# Green loans and Financial Development: New Evidence?

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**Abstract**

Green loans have emerged as a financial instrument for promoting sustainable development and addressing environmental challenges. But what role does financial development play in the issuance of green loans? We begin by analysing whether any convergence occurred among European countries and the U.K. in the amount issued during 2016-2022, providing evidence of the influences exerted by market maturity, banking structure, and environmental variables in influencing different paths toward club memberships. Next, we investigate the potential impact of financial development on green loans. From these analyses, two main policy implications emerge: the necessity of tailored policy approaches that recognize the distinct characteristics among countries within different clubs, and the importance of pursuing dual goals, promoting private sector involvement and balancing bank lending activities which necessitate a comprehensive and well-coordinated approach from policymakers. Our main recommendations align with the EU's request to increasing private capital inflow into sustainable investments, emphasizing the importance of a more inclusive sustainable finance framework. The latter should facilitate access to sustainable financing, including green loans and mortgages, for households and small businesses.

**Keywords:** Climate Finance, Green loans, Financial Markets, Financial Development, Banking structure, European Banking Authority, Ecological Footprint, Club Convergence

**JEL Classification:**

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## 1. Introduction

It would not be an exaggeration to say that the emergence of green finance has been a response to the demand for ecological transition. This is because it involves the allocation of investments toward sustainable and environmentally-friendly projects, with the aim of facilitating the transition to a low-carbon and climate-resilient economy (Falcone, 2020).

Within the realm of green finance, green loans have carved out a significant niche. The inception of green lending can be traced back to as early as 2005 when major U.S. banks began allocating resources to support sustainable entrepreneurship (Gilchrist et al., 2021). These financial instruments are exclusively designated for financing or refinancing eligible green projects, regardless of whether they are new or existing. The ambiguity surrounding the use of proceeds from green funds has, in part, stimulated international commitment.

In response to this growing international commitment and the need for greater transparency, the Loan Market Association (LMA) introduced the Green Loan Principles (GLP) in December 2018[1]. These principles aim to enhance transparency and establish standardized practices, providing a framework for categorizing loans as green based on factors like the use of proceeds, project evaluation, management of funds, and reporting.

Since the introduction of the GLP, the green loan market has experienced a valuable increase. A growing body of academic literature has emerged, delving into various facets of green loans (Akomea-Frimpong et al., 2022; Gilchrist et al., 2021; Vanishvili & Katsadze, 2022). Existing studies have indeed provided valuable insights into the evolution of the need for green loans, with a particular focus on several key determinants (Zahedi, 2010; D'Orazio & Popoyan, 2019; Gilchrist et al., 2021; Debrah et al., 2022; Rahman et al., 2022; Vanishvili & Katsadze, 2022; Akomea-Frimpong et al., 2022; Debrah et al., 2023).

This surge of interest has not only garnered attention within financial actors but has also sparked the interest of policymakers. At regulatory level, the European Banking Authority (EBA) received a Call for Advice from the European Commission to be delivered by 29 December 2023. The latter focuses on defining and proposing potential supporting tools for green loans and mortgages provided to retail and SME borrowers, "[...] including regulatory and legislative measures, related to [...], the loan origination process, pre-contractual information and advice to the borrower, necessary information by the credit institution, advertising, product governance and consumer protection[2]".

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[1] LMA, 2018: https://www.lma.eu.com/application/files/9115/4452/5458/741_LM_Green_Loan_Principles_Booklet_V8.pdf

[2] EBA (2022, p.4). Call for advice to the European Banking Authority on green loans and mortgages. Available at: https://www.eba.europa.eu/sites/default/documents/files/document_library/About%20Us/Missions%20and%20tasks/Call%20for%20Advice/2022/CfA%20on%20green%20loans%20and%20mortgages/1043881/EBA%20Call%20for%20Advice%20Green%20Loans%20and%20Mortgages_Clean.pdf

To answer this call, we should first address a significant gap in our understanding regarding the potential fragmentation in the issuance of green loans among European countries and the United Kingdom, as well as the role that financial development plays in this context. Why is this the case? To what extent? More precisely, is there a common approach among European green loan issuers? If not, what are the main drivers behind their actions? Does financial development influence the issuance of green loans, and if so, to what extent?

We propose to address this gap by examining whether a pattern of convergence emerges and by identifying potential clustering groups among European nations. The arguments are developed as follows. We first make the readers wonder why it is important to make a distinction between green loans and green bonds. Indeed, we offer a comparative analysis of those instruments, highlighting their unique characteristics and their pivotal roles in advancing sustainability within the financial sector.

After exploring the scale of green loans market among the EU countries and the U.K, we investigate the formation of clubs among issuers in the green lending by applying a convergence log-t-test to a panel dataset spanning from 2016 to 2022. Having defined four distinct groups that are converging along their own individual paths, with one group diverging from the others, we offer insights into the levels of green commitment experienced by countries.

We conduct additional tests using ordered probit and logit models to investigate whether green loan issuance patterns within these clubs are affected by market maturity, environmental considerations, and banking structure factors. We also examine the potential influence of financial development on green loan issuance. For this analysis, we employ a panel data analysis approach, including the Pooled OLS estimator and the Population-averaged estimator, both with and without fixed effects. We incorporate country and year fixed effects, as well as random effects. Finally, we explore potential regulatory actions that could increase private capital inflow into sustainable investments, as requested by the European Commission (EBA, 2022).

This study makes a significant contribution to the existing literature by introducing potential drivers for the convergence of the green loan market among European countries and the U.K. It represents the first known attempt to conduct such an analysis, adding to its novelty. The findings provide evidence of the complex relationships between market maturity, environmental considerations, and banking structures in promoting green finance. Furthermore, it marks the first known attempt to explore the potential impact of financial development on green loan issuance.

The remaining sections of the paper are structured as follows: Section 2 discusses the institutional and legal differences between green loans and green bonds. Section 3 presents the data concerning the green loan market in the EU and the U.K. Section 4 presents the main findings, which include the results of the club convergence analysis, the ordered probit and logit models, and the OLS method. Lastly, Section 5 concludes highlighting its policy implications.

## 2. Institutional and Legal differences between green loans and green bond

In recent years, the field of sustainable finance has experienced significant expansion, marked by a growing emphasis on environmentally responsible investments (Migliorelli, 2021). Within this landscape, two prominent financial instruments, namely green loans and green bonds, have emerged as pivotal channels for directing capital towards environmentally friendly projects. Despite sharing the common objective of advancing sustainable development, these instruments exhibit notable distinctions concerning their market prominence, financial attributes, regulatory frameworks, liability mechanisms, and accessibility to diverse borrower profiles (McGarry et al., 2018). This section conducts a comprehensive comparative analysis of green loans and green bonds, highlighting their unique characteristics and their pivotal roles in advancing sustainability within the financial sector.

Green bonds have commanded substantial attention in capital markets for an extended period, capturing the interest of investors, issuers, and regulators alike (Alamgir & Cheng, 2023). These fixed-income securities have established a robust market presence, driven by substantial issuance volumes and diverse applications in project financing[3]. In contrast, green loans have remained relatively understated within the realm of sustainable finance. Despite their potential to address sustainability initiatives, green loans have not garnered the same level of recognition as green bonds (McGarry et al., 2018). Highlighting this disparity in market popularity is essential, as it reflects varying degrees of awareness and adoption among participants in financial markets.

