhance natural capital, promoting a sustainable, fair, and competitive economy across the European Union (Cziesielski et al.2024).

According to Flammer 2021, the green bond market began with the issuance of the "Climate Awareness Bond" by the European Investment Bank (EIB) in 2007. Poland became the first country to issue a green sovereign bond in December 2016, followed by France in January 2017 (Tang & Zhang, 2020). However, since 2013, the market has witnessed the participation of private sector issuers, and they have begun to grow significantly (Flammer, 2021).

At the United Nations Climate Change Conference (COP21) that took place in Paris in 2015, 196 countries agreed to regulate global average temperature increases below 2ºC (3.6 ºF). To achieve the target, Europe develops strategies such as the European Green Deal, aiming to transform the EU into a modern, resource-efficient, and competitive economy and to achieve carbon neutrality by 2050, among other goals (Agliardi & Agliardi, 2019; Wu, 2022). Fixed-income investors are increasingly focused on Environmental Social Governance (ESG) factors, with green bonds potentially impacting more than ESG-related equity investments (Maltais & Nykvist, 2020; Hanson et al., 2017).

Green investments, often driven by expectations of better financial performance, have become a significant focus (Hartzmark & Sussman, 2019). Tiftik et al. (2020) reported that over 90% of green bonds were investment-grade and rated with quality credit ratings such as AAA, AA, A, and BBB. Hachenberg and Schiereck (2018) examined how green bonds were priced compared to conventional bonds. They found no significant overall difference in trading prices between the two types; however, closer analysis revealed that specific factors, such as bond ratings, influenced price differences. Maltais and Nykvist (2020) also identified a new trend among fixed-income investors, focusing on ESG factors that concern companies.

Hanson et al. (2017) noted that green bonds potentially have a greater impact than ESG-related equity investments. Tang and Zhang (2020) explore the benefits to shareholders, demonstrating that the announcement of green bond issuance leads to improvements in short-term firm value, institutional ownership, and stock liquidity. Similarly, Flammer (2021) finds that green bond issuance positively impacts issuing firms' environmental and financial performance, boosting green innovations and attracting long-term green investors.

Despite the companies' efforts, a significant part of the public still perceives business as detrimental to the environment. The topic is particularly relevant in developing countries, where industrialization requires natural resource consumption and waste production (Wang et al., 2020). Additionally, while numerous companies focus on eco-friendly initiatives, some are reluctant to share their environmental successes or release environmental reports (Lyon & Maxwell, 2011). The issuance of corporate green bonds can signal a company's commitment to environmental sustainability, addressing information asymmetry (Flammer, 2021; Lyon & Maxwell, 2011).

In 2017, the Task Force on Climate-related Financial Disclosures released in 2017 provided a framework for consistent disclosure related to climate-related risk and opportunity disclosures (TFCD, 2017). Gianfrate & Peri (2019) stated that in Europe, green bond issuance is expected to rise significantly, driven by fundamental factors, especially after the European Commission's Action Plan: Financing Sustainable Growth. The authors explained that the plan was released in 2018, introducing a unified EU green asset taxonomy, standardising criteria for green investments, and boosting investor confidence.

According to Tang and Zhang (2021), green bonds offer the advantage of expanding their investor base and potentially securing a lower cost of capital and longer maturities compared to traditional corporate bonds from the issuers' perspective. Besides, green bonds fulfil environmental objectives for investors and enhance their ESG scores.

Investors with a pro-environmental preference are willing to pay a higher price and accept a lower return than traditional bonds. Ideally, if issuers' expectations and investors' preferences are adequately reflected in the pricing of green bonds, the likelihood of a negative green bond premium, known as the "greenium", might increase (Agliardi & Agliardi, 2019; Löffler et al., 2021; MacAskill et al., 2021).

The "greenium" indicates lower risks and a lower cost of capital for green bonds relative to their conventional counterparts (Wu, 2022). Löffler et al. (2021) found that green bonds with a "Green

Label" tend to sell at a higher price than those without it. MacAskill et al. (2021) explain that a "negative greenium" occurs when a green bond is traded at a lower yield or higher price compared to a conventional bond with similar characteristics. It suggests that investors are prepared to accept a lower return on investment in exchange for the opportunity to contribute to environmental sustainability.

Regarding the risks, conventional bonds may face long-term climate change threats, such as carbon taxes or other future physical impacts. In contrast, green bonds are not exposed to these same risks. Green bonds come with their unique risks due to uncertainties in developing green technologies and investments in the renewable energy sector. If these risks are factored into pricing, it could reduce the greenium, making green bonds less financially attractive compared to conventional bonds (Löffler et al., 2021).

Despite the growing body of literature on green bonds, most existing studies focus either on firm-level effects of green bond issuance or on investor behaviour in equity markets. Less attention has been given to the macroeconomic, financial, and policy-level drivers that influence the supply of green bonds across countries, especially within the European context. Moreover, while the EU has taken a leading role in green finance through regulations and initiatives like the European Green Deal, the country-level factors that shape green bond issuance remain underexplored.

By this taken, this study contributes to the literature by examining how macroeconomic conditions, financial market development, and climate policy influence green bond issuance across European countries. Unlike firm-level analyses, this paper adopts a cross-country perspective, providing insights into the broader economic and institutional determinants of sustainable finance. By combining descriptive analysis of market trends with an econometric panel data approach, this research offers qualitative and quantitative insights into the dynamics of green bond issuance in Europe.

The remainder of the paper is structured as follows. Section 2 presents a descriptive analysis of the European Green bond markets. Section 3 presents materials and methods, including data and methodology used for the econometric study. Section 4 presents the results from the econometric analysis. Finally, Section 5 concludes.

2. DESCRIPTIVE ANALYSIS OF THE EUROPEAN GREEN BOND MARKET

The primary goal of the descriptive analysis is to identify the key drivers that encourage industries to issue green bonds and to uncover emerging trends and patterns reflected in the graphs over the past ten years. By analysing these developments, the study aims to provide an overview of the European green bond market and, ultimately, to address the following question: How does the green bond market develop across European countries?

For the trend analysis, data were extracted from the Climate Bonds Initiative database, a leading repository of global green, social, and sustainability bond information. After accessing the raw data through their Interactive Data Platform, we organised and filtered the information to focus specifically on European green bond market trends between 2014 and 2023.

Data collection was conducted on a year-over-year basis and included variables such as issuer types, use-of-proceeds categories, currencies, deal sizes, market types, and country-level distribution. The methodology employed descriptive statistical analysis to identify significant patterns, growth trajectories, and structural changes within the market. This approach enabled a comparative analysis across temporal, geographical, and categorical dimensions, revealing both macro-level trends and granular shifts that have characterised Europe's green bond landscape over the past decade.

Figure 1 represents the distribution of green bond issuance across European countries, showing significant volume and market maturity disparities.

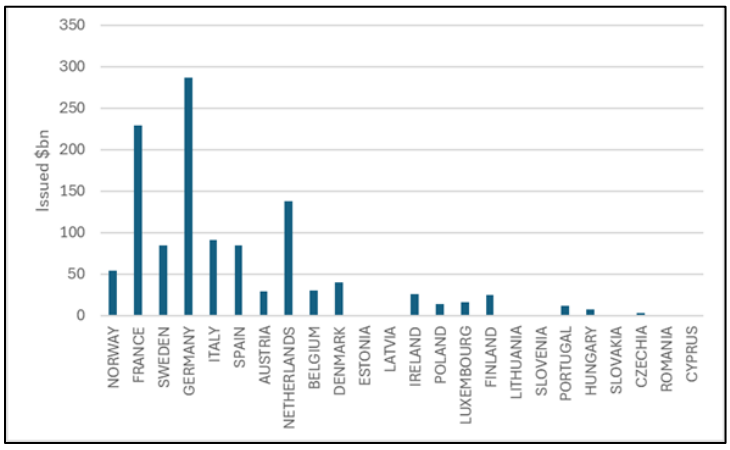

Figure 1. Green Bond Issuance by Country in Europe
Source: Climate Bonds Initiative database