A fundamental differentiation between green loans and green bonds pertains to their financial attributes. The latter, often issued in larger denominations and featuring extended tenors, predominantly cater to well-established entities and sizable projects. Additionally, these bonds are typically endowed with public credit ratings, augmenting their visibility and appeal to institutional investors (Bhutta et al., 2022). Conversely, green loans exhibit distinct financial dynamics, typically encompassing smaller loan amounts and shorter tenors. This divergence in financial characteristics underscores the significance of comprehending the specific requirements and contexts of prospective borrowers or issuers when navigating the choice between these two green tools.

Another distinguishing factor between these instruments concerns their purpose and the utilization of proceeds. Green bonds are noted for their ring-fenced proceeds, wherein funds raised are explicitly earmarked for financing environmentally responsible projects. This earmarking of

[3] ICMA (January 2022). The GBP Guidance Handbook. Available at: https://www.icmagroup.org/assets/GreenSocialSustainabilityDb/The-GBP-Guidance-Handbook-January-2022.pdf.

proceeds fosters transparency and accountability, guaranteeing that capital is directed towards predefined green initiatives (Flammer, 2021; Park, 2018). In contrast, green loans exhibit a higher degree of flexibility concerning their purpose. While certain green loans may involve funds disbursed contingent upon the borrower fulfilling specific environmental commitments, others may be allocated for general purposes. Borrowers are incentivized with reduced funding costs, contingent on the extent to which their business aligns with environmental criteria as assessed by lenders over a specified timeframe (Chan, 2021; Gilchrist et al., 2021; McGarry et al., 2018). This uncertainty in the utilization of green loan proceeds accommodates a broader spectrum of projects and borrowers, rendering green loans a versatile option within the domain of sustainable finance.

Furthermore, green bonds have benefited from the establishment of recognized and standardized principles, exemplified by the Green Bond Principles (GBP), which function as benchmarks for issuers when structuring green bonds. These principles foster consistency, streamline tracking processes, and promote mutual recognition across markets, playing a pivotal role in the global expansion of the green bond market and instilling confidence among both investors and issuers. In contrast, green loans lack universally recognized principles, resulting in a more diverse array of structures (McGarry et al., 2018). The Green Loan Principles (GLP), introduced by the Loan Market Association (2018) serve as a framework to facilitate and support environmentally sustainable economic activities (LSTA University, 2023). These principles, built upon the foundation of the GBP, aim to create consistency within financial markets. The GLP provides voluntary guidelines applicable on a case-by-case basis to categorize a loan as green, encompassing four essential components: use of proceeds, process of project evaluation and selection, management of proceeds, and reporting. While applying use of proceeds rules akin to green bonds may be feasible for some green loans, it becomes more complex for multiple-use revolving credit facilities. Consequently, specific guidelines tailored to these instruments need to be developed, reflecting the evolving nature of the green loans market (McGarry et al., 2018).

The matter of liability concerning non-compliance with environmental commitments and sustainability targets holds significant importance within the realm of green finance. Green loans and green bonds employ distinct mechanisms to address this issue. In the case of former, borrowers may face explicit consequences for non-compliance. For instance, failing to allocate loan proceeds for green purposes can trigger an event of default or lead to built-in penalties until the breach is rectified (Chan, 2021; Lupo-Pasini, 2022; Ozili, 2022). Conversely, green bonds typically rely on legal actions, such as misrepresentation claims, in cases of non-compliance. Bondholders may pursue legal remedies if issuers fail to uphold their commitments (McGarry et al., 2018). This divergence in liability mechanisms reflects the contrasting nature of green loans, often involving bilateral contracts, and green bonds, which are widely held instruments characterized by complex legal structures.

Additionally, both green instruments differ significantly in terms of accessibility and suitability for various borrowers and projects. Green bonds, with their larger denominations and longer tenors, are well-suited for established entities and large-scale projects, attracting institutional investors seeking stable, long-term investments with dedicated green proceeds (Flammer, 2020). In contrast, green loans adopt a more inclusive approach, catering to a broader spectrum of borrowers, including SMEs and individuals (Li et al., 2018). Their smaller loan amounts and shorter tenors enhance accessibility for entities with diverse financing requirements (McGarry et al., 2018). Furthermore, the inherent flexibility of green loans enables them to adapt to the unique circumstances of borrowers, reflecting a more personalized approach to sustainable financing.

Notably, a distinctive feature of green loans is the potential for interest rates to be directly linked to a borrower's overall sustainability performance as a company (Lupo-Pasini, 2022). This innovative approach contrasts with green bonds, where investment returns are not directly influenced by environmental factors. For example, certain green loans may tie interest margins to key performance indicators (KPIs) related to sustainability. Meeting these KPIs may result in a decrease in the loan's interest rate (Lupo-Pasini, 2022), incentivizing borrowers to invest in sustainability initiatives to reduce their interest expenses. These mechanisms encourage companies to adopt greener practices throughout their operations, aligning financial incentives with environmental commitments.

Despite the exponential growth in the utilization of green loans over the years, the absence of regulatory mandates for banks to disclose green lending makes it challenging to ascertain the precise size of the green loan market (Gilchrist et al., 2021). In the following section, we attempt to quantify the scale of this market within the EU countries and the U.K.

## 3. The green loans market in EU countries and the U.K.

The loan data are obtained from Refinitiv's Advanced Search – Government and Corporate loans database. Since the green loan market started in 2016, we extract all the green lending with the country of issue related to EU20[4] and the U.K., between January 1, 2016, and December 31, 2022. To distinguish between green and ordinary loans, we set Refinitiv's filter "Market Segment: Green Loans". This yields a total of 903 green loans.

In the following, we initially outline the progression of the green loan market over the

[4] EU20 includes Austria, Belgium, Croatia, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Spain, Sweden. No green loans were issued by Czech Republic, Bulgaria, Estonia, Latvia, Malta, Slovakia, and Slovenia in the chosen period.

years. Then, we offer a distinct analysis based on countries issuance. Table 1 presents data on the issuance of green loans on an annual basis. The first column indicates the amount of green loans issued in billions of euros (with foreign currencies converted to euros), while the second column represents the number of green issued.

**Table 1**

Green Loans over time

| Year | Issuance of Green Loans (€B) | Number of Green Loans |
|---|---|---|
| 2016 | 0.90 | 10 |
| 2017 | 1.75 | 14 |
| 2018 | 12.83 | 67 |
| 2019 | 18.87 | 108 |
| 2020 | 25.09 | 154 |
| 2021 | 29.25 | 212 |
| 2022 | 61.06 | 338 |
| Total | 149.76 | 903 |

**Note:** This table reports the amount in billion EUR, and the number of green loans issued on an annual basis. The data set includes green issues in Refinitiv issued for the above-mentioned countries between January 1, 2016, and December 31, 2022.

Over the course of 7 years, the issuance of green loans has experienced a remarkable surge, increasing from 0.9 €B in 2016 to 61.06 €B in 2022.

Table 2 presents summary statistics for each individual country. Notably, the leading issuers are United Kingdom, Spain, Germany, and France.

**Table 2**

Green Loans across Countries

| Country | Issuance of Green Loans (€B) | Number of Green Loans |
|---|---|---|
| Austria | 1.45 | 9 |
| Belgium | 2.57 | 14 |
| Croatia | 0.13 | 4 |
| Cyprus | 0.50 | 1 |
| Denmark | 1.21 | 7 |
| Finland | 1.67 | 8 |
| France | 18.30 | 103 |
| Germany | 18.49 | 57 |
| Greece | 0.25 | 6 |
| Hungary | 2.30 | 5 |
| Ireland | 0.88 | 6 |
| Italy | 10.50 | 135 |

| | | |
|---|---|---|
| Lithuania | 0.17 | 4 |
| Luxembourg | 3.74 | 26 |
| Netherlands | 4.25 | 35 |
| Poland | 0.65 | 14 |
| Portugal | 4.17 | 18 |
| Romania | 0.14 | 3 |
| Spain | 27.64 | 231 |
| Sweden | 7.53 | 39 |
| United Kingdom | 43.23 | 178 |
| Total | 149.76 | 903 |

**Note:** This table reports the amount in billion EUR, and the number of green loans issued by the country. The data set includes green issues in Refinitiv issued for the above-mentioned countries between January 1, 2016, and December 31, 2022

Figure 2 displays a visual representation of the data presented in Table 2. Panel A represents the euro amount of green loan issuance, while panel B represents the number of green loans issued. Darker shades in the visualization indicate higher levels of issuance and a larger number of green lending. The overall pattern highlights United Kingdom, Spain, Germany and France as the primary issuers. The remaining European countries exhibit a more fragmented distribution of green loan issuance. In the following section, we explore possible reasons behind this fragmentation and the impact of financial development on green loans.

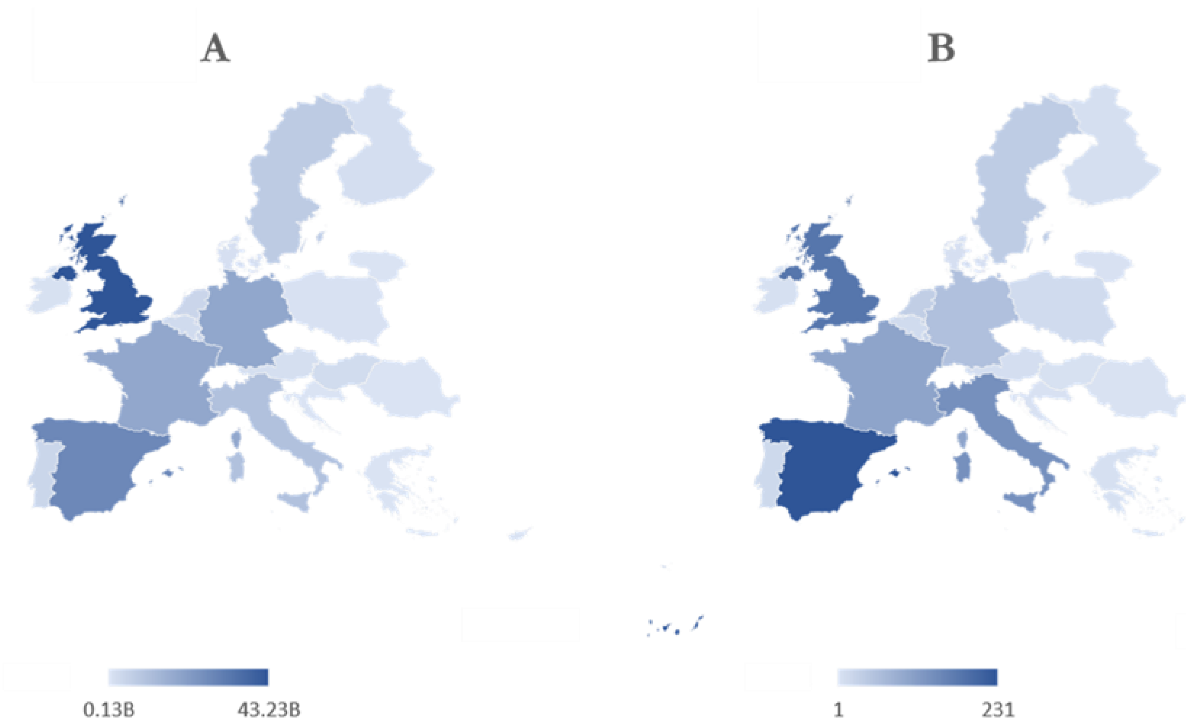


**Fig. 2.** Green loans across countries. **Panel A**, Green loans issuance in billion EUR. **Panel B**, Number of Green loans.
**Notes:** This figure reports the prevalence of green loans across countries. Darker-shaded areas represent higher issuance amounts (A) and a higher number of green loans (B), respectively. The underlying statistics are provided in Table 2.

## 4. Empirical investigation

This section of the study aims to address this gap by examining whether a convergence pattern can be observed and identifying potential clustering clubs among European nations. We begin by presenting our methodology (4.1) and then provide a comprehensive discussion of the main findings regarding club convergence (4.2). Subsequently, we aim to offer insights into the potential factors influencing club membership (4.3). Finally, we explore the potential impact of financial development on green loans (4.4).

### 4.1. Methodology

To investigate the club convergence across European countries and the U.K. in adopting a green finance emissions strategy, we apply the log t-test as developed by Phillips and Sul (Phillips & Sul, 2007). The approach identifies club convergence groups that move towards distinct equilibria or steady states, without making any specific assumptions about the stationarity of trends or the non-stationarity of stochastic processes (Okazaki & Sakai, 2020).

Let $y_{it}$ denote the amount green loans issued of country $i=1,..., N$ at time $t=1,\dots, T$.

Adhering closely to the methodology outlined by Phillips and Sul, we make the assumption that $y_{it}$ can be modeled as a nonlinear common-factor model that varies over time, such that:

$y_{it} = \delta_{it}\mu_t$

where $\mu_t$ is a single common component and $\delta_{it}$ is a time-varying idiosyncratic element, which captures the deviation of country $i$ from the common path $\delta$ defined by $\mu_t$.

Given that the number of parameters exceeds that of observations, Phillips and Sul eliminate the common component $\mu_t$ through rescaling by panel average:

$$h_{it} = \frac{y_{it}}{{}^{1}\!/_{N} \sum_{i=1}^{N} y_{it}} = \frac{\delta_{it}}{{}^{1}\!/_{N} \sum_{i=1}^{N} \delta_{it}}$$

where the panel average $N^{-1} \sum_{i=1}^{N} \delta_{it}$ and its limit as $N \to \infty$ both exist and differ from 0.