As is seen in Figure 1, Germany leads by a wide margin, with approximately $285 billion in cumulative issuance, followed by France at around $230 billion, reflecting strong economies, early adoption of green finance, and supportive regulatory environments. The Netherlands ranks third with roughly $140 billion, underscoring its outsized role in sustainable finance relative to its economic size. Countries such as Sweden, Italy, and Spain form the next tier, each issuing between $80-90 billion, while mid-level issuers like Denmark, Belgium, and Austria contribute between $30-40 billion. Smaller but active participants, including Ireland, Finland, and Luxembourg, issue under $25 billion, indicating engagement across these countries. Emerging markets in Eastern Europe, such as Hungary, Slovakia, and Romania, show minimal but growing issuance, suggesting a gradual flow of green finance. Overall, the data reinforce Europe's direction in the global green bond market, with strong contributions concentrated in Western and Northern European financial centres.

Figure 2 illustrates the distribution of green bond issuance across market types from 2014 to 2023, showing the dominant role of developed markets in driving growth. Issuance from developed markets surged from minimal levels in 2014 to nearly $280 billion by 2021, followed by a brief dip in 2022 and a strong rebound in 2023, again reaching approximately $280 billion. This trend aligns with data indicating that Europe accounted for over half of the global aligned green bond volume in 2023, with a 23% year-over-year increase. Supranational issuers maintained a steady, though smaller, contribution throughout the period, typically between $5 and 15 billion annually, emphasising the consistent role of institutions such as the European Investment Bank. In contrast, emerging markets played a minimal role in green bond issuance, though a slight uptick in 2023, driven by new market entrants, signals early-stage growth potential.

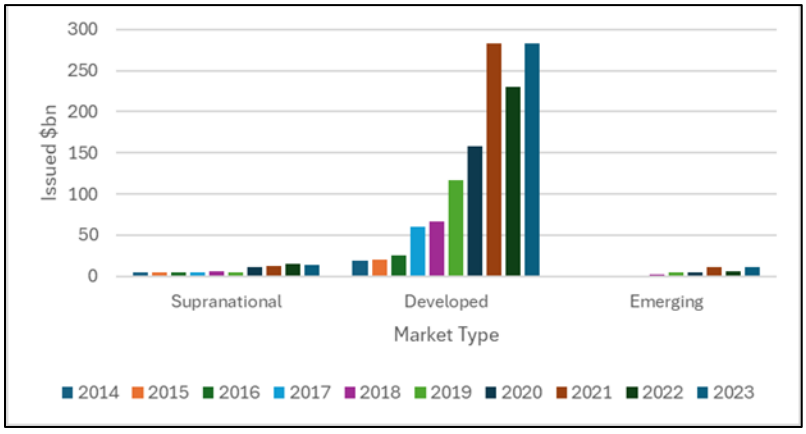

Figure 2. Green Bond Issuance by Market Type
Source: Climate Bonds Initiative database

Moreover, Figure 3 demonstrates the evolution of the European green bond market from 2014 to 2023, with significant growth across various issuer types.

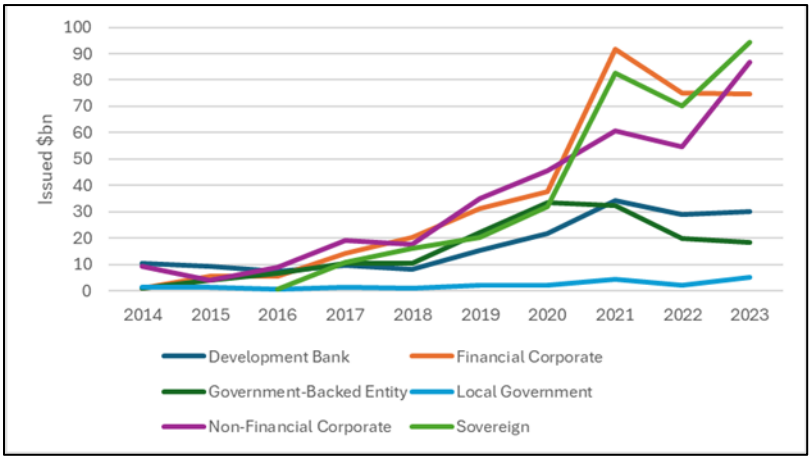

Figure 3. Green Bond Issuance by Issuer type
Source: Climate Bonds Initiative database