To test for convergence, Phillips and Sul (2007) assume that $\delta_{it}$ has the following transition form:

$$\delta_{it} = \delta_i + \sigma_i \xi_{it} L(t)^{-1} t^{-\alpha}$$

where $\delta_i$ is fixed, $\sigma_i > 0$ is an idiosyncratic scale parameter, $\xi_{it}$ is iid $(0, 1)$ with finite fourth moment over i, $L(t)$ is a slowly varying function and $\alpha$ is the decay rate. Since all countries will converge to the same steady state if $\delta_{i,t+k} = \delta \; for \; all \; i$, which holds if and only if $\delta_i = \delta$ for all $i$ and $\alpha \geq 0$,

the null hypothesis of convergence is as follows:

$$H_0: \delta_i = \delta \; for \; all \; i \; and \; \alpha \geq 0$$

and the alternative:

$$H_A: \delta_i = \delta \; for \; all \; i \; and \; \alpha < 0$$

These hypotheses are tested using the following "log t" regression model (Phillips & Sul, 2007)

$$log(H_1/H_t) - 2logL(y) = \hat{c} + \hat{b} \; log t + u_t$$

where $log(H1/Ht)$ is the cross-sectional mean square transition differential and measures the distance of the panel from the common limit; and $t = [rT], [rT] + 1, \ldots, T, with \; r > 0$.

### 4.2. Club convergence

This subsection aims to examine whether any convergence pattern emerges and identifies potential clustering clubs among European nations. Our analysis utilizes a sample comprising 20 European countries and the U.K., covering the period from 2016 to 2022. Czech Republic, Bulgaria, Estonia, Latvia, Malta, Slovakia, and Slovenia are excluded from our analysis due to the absence of green loan issuance during the selected period. To ensure comparability, we convert all currencies to euros using the Refinitiv filter. Our panel dataset consists of the total amount of green loans (GL) issued in euros, for each country and each year.

Table 4 presents the results of the convergence log-t-test applied to the amount of GL. The time series data undergo the Hodrick-Prescott filter to remove any seasonal or cyclical factors. The test rejects the hypothesis of overall convergence at a statistically significant level of 1%.

**Table 4**

Convergence Club Classification

| Club | Coefficient | T-stat | Club members |
|---|---|---|---|
| Full sample | -1.0424 | -74.570 | |
| Club 1 | 0.168 | 3.989 | France, Germany, Spain, United Kingdom |
| Club 2 | 0.115 | 0.827 | Hungary, Italy, Sweden |
| Club 3 | 0.323 | 8.162 | Austria, Denmark, Finland, Luxembourg, Poland, Portugal |
| Club 4 | 0.538 | 27.984 | Croatia, Cyprus, Greece, Ireland, Lithuania, Romania |
| Not convergent | -7.709 | -5.422 | Belgium, Netherlands |

**Note:** Log (t) results for convergence in green loans amount for the above-mentioned countries between January 1, 2016, and December 31, 2022. The null hypothesis of convergence is rejected at the 5% level if T-stat < -1.65. In our case, the null hypothesis of convergence is rejected at the 1% level because T-stat = - 74.570

Four distinct clubs have been identified based on the analysis: the first group consists of four countries, the second group comprises three countries, the third group includes six countries, and the fourth group is composed of six countries. However, it is important to note that there are two countries that do not belong to any specific group and diverge from the identified clubs.

As observed by Phillips and Sul (Phillips & Sul, 2009) as well as Lyncker and Thoennessen (2017) and Mendez (2020), it is possible for the convergence club algorithm proposed by Phillips and Sul in 2007 to overestimate the number of clubs. To tackle this problem, it is suggested to conduct a sequential merging test among the clubs. The outcome of this test is displayed in Table 4.1. Even though all the coefficients exhibit negative values, the primary parameter for assessing club convergence is the t-statistic. If this statistic falls below -1.65, the null hypothesis of convergence can be rejected. The null hypothesis of convergence can be rejected between the merge between Club 1 and 2 (-22.010 < -1.65), Club 2 and 3 (-13.287 < -1.65) and Club 3+4 (-11.501 < -1.65).

**Table 4.1**

Club merge test

| Statistic | Club 1+2 | Club 2+3 | Club 3+4 |
|---|---|---|---|
| Coeff | -0.608 | -0.794 | -0.474 |
| T-stat | -22.010 | -13.287 | -11.501 |

Following these criteria, the results highlight that no clubs can be merged. This underscores the robustness of the four clubs identified in the analysis, as presented in Table 4. The final composition of each group, as well as the separate countries, is illustrated in Figure 3.

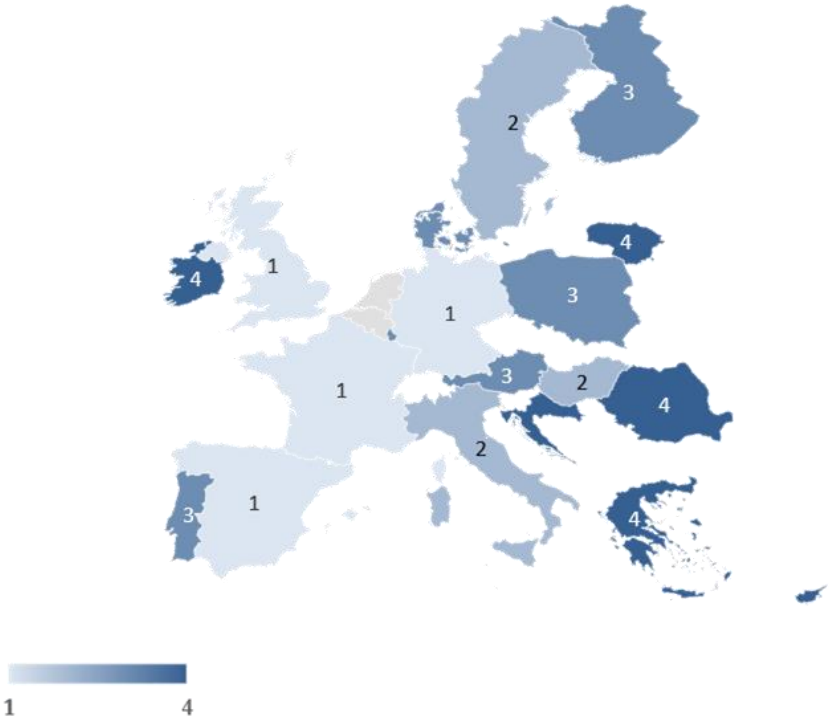


**Fig. 3.** Club Convergence.

The result of the log t-test for club 1 is 0.168 with a statistical value t of 3.989 so the null hypothesis of convergence is not rejected and France, Germany, Spain, and United Kingdom converge according to the log t-test. Analogously, the log t-tests provide evidence of convergence of the other clubs. Club 2, whose t-test is 0.115 with a statistical value t of 0.827 is composed of Hungary, Italy, and Sweden. Club 3 leads to a similar outcome, whose value of the log t-test is 0.323 with a statistical value of t of 8.162. This is the reason why the null hypothesis of convergence of Austria, Denmark, Finland, Luxembourg, Poland, and Portugal is also not rejected. Club 4 results in a value of 0.538 for the log t-test and a statistical value t of 27.984, so the null hypothesis of convergence is not rejected and Croatia, Cyprus, Greece, Ireland, Lithuania, and Romania converge.