Among the issuer types, sovereign issuers (green line) exhibit the most intense expansion, particularly after 2019, growing from virtually no issuance before 2016 to nearly $95 billion by 2023. This rise underscores the increasing reliance of European governments on green bonds as a financing mechanism. Non-financial corporates (purple line) also show strong and steady growth, especially post-2019, reaching nearly $87 billion by 2023, positioning them as the second-largest issuer group. Financial corporates (orange line) follow a more volatile trajectory but demonstrate upward momentum, peaking near $92 billion in 2021 before stabilising around $75 billion. Development banks (dark blue line) and government-backed entities (dark green line) experienced moderate growth early on, with issuance flattening or declining slightly in recent years. Local governments (light blue line) consistently issued the lowest volumes, never surpassing $5 billion. Overall, the data indicate that European countries are increasingly using green bonds as a tool to finance climate-related initiatives, reflecting a broader shift toward sustainable finance across both public and private sectors.

Figure 4 provides information about the use of proceeds and the green bond resource allocation from 2014 to 2023.

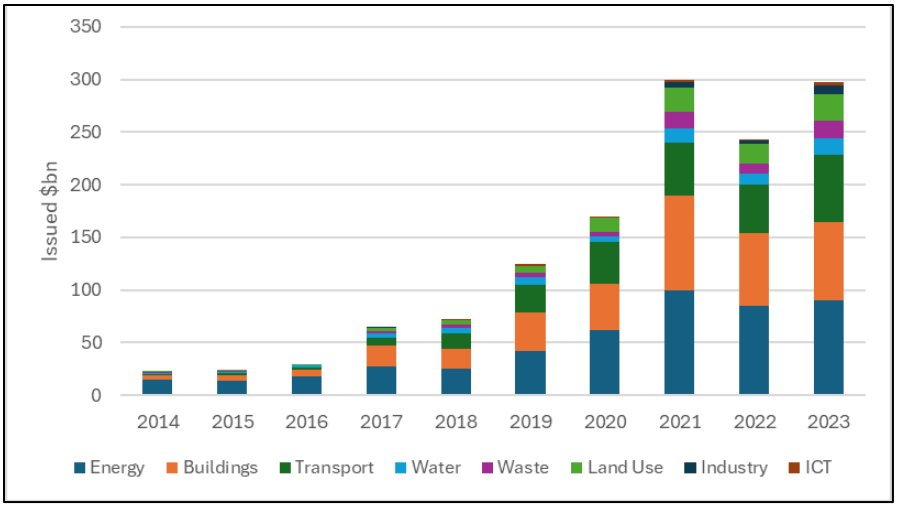

Figure 4. Green Bond Issuance - Use of Proceeds
Source: Climate Bonds Initiative database

The European green bond market experienced strong growth from $20 billion in 2014 to nearly $300 billion in 2023. Energy projects consistently constituted the largest share of proceeds, growing steadily to approximately $90 billion by 2023, and remaining the keystone of green bond financing. Buildings showed rapid expansion between 2019 to 2021, peaking at $90 billion in 2021 before declining to $70 billion in 2023, in line with a drop in share from 25% (2022) to 18% (2023). Transport saw sustained growth, especially post-2019, reaching $65 billion by 2023. These three sectors, Energy, Buildings, and Transport, accounted for 75% of green bond volume in 2023, down from 77% in 2022 and 79% cumulatively, indicating a trend toward diversification. Land Use grew modestly from 5% in 2022 to 6% in 2023. Meanwhile, Water, Waste, Industry, and ICT continued smaller allocations but gradual increases, reflecting broader market maturity. The advancing allocation patterns suggest that, while core sectors remain dominant, the market is progressively diversifying as issuers, including sovereigns, expand financing to a wider range of environmental initiatives.