**4.3. Club membership**

In this subsection, we attempt to shed some light on the potential drivers of club membership. The main goal is to test whether green loan issuance patterns across clubs are influenced by market maturity, environmental considerations, and banking structures. As suggested by Bartkowska and Riedl (Bartkowska & Riedl, 2012), we perform an ordered logit with the standard error that is robust, to explain club membership of the four convergence clubs, denoted by the ordinal variable c (McKelvey & Zavoina, 1975). Following Bartkowska and Riedl (Bartkowska & Riedl, 2012), We can model the dependent variable as an ordinal variable since convergent clubs can be ranked according to the amount of green loans each country in the respective club has issued. We assume that there exists a continuous latent variable that is associated with club membership, given that we do not have knowledge of the variations in steady-state levels between different clubs, y*, such that:

$$y_i^* = X_i\beta + \varepsilon_i$$

where X are the explanatory variables in the initial period, and ε are the errors with a mean of zero and a variance of $\pi^2/3$. Due to the few observations, it is not possible to include a large set of variables. Hence, in what follows we adopt a parsimonious specification of the regression model to maintain enough degrees of freedom (Brosio et al., 2022). Belgium and the Netherlands are assigned to Club 4 and Club 2, respectively, based on an evaluation method considering the clubs that would have formed from 2017 to 2022. To ensure the robustness of the analysis, the regressions are tested with and without these two countries[5]. The results show consistency, with no significant changes.

[5] Please refer to the Stata Do-file for the version without these two countries

Table 5 presents the descriptive statistics for the data employed. Previous studies demonstrate that the size of the domestic currency bond markets tends to be larger in economies with higher stock market capitalization (Claessens et al., 2000; Tolliver et al., 2021). We suspect that a similar relation may holds for the green loans market as a club determinant. Therefore, we assess the positive relationship between green loans and the financial market structure using as a proxy Market Capitalization. Data are obtained from the World Bank's World Development Indicators (2019) and represents the value of stocks traded as a percentage of GDP for each country in 2016.

To capture the importance of environmental degeneration in the decision of green issuing, we use the Ecological Footprint (EF) following Ulucak et al. ( 2020), and Arogundade et al. ( 2023). The EF quantifies the amount of land and water needed to sustain the resources consumed by an individual, population, or activity, along with the urban infrastructure it occupies and the waste it produces, given the current technology and resource management practices. The EF is an exhaustive framework for evaluating the consumption of natural resources by a population, as well as the effect of anthropogenic activities on nature. The dataset is produced by the Ecological Footprint Initiative of York University in collaboration with the Global Footprint Network[6], which provides data on EF Consumption expressed as global hectares per person for 2016.

To examine the role of bank structure in promoting (or not) green financing, we use bank concentration as a proxy, representing the share of total assets held by the five largest banks at the country level in 2016. This data is provided by the Global Financial Development Indicator archived in the World Bank database. Following the literature (Karadima & Louri, 2021), as a robustness check, we assess the reliability of our regression results by employing a stricter alternative measure, which involves examining the assets of the three largest commercial banks as a share of total commercial banking assets. The findings are consistent, with no variations.

Moreover, we investigate the relationship between bank efficiency and the issuance of green loans. Several studies have shown that efficient banks tend to perform better overall (Abd Karim et al., 2010; Lin & Zhang, 2009; Louzis et al., 2012; Ozili, 2019). Building on this understanding, we propose that bank efficiency might influence the propensity to issue green loans. To measure bank efficiency, we use the bank cost-to-income ratio expressed as a percentage. For a robustness check on the financial stability of the bank structure, we consider two alternative measures provided by the WB database in place of bank efficiency: deposit money bank assets to GDP, serving as an indicator of the size and significance of the banking sector relative to the overall economic activity of a country in 2016, and bank regulatory capital to risk-weighted assets.

[6] https://www.footprintnetwork.org/resources/data/

The latter ratio evaluates a bank's financial strength and its capacity to absorb losses, representing the relationship between a bank's regulatory capital and its risk-weighted assets. However, for this measure, due to variances in national accounting, taxation, and supervisory regimes, the data might not be directly comparable across countries. Appendix 1 presents the robustness check.

**Table 5**

Covariate-level descriptive statistics

| | Mean | StD | Min | Max |
|---|---|---|---|---|
| Market capitalization (% of GDP) | 56.868 | 40.213 | 8.989 (Lithuania) | 139.104 (Sweden) |
| Ecological Footprint (gha per capita) | 5.135 | 2.231 | 1.492 (Spain) | 12.783 (Luxembourg) |
| Bank concentration (%) | 68.612 | 15.662 | 33.525 (Luxembourg) | 98.184 (Greece) |
| Bank cost to income ratio (%) | 60.026 | 10.663 | 46.435 (Lithuania) | 84.022 (Germany) |
| Deposit money banks' assets to GDP (%) | 97.830 | 39.180 | 17.174 (Cyprus) | 176.251 (Denmark) |
| Bank regulatory capital to risk-weighted assets | 19.572 | 3.905 | 12.273 (Portugal) | 26.941 (Ireland) |

Since $y_i^*$ is not observable, we compute the probabilities of belonging to a specific club, c, given the set of covariates X by performing a maximum likelihood technique. To prevent possible cases of heteroscedasticity we use the ordered logit model with the standard error that is robust to misspecification. As a robustness check of our empirical estimation, we followed Johnston et al. (Johnston et al., 2020)and used the ordered probit model with the robust standard error.

Table 6 displays the marginal effects of the predicted probabilities of variables in predicting club membership[7]. The marginal effects assess how the probability of belonging to a club change when one of the independent variables is changed by one per cent (Market capitalization, Bank concentration, Bank cost to income ration) or by one unit (Ecological footprint), while all other variables are held constant at their sample averages. In other words, the coefficients indicate how much the probability of being a member of a particular club would alter with a slight variation in the covariates.

[7] We acknowledge that additional potential covariates could be used to capture the complexity of the green loan issuing decision, but we are forced to adopt a parsimonious specification due to the small dimension of the sample.

**Table 6**

What determines membership in the Green Loan Club? Marginal effects on probabilities with robust SE.

| | | Ordered logit model | | Ordered probit model | |
|---|---|---|---|---|---|
| **Variables** | **Club** | **dy/dx** | **Std. Err.** | **dy/dx** | **Std. Err.** |
| Market capitalization | 1 | 0.006*** | 0.001 | 0.006*** | 0.001 |
| | 2 | 0.002 | 0.001 | 0.002 | 0.002 |
| | 3 | 0.004** | 0.001 | 0.003* | 0.002 |
| | 4 | -0.012*** | 0.002 | -0.012*** | 0.002 |
| Ecological Footprint | 1 | -0.058*** | 0.009 | -0.056*** | 0.009 |
| | 2 | -0.020 | 0.016 | -0.023 | 0.017 |
| | 3 | -0.033* | 0.016 | -0.028 | 0.017 |
| | 4 | 0.111*** | 0.027 | 0.108*** | 0.027 |
| Bank concentration | 1 | -0.006*** | 0.002 | -0.006*** | 0.002 |
| | 2 | -0.002 | 0.002 | -0.002 | 0.002 |
| | 3 | -0.003* | 0.002 | -0.003 | 0.002 |
| | 4 | 0.012*** | 0.004 | 0.011*** | 0.004 |
| Bank cost to income ratio | 1 | 0.015*** | 0.002 | 0.015*** | 0.002 |
| | 2 | 0.005 | 0.004 | 0.006 | 0.004 |
| | 3 | 0.008** | 0.004 | 0.008** | 0.004 |
| | 4 | -0.029*** | 0.003 | -0.029*** | 0.003 |

*** Significance at 1%, **Significance at 5%, *Significance at 10%.
Appendix A1 displays the table with the two alternative measures used in substitution for the Bank cost-to-income ratio

One of the foundational assumptions in ordered logistic (and ordered probit) regression is that the relationship between each pair of outcome groups remains consistent. This means that ordered logistic regression operates on the premise that the slope of the logistic function is uniform across all categories. We evaluate the assumption of proportional odds by conducting an approximate likelihood-ratio test using the Stata command *omodel*. Under the null hypothesis, we test for disparities in coefficients between groups, and we deem the assumption valid if we obtain a non-significant result. The results chi2(8) = 11.08; Prob >chi2= 0.1974 suggest that the proportional odds approach is reasonable since the chi-square test is not significant (Wolfe, 1997). The robustness check for probit regression yields similar findings.

Analysing the factors influencing green loan issuance across various country clubs reveals intricate relationships. A one percentage increase in stock market capitalization relative to GDP corresponds to 0.006 points increase in the probability that a country belongs to Club 1, the highest green loan issuer (p-value of 0.000). This suggests that nations with larger and more mature stock markets have a more proactive approach to issuing green loans, underlining the importance of a developed financial system in sustainable finance integration. For Club 2 the effect is positive but not statistically significant, with a p-value of 0.159, indicating that the observed relationship could be due to random chance. For Club 3, a positive effect is observed, and it's statistically significant at the 5% level with a p-value of 0.043, indicating moderate evidence against the null hypothesis. For Club 4, the effect is negative and highly statistically significant with a p-value of 0.000. The negative relationship suggests that as stock market capitalization increases, the likelihood of a country belonging to Club 4 decreases, the lowest green loan issuer.

In contrast, the ecological footprint per capita presents an anomaly[8]. With each increase, there is a marked decrease in the likelihood of high green loan issuance in Club 1, p-value of 0.000, hinting at a potential gap between environmental concerns or impact and green loan financing. For Club 2, the effect is negative but not statistically significant, with a p-value of 0.208. For Club 3, the effect is negative with a p-value of 0.051, meaning it is just above the conventional significance level of 0.05, which may suggest a borderline significance. For Club 4, the positive relationship indicates that as the ecological footprint per capita increases, the likelihood of a country being in Club 4 also increases. This relationship is highly statistically significant, with a p-value of 0.000. The higher the ecological footprint consumed per person, the greater the likelihood that a country belongs to the group with the lowest green loan issuance.

The banking sector's structure also plays a role. For every percentage increase in bank concentration, there is a decrease in the probability of high green loan issuance for Club 1, p-value of 0.000, indicating that countries with a few dominant banks might face challenges in diversifying their loan portfolios to integrate green loans. For Club 2, the effect is negative but not statistically significant, with a p-value of 0.234. For Club 3, the negative relationship has a p-value of 0.080, suggesting it is nearly significant at the 10% level. For Club 4, the implication of the positive effect is that as the concentration in the banking sector increases, a country is more likely to belong to Club 4, the club with the lowest green issuance. This effect is significant, with a p-value of 0.003.

Yet, the bank cost-to-income ratio offers a peculiar insight. An increase in this percentage ratio, which might indicate inefficiency, interestingly correlates with a heightened probability of green loan issuance in Club 1 and a p-value of 0.000. It hints at the idea that some banks or regions might prioritize green financing, even if it is operationally costlier. For Club 2, the effect is positive but not statistically significant, with a p-value of 0.171. For Club 3, the positive relationship is statistically significant with a p-value of 0.016. For Club 4, the negative relationship suggests that as the bank cost-to-income ratio increases, the probability of a country being in Club 4 decreases. This is confirmed as highly significant with a p-value of 0.000.

[8] The word 'anomaly' is used when comparing the main finding of the Ecological Footprint presented in second paper of my dissertation, titled: Green Debt: Do European countries' green bond issuances converge?

However, some words of caution are needed. Green loan issuance patterns across countries paint a detailed picture, influenced by market maturity, environmental considerations, and banking structures. While these observations offer insights, identifying clear cause-and-effect relationships demands a closer look, especially considering the unique financial and environmental aspects of each country. In the following subsection, we investigate the impact of financial development on green loans starting from the green loan sample used in subsection 4.2.

### 4.4. Financial Development impact

Previous studies confirmed that financial development is particularly relevant for bank profitability and efficiency (Demirgüç-Kunt & Huizinga, 1998; O'Connell, 2023), and its importance has been highlighted by Claessens et al. (2000), Naceur and Omran (Naceur & Omran, 2011) and Ozili (2015). The level of financial development within a country is crucial because it can influence the domestic mobilization of resources necessary to address various crises, including those related to climate change (Naudé, 2009; Ozili, 2019). For instance, developed countries recovered more swiftly from the 2008 global financial crisis than less financially developed nations (Naudé, 2009). Despite the establishment of green principles and various national policy frameworks aimed at promoting green loan issuance the relative slow growth of green loans compared to green bonds remains a significant concern. This raises questions about the effectiveness of existing policy measures in encouraging green finance. We contend that assessing the level of financial development can provide valuable insights to enhance our understanding of the relatively growth of green loans.

We are interested in the cross-country impact of financial development on aggregate green loans. To explore this, we use a panel dataset that includes 19 European countries from 2016 to 2021. We have excluded the year 2022 and countries such as Cyprus and the United Kingdom due to data availability constraints. Data was obtained from the global financial development indicator in the World Bank database. While appendix A2 provides a full description of the variables, Table 7 displays a summary of the descriptive statistics.

**Table 7**

Descriptive statistics

| | Obs. | Mean | StD | Min | Max |
|---|---|---|---|---|---|
| Financial Development | 126 | 0.620 | 0.173 | 0.196 (Lithuania) | 0.901 (Spain) |
| Bank credit to bank deposits | 114 | 101.532 | 53.025 | 22.705 (Luxembourg) | 297.096 (Denmark) |
| Bank non-performing loans to gross loans | 104 | 6.501 | 9.2555 | 0.495 | 45.572 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | (Sweden) | (Greece) |
| Private credit by deposit money | 120 | 84.362 | 35.955 | 24.735 | 166.561 |
| | | | | (Romania) | (Denmark) |
| Bank Z score | 124 | 17.559 | 11.632 | 5.122 | 57.441 |
| | | | | (Lithuania) | (Luxembourg) |
| Government Effectiveness | 126 | 1.135 | 0.579 | -0.257 | 2.047 |
| | | | | (Romania) | (Finland) |

To investigate the impact of financial development on green loans, we aim to expand the existing literature on non-performing loans (NPL) to encompass green issuance. In doing so, we adopt a simplified version of the models used by Ozili (Ozili, 2015, 2019), Beck et al. (R. Beck et al., 2015), Louzis et al. (2012), and Dimitrios et al. (2016). Our hypothesis is that financial development and banking factors influencing non-performing loans may also have an impact on green loan issuance.