In addition, Figure 5 indicates that the European green bond market has been predominantly Euro-denominated (EUR), with EUR consistently representing the largest share of issuance throughout 2014-2023.

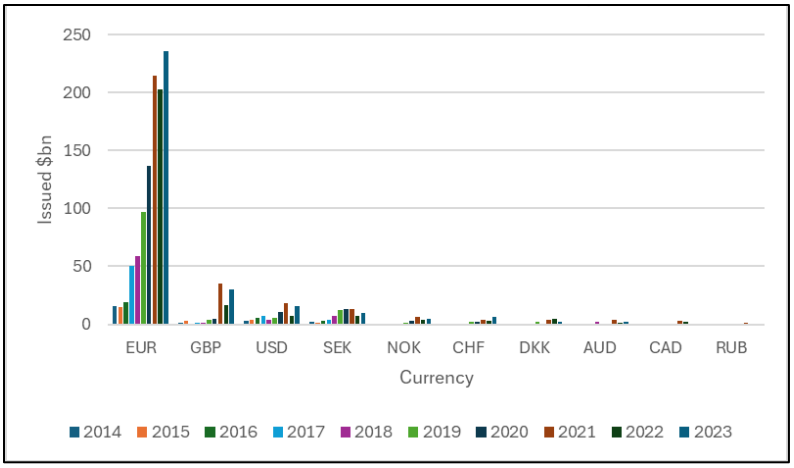

Figure 5. Green Bond Issuance -Amount issued
Source: Climate Bonds Initiative database

Issuance in EUR experienced substantial growth from 2018 to a peak of approximately $210-220 billion in 2021, followed by a slight dip in 2022 and a moderate recovery in 2023. This sustained dominance is consistent with reports that EUR led green bond issuance for the sixth consecutive year and accounted for 44% of global green bond volume. The British Pound (GBP) is the second most prominent currency, although at significantly lower volumes. GBP issuance showed volatility, with notable spikes in 2021 (~$40 billion) and a spike again in 2023, likely driven by increased sovereign issuance from the UK. The US Dollar (USD) maintained a stable presence as the third most significant currency, with relatively constant issuance levels in 2021, accentuating the USD's broader role in global finance. The Swedish Krona (SEK) contributed modest but consistent issuance during 2019 and 2020. Other currencies, such as Norwegian Krone (NOK), Swiss Franc (CHF), Danish Krone (DKK), Australian Dollar (AUD), Canadian Dollar (CAD), and Russian Ruble (RUB), played only minor roles, each showing minimal issuance volumes throughout the period. Overall, the data reflects multi-currency growth in green bond issuance during the period, followed by stabilisation or market maturation in the last two years. The enduring dominance of EUR and the continued, albeit smaller, roles of GBP and USD reflect regional leadership and global connection within sustainable finance.

Finally, Figure 6 shows the evolution and maturation of the European green bond market between 2014 and 2023, marked by a pronounced shift toward larger deal sizes.

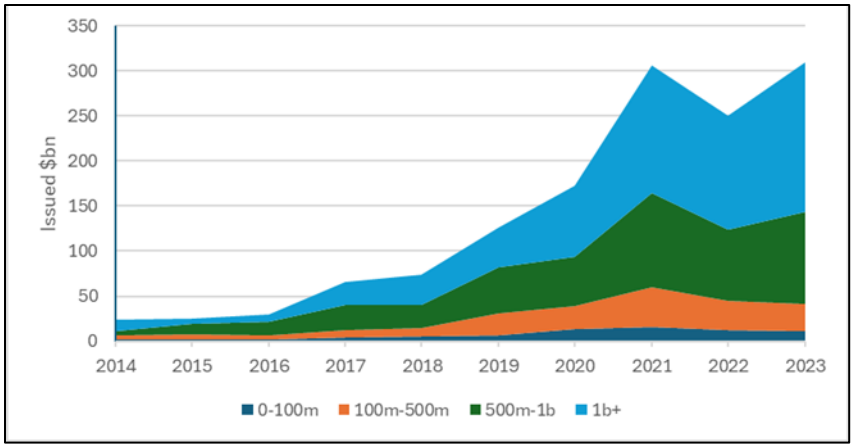

Figure 6. Green Bond Issuance - Deal size
Source: Climate Bonds Initiative database