Several reasons explain why these factors may be interconnected. When the banking sector lacks adequate risk assessment mechanisms, it can lead to higher NPLs. Conversely, robust risk assessment practices can reduce NPLs. This risk assessment process can also influence the issuance of green loans. If banks improve their ability to assess the creditworthiness of green projects and borrowers, it can lead to more green loan issuance. Moreover, financial development affects interest rates and lending conditions. Lower interest rates and favorable lending terms can stimulate borrowing activity and reduce the likelihood of NPLs. These conditions can also encourage businesses to seek green loans for environmentally friendly projects, as the cost of borrowing becomes more attractive. Additionally, a well-developed financial sector tends to inspire greater investor and borrower confidence. When borrowers have confidence in the banking system, they are more likely to repay their loans promptly, reducing NPLs. This trust can also extend to green loans, as borrowers may have more faith in the financing of environmentally sustainable projects through established banks.

Developed financial markets often offer a broader range of risk mitigation tools, such as credit derivatives and insurance. These tools can help banks manage their exposure to NPLs and reduce losses. Similarly, banks can use these instruments to manage risks associated with green loans, making it more attractive for them to issue such loans. Moreover, a well-developed financial sector provides banks with access to several funding sources. This access can reduce their reliance on short-term and volatile funding, making them more resilient to economic shocks. Finally, the reputation of banks and their commitment to environmental, social, and governance (ESG) principles can influence their NPLs and green loan issuance (Bătae et al., 2020). Banks that are perceived as responsible and sustainable may attract more green borrowers and investors, reducing

NPLs and increasing the demand for green loans.

Green loan (GL) is estimated as a function of internal and external determinants while controlling for financial development which is the variable of interest. The model is expressed as:

*Green Loan = $\beta 0$ + $\beta 1$ Financial Development + $\beta 2$ Bank credit to bank deposits + $\beta 3$ Bank non-performing loans to gross loans + $\beta 4$ Private credit by deposit money + $\beta 5$ Bank Z score + $\beta 6$ Government Effectiveness + $e$*

The analysis estimates the impact of financial development on GL after controlling for some bank-level determinants and the financial structure of the banking sector across countries.

We control for two determinants that potentially influence the level of green loans at the bank level: Bank credit to bank deposits ratio (BCBD), which measures banking sector liquidity, and Bank non-performing loans to gross loans (NPL), which reflects the credit quality of banks' loan portfolios. We select BCBD because banking sector liquidity can influence a bank's ability and willingness to extend credit (Demirgüç-Kunt & Huizinga, 1998; European Commission. Directorate General for Energy. et al., 2022; Ozili, 2019). A higher liquidity level might suggest that a bank is more willing to explore new lending opportunities, including green loans. As a result, we expect a positive relationship between them. NPL serves as an indicator of a bank's asset quality. Furthermore, asset quality is a pivotal indicator of the performance of a country's banking sector, among other performance indicators (ECB, 2007; Laeven & Majnoni, 2003). We highlight the importance of NPL. This is because, as Nkusu (2011) points out, a high NPL ratio can impact a bank's capital buffers negatively and diminish its profitability. Banks with limited capital might be less inclined to issue new types of loans, such as green loans. Consequently, we expect a negative relationship between these variables.

Next, we incorporate a financial sector development indicator into the model, Private credit by deposit money banks to GDP (PCDM), which represents the extent of financial intermediation. This indicator is measured as the private credit by domestic banks to GDP ratio (Čihák et al., 2012; Claessens et al., 2000). PCDM serves as a barometer of the depth of the financial sector in a particular country (Laeven & Levine, 2009). It signals the extent to which the private sector accesses bank credit, fundamental for economic activities, including green projects. A higher PCDM ratio might suggest a more mature financial sector where banks play a crucial role in channeling savings towards investments (Rajan & Zingales, 1998). In such an environment, the likelihood of green loans being part of the bank's portfolio might be higher due to a more diverse lending portfolio (Scholtens & Dam, 2007).

Next, we integrate a financial structure indicator into the model that represents bank stability in each country. The z-score index (Z-score) is commonly used in the literature to measure banking stability, as it captures the probability of default of a country's commercial banking system (Demirgüç-Kunt & Huizinga, 2010; Foos et al., 2010; Laeven & Levine, 2009; Ozili, 2018, 2019). Higher z-score values indicate increased banking stability, which often translates to a degree of risk aversion (Anginer & Demirguc-Kunt, 2014; Berger et al., 1995). When considering green loans, perceived as novel or unfamiliar, a stable bank might exhibit greater caution (Jeucken, 2001; Scholtens, 2006). This can lead to a potential inverse relationship between stability and the volume loans (Jeucken, 2001), green issuance included.

Finally, we introduce an institutional development indicator into our model: Government Effectiveness (GE). GE comprehensively assesses the quality of public services, the civil service's independence from political influences, the effectiveness of policy formulation and implementation, and the government's commitment to these policies. The quality and effectiveness of governmental institutions often shape the broader socio-economic and regulatory environment in which banks operate (Acemoglu et al., 2005; La Porta et al., 2002). This environment can subsequently influence a bank's willingness or ability to engage in certain types of lending, including green loans (Boot et al., 1993). An effective government, characterized by clear policy direction and commitment, can provide a more predictable regulatory landscape (Djankov et al., 2006). Such predictability is vital for banks when considering longer-term and potentially riskier investments, such as green projects (Scholtens & Dam, 2007). Therefore, we expect a positive relationship between government effectiveness and the lending decision (T. Beck et al., 2003).

The correlation matrix in Appendix 3 shows that multicollinearity may be an issue in our analyses. Therefore, we run Variance Inflation Factor (VIF), which is a common method to check multicollinearity (O'brien, 2007). A VIF value above 10 suggests multicollinearity. While PCDM has a VIF close to 10 (9.02), suggesting potential concerns, the other variables have VIF values well below 10, BCBD (3.68); FD (2.97), GE (2.67), Z-score (2.46), NPL (1.79) indicating moderate to low multicollinearity. The average VIF is also below 10 (3.77), suggesting that, on average, multicollinearity might not be a severe concern in this model.

Finally, the model is estimated using the Pooled OLS estimator, the Population-averaged estimator, without and with fixed effects, country and year fixed effect, and random effects.