The most prominent trend is the rapid growth of large deals over $1 billion, which surged from insignificant levels before 2016 to approximately $160 billion by 2023, consistently comprising most of the total issuance volume since 2018. Medium-large deals ($500 million to $1 billion) also demonstrate steady expansion, particularly after 2018, reaching around $100 billion by 2023 and forming the second-largest market segment. In contrast, medium-sized deals ($100 million to $500 million) experienced moderate growth before slightly declining after 2021, while small deals under $100 million remained marginal throughout the period. By 2023, benchmark-sized deals (those above $500 million) represented an estimated 74% of total green bond issuance in Europe, reflecting increasing institutional demand, enhanced market liquidity, and the rising participation of sovereign issuers. This trend underscores a broader market shift toward the green bond market, reflecting signs of increasing maturity.

The descriptive analyses, presented in this section, indicate an increase in issuance volumes, driven predominantly by developed markets and large sovereign and corporate issuers. The concentration of activity in Western and Northern Europe, the dominance of benchmark-sized deals, and the prevalence of euro-denominated issuances all signal increasing maturity with growing investor confidence and regulatory support. While energy, buildings, and transport remain the primary sectors financed through green bonds, a gradual diversification in the use of proceeds suggests an expanded scope of sustainable investment. Collectively, these trends underscore Europe's central role in the

global green bond landscape. Besides, it establishes a basis for further investigation into the macroeconomic and policy-related factors influencing green bond issuance across different contexts.

3. MATERIALS AND METHODS

Building on the descriptive analysis in Section 2, which identified notable trends in green bond issuance across European countries, this section employs an empirical approach to investigate the key determinants driving these patterns. While the descriptive results suggest that macroeconomic stability, financial market development, and policy environments play an influential role, a formal econometric framework is necessary to establish these factors' statistical significance and relative importance. Accordingly, this section outlines the data sources, variable construction, and methodological approach used in the empirical analysis.

3.1. Data

The dataset used in this study comprises annual observations for 27 European countries over a 10-year period. The primary sources include the European Environmental Agency (EEA), the World Bank's World Development Indicators (WDI), and the International Monetary Fund (IMF). Table 1 summarises the key variables included in the analysis, along with their sources and descriptions.

Table 1. Descriptions of the variables used

Variable	Database	Description
Green bond issuance by corporates and governments *(GB)*	EEA	Green bonds are loans provided by an investor to a borrower which are used to fund projects or activities that promote climate change mitigation or adaptation or other environmental objectives. This indicator includes bonds that are aligned with the four core components of the International Capital Market Association (ICMA) green bond principles or are certified by the Climate Bond Initiative (CBI).
Financial Market Access *(FMA)*	IMF	Financial market access includes Stock market capitalization to GDP, Stocks traded to GDP, International debt securities of government to GDP, Total debt securities of financial corporations to GDP, and Total debt securities of nonfinancial corporations to GDP
Financial Market Debt *(FMD)*	IMF	Financial market debt reflects the size of the stock market (capitalization, or the value of listed shares) and how active it is (stocks traded), the outstanding volume of international debt securities of sovereigns and international and domestic debt securities of financial and nonfinancial corporations.
Financial Market Efficiency *(FME)*	IMF	Financial market efficiency represents the stock market turnover ratio – the ratio of the value of stocks traded to stock market capitalization.
Inflation, consumer prices (annual%) *(INF)*	WDI	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.

Interest payments (% of expense) *(INT)*	WDI	Interest payments include interest payments on government debt--including long-term bonds, long-term loans, and other debt instruments--to domestic and foreign residents.
Unemployment, total (% of total labour force) *(UNEMP)*	WDI	Unemployment refers to the share of the labor force that is without work but available for and seeking employment.

Sources: European Environmental Agency, International Monetary Fund, World Development Indicators DataBank

3.2. Methodology

To evaluate the impact of macroeconomic conditions and financial development on green bond issuance, we estimated a panel data model that captures both cross-country and over-time variation. Specifically, we test for the appropriate model specification using the Hausman test, which favours a fixed effects model over a random effects model. The test result yields a chi-square statistic of $\chi^2(7)$ with a p-value of 0.0019, indicating a statistically significant preference for the fixed effects estimator at the 1% level.

The fixed effects model is presented in equation (1).

$$lnGB_{it} = \beta_0 + \beta_1 lnFMA_{it} + \beta_2 lnFMD_{it} + \beta_3 lnFME_{it} + \beta_4 lnINT_{it} + \beta_5 lnINF_{it} + \beta_6 lnUNEMP_{it} + \gamma_t YearDummy_t + u_i + \varepsilon_{it} \quad (1)$$

As is seen in the model, all the variables are log-transformed to facilitate the interpretation. Here, the dependent variable $\boldsymbol{GB_{it}}$ represented the green bond issuance by corporates and governments for each country $\boldsymbol{i}$ and time $\boldsymbol{t}$. The independent variables are financial market access (FMA), depth (FMD), efficiency (FME), inflation (INF), interest payments (INT), and unemployment (UNEMP). $\boldsymbol{u_i}$ represents the unobserved time-invariant individual effect (country-specific fixed effects) and $\boldsymbol{\varepsilon_{it}}$ is the idiosyncratic error term. $\boldsymbol{\beta_s}$ and $\boldsymbol{\gamma}$ are the coefficients estimated by the model. The year dummy variables are included in the model to control for unobserved year-specific factors.

4. RESULTS

The descriptive statistics of the variables introduced in the econometric model are presented in Table 2. It is possible to see the number of observations, mean, standard deviation, and minimum and maximum values of the data covering 27 countries and 10 years. The values represented in this table already reflect the log-transformed values.

Table 2. Descriptive Statistics of the selected variables

Variable	Obs.	Mean	Std.Dev.	Min.	Max
GB	270	0.8057	0.9821	0	3.5091
FMA	270	-1.279074	1.2281	-4.6051	0
FMD	270	-1.2749	1.04	-3.9121	-0.0408
FME	270	0.3098	0.2669	0	0.6931
INF	270	2.5054	0.2506	2.0672	3.3913
INT	270	2.6217	0.1731	2.3171	3.0435
UNEMP	270	1.8929	0.4691	0.7006	3.2849

The results of the fixed effects regression model are presented in Table 3. These findings provide empirical support for the descriptive trends outlined in Section 2 and offer new insights into the underlying drivers of green bond issuance across European countries.

The fixed effects regression results reveal that financial market characteristics significantly influence green bond issuance across countries over time. Specifically, a 1% increase in financial market access is associated with a 0.53% decrease in green bond issuance, while a 1% increase in financial market depth correlates with a 0.73% decrease. While broader financial market access might intuitively support green finance by encouraging participation, the negative coefficient could indicate that, in certain contexts, greater access facilitates conventional investment flows that compete with or overshadow green financial instruments. In less mature green finance ecosystems, traditional sectors may still dominate investor portfolios, and without dedicated green incentives, financial openness may not automatically translate into sustainable investment behaviour. Similarly, financial market depth, often seen as a sign of financial sophistication, is also associated with a reduction in green bond issuance. One interpretation is that deeper markets may gravitate towards high-yield instruments, leaving low-return and long-horizon green bonds relatively underfunded. This observation supports the notion found in previous research (see Adoukonou et al., 2024) that financial systems without explicit sustainability-aligned incentives may deprioritise green bonds. It also aligns with studies identifying non-linear relationships between market depth and green finance, where green issuance may initially decline before recovering as markets evolve (Yuan et al., 2023).

Table 3. Results of the fixed effects model

Variable	Coefficient	Std. Error
lnFMA	-0.5289***	0.1771
lnFMD	-0.7339**	0.4155
lnFME	2.3595***	0.8385
lnINT	0.2420	1.0711
lnINF	-0.9628**	0.5260
lnUNEMP	0.2728	0.3761
Year Fixed Effects		
2015	0.2720*	0.1931
2016	0.1987	0.1996
2017	0.6679***	0.2289
2018	0.8877***	0.2594
2019	1.1669***	0.2843
2020	0.9861***	0.2721
2021	1.7956***	0.3049
2022	2.4023***	0.4499
2023	2.1683***	0.3709
Cons_	-1.3186	2.9637
No. of Obs: 270		
No. of Countries: 27		
R-squared (within): 0.4436		
Sigma_u (fixed effects variance): 1.3134		
Sigma_ε (residual variance): 0.6812		
Rho (fraction of variance due to u_i): 0.7880		
F-test: F(26, 225) = 3.64, p = 0.0000		

***, **, and * represents 0.01, 0.05, and 0.1 significance levels, respectively.

In contrast, financial market efficiency appears to play a strongly positive role. A 1% increase in efficiency is associated with a 2.36% increase in green bond issuance, suggesting that reduced transaction costs and more transparent pricing environments may encourage both issuers and investors to participate in green finance. This finding points to the enabling role of structural efficiency, especially when paired with policy clarity and ESG integration, in enhancing the attractiveness of green financial instruments. These results lend support to previous studies with a similar context (see Adoukonou et al., 2024), which emphasise the need for institutional frameworks that translate market structure into sustainability outcomes. Among the macroeconomic controls, higher inflation appears to reduce green bond activity (a 1% increase in inflation leads to a 0.96% decrease). Higher inflation often raises the cost of borrowing and generates uncertainty around long-term investment conditions that can discourage the issuance of instruments like green bonds, which often require stable environments and longer planning horizons. Unemployment and interest rates show no statistically significant effects. Finally, the year dummy variables indicate that green bond

issuance has increased steadily and significantly since 2017, with particularly large and statistically significant jumps in 2019 through 2022. This pattern suggests strong temporal effects, potentially reflecting growing global awareness and policy support for sustainable finance during this period.

5. CONCLUSION

The macroeconomic, financial, and policy factors affecting green bond issuance in 27 European nations were examined over ten years. The research shows how structural and economic factors affect sustainable finance in Europe by combining descriptive market analysis with a fixed effects panel regression model.

The descriptive findings show that the European green bond market is maturing, with rising issuance volumes, reliance on sovereign and corporate issuers, and benchmark-sized deals. West and Northern Europe dominate the market, with the euro dominating issuance currencies. Energy, buildings, and transport still dominate green bond funding, but new environmental industries are emerging. These trends demonstrate Europe's leadership in global green finance and imply a growing climate-focused institutional and investor base.

The econometric research shows how financial market development affects green bond activity in different ways. Financial market efficiency increased green bond issuance, demonstrating the relevance of streamlined, transparent, and cost-effective financial institutions for sustainable investment. Increased financial market access and depth are negatively correlated with green bond volumes. These findings show that typical financial expansion may favour high-yield investments over green ones without sustainability incentives or regulation. On the macroeconomic front, inflation emerged as the only significant deterrent to green bond issuance, consistent with the notion that economic instability raises risk premiums and discourages long-term investment.

The data indicates that green bond issuing requires more than traditional financial development. This requires targeted policy initiatives, regulatory clarity, and a commitment to financial market sustainability. European authorities must maintain macroeconomic stability and implement green finance norms into the financial infrastructure to ensure capital markets support the green transformation. Institutional variables, including environmental policy severity, governance quality, and central bank climate risk requirements, could enhance this paradigm in future research.

The substantive importance of green bond issuance necessitates rigorous empirical research capable of informing evidence-based policy interventions. Our future research agenda includes extending this work beyond the conventional macroeconomic frameworks to systematically incorporate policy

effects, enabling the identification of high-impact policy instruments and the evidence-based design of future regulatory initiatives.

A critical impediment to advancing the green bond literature concerns data limitations: most commercially available datasets operate at the firm level with restricted accessibility, while country-level aggregations remain sparse and characterized by incomplete indicator coverage. These structural constraints significantly constrain the development of comprehensive empirical models and limit the generalizability of findings across jurisdictions and time periods.

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