**Table 8**

Regression results

| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
|---|---|---|---|---|---|
| | Coefficient (t-statistic) | Coefficient (t-statistic) | Coefficient (t-statistic) | Coefficient (t-statistic) | Coefficient (t-statistic) |
| FD | 1677.256** | 1673.434** | -8442.325* | -6225.46 | 1422.189* |
| | (675.706) | (651.417) | (5012.9) | (5390.653) | (805.649) |

| | | | | | |
|---|---|---|---|---|---|
| BCBD | -6.480**<br>(2.854) | -6.503**<br>(2.750) | -25.292**<br>(9.793) | -39.410***<br>(14.547) | -7.936**<br>(3.254) |
| NPL | -36.633***<br>(10.700) | -36.699***<br>(10.311) | -15.763<br>(32.716) | -3.246<br>(33.927) | -40.700***<br>(12.337) |
| PCDM | 15.946**<br>(6.226) | 15.995***<br>(5.998) | 37.540**<br>(16.048) | 57.641***<br>(20.477) | 19.079***<br>(7.074) |
| Z-score | -18.916**<br>(8.925) | -18.949**<br>(8.603) | 74.266<br>(51.760) | 32.516<br>(55.884) | -20.735**<br>(10.546) |
| GE | -635.128***<br>(186.308) | -635.826***<br>(327.674) | -1517.698<br>(3158.059) | -1408.307<br>(955.383) | -681.370***<br>(222.352) |
| Constant | -14.796 | -12.277 | 5507.212 | 4432.524 | 146.938 |
| Fixed Effect (FE) | NO | NO | YES | | NO |
| Country FE | NO | NO | NO | YES | NO |
| Year FE | NO | NO | NO | YES | NO |
| Random Effect | NO | NO | NO | NO | YES |
| Observation | 92 | 92 | 92 | 92 | 92 |
| Adj R-squared | 0.278 | | | | |
| R-squared (Within) | | | 0.286 | 0.363 | 0.158 |
| R-squared (Between) | | | 0.130 | 0.160 | 0.607 |
| R-squared (Overall) | | | 0.022 | 0.000 | 0.323 |
| Sigma_u (α) | | | 1862.797 | 1644.456 | 212.422 |
| Sigma_e | | | 594.263 | 579.166 | 594.263 |
| Rho | | | 0.908 | 0.889 | 0.115 |
| Theta (median) | | | | | 0.222 |

Columns (1)-(5) report regression results for countries starting from the analysis presented in Table 2, section 3. However, the U.K. and Cyprus are excluded due to missing values in the covariates for the period from 2016 to 2021. Results are in millions of euros. T-statistics are reported in parentheses. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively. The regression includes the Pooled OLS estimator (1), the Population-averaged estimator without fixed effects (2), with fixed effects (3), combined country and year fixed effects (4), and random effect (5). Standard errors are not clustered

Column 1 of Table 8 reports the regression results using the Pooled OLS estimator, while columns 2, 3, and 4 present the regression results for the Population-averaged estimator without fixed effects (column 2), with fixed effects (column 3), country and year fixed effect (column 4), and with random effects (column 5).

We apply the Hausman test (1978) for fixed versus random effects model and the Breusch-Pagan LM test (Breusch & Pagan, 1980) for random effects versus OLS. We evaluate the coefficient consistency in a regression model, distinguishing between fixed effects and random effects models based on the null hypothesis (H0) suggesting the appropriateness of the random effects model for the data. The decision to accept or reject H0 depends on the comparison of the p-value (Prob > chi2) to the common significance level, often set at 0.05. A p-value below this threshold leads to H0 rejection, implying unsuitability of the random effects model and preference for the fixed effects model due to statistically significant coefficient differences. Conversely, a p-value exceeding the significance level results in H0 acceptance, signifying the suitability of the random effects model, as the coefficient disparities lack statistical significance. In our analysis, the Hausman test yielded chi2(6) = 16.80 with a p-value (Prob > chi2) of 0.0100, falling below the 0.05 threshold, thereby supporting H0 rejection and endorsing the fixed effects model due to statistically significant coefficient differences.

Next, we provide further comments related to the results from a fixed-effects regression analysis (Column 3) using the Stata *xtreg* command with the option *fe*. There are 92 total observations in the data, and 19 unique groups in the dataset. Countries such as Cyprus and the United Kingdom are excluded because of data availability constraints. Groups have between 3 and 5 observations, averaging 4.8 observations per group, which reflects few missing data. Moreover, 28.6 percentage of the within-country variation in green loans can be explained by the independent variables, 13.05 percentage of the between-country variation is explained by the independent variables. Overall, the independent variables explain 2.23 percentage of the variation in green loans. The F-statistic (4.48) tests if all the coefficients of the independent variables are zero. The p-value (0.0007) suggests rejecting this null hypothesis at any conventional significance level, implying that at least one predictor is significant in explaining the variation in green loans (in millions of euros).

For Financial Development, which ranges from 0 (lowest) to 1 (highest financial development), a shift from the lowest to the highest level is associated with a decrease of about €8,442 million in green loans (€ 8.44 billion). However, this is not statistically significant at the 5% level (p-value=0.097), though it is weakly significant at the 10% level. There are several potential reasons behind the observed inverse relationship. One possibility lies in the nature of mature financial systems in countries with advanced financial development. In such systems, there might be a preference for traditional or established forms of investments over green loans. Scholars like Rajan and Zingales (Rajan & Zingales, 1998) analysed how financial systems evolve and can potentially become resistant to change due to ingrained practices. Risk perception is another factor to consider; developed financial systems might perceive green loans or sustainable investments as riskier or less profitable in the short term compared to other opportunities. The regulatory environment may also play a crucial role; countries with well-developed financial systems might lack supportive regulatory measures for green initiatives. Indeed, countries with mature financial markets and institutions often have systems that evolved over extended periods, shaped by historical economic priorities and strategies (Rousseau & Sylla, 2003). These systems may have taken shape during times when environmental concerns were not as pronounced as they are today. Consequently, the regulatory framework could align more with traditional industries and financial practices than with contemporary green or sustainable initiatives. Furthermore, the economic structure in countries experiencing high financial development might have major industries that do not focus on green practices, leading to diminished green lending activities. It is noteworthy to mention the statistical significance of this relationship. In our dataset, while the inverse relationship is not statistically significant at the 5% level, it demonstrates weak significance at the 10% level. This suggests that the observed relationship might be influenced more by random variation in the data than by a genuine underlying relationship.

Private credit by deposit money represents the financial resources provided to the private sector by domestic money banks as a share of GDP. A one percentage increase in this metric is associated with an increase of €37.54 million in green loans. This effect is statistically significant at the 5% level (p-value=0.022). One potential explanation for the observed positive relationship is the increase in financial capacity within the private sector. As the private sector gets more credit relative to GDP, it suggests that there is more financial activity and possibly more liquidity in the market. With more funds available, there might be more willingness or ability for banks or financial institutions to allocate resources (Maksimovic et al., 2000), green investments included. Another reason could be tied to risk diversification strategies employed by banks. As financial institutions provide more credit, they might attempt to diversify their loan portfolios to hedge against potential market downturns (Scholtens, 2006). Green loans, in this context, can offer a special avenue for diversification, given that their performance could deviate from traditional loans, especially in economies that are progressively shifting towards environmentally-friendly initiatives. Another reason could be reputation and branding, as sustainability becomes a more prominent global concern, many banks and financial institutions are focusing on green initiatives as part of their corporate social responsibility. This not only enhances their reputation but also their competitive advantage becoming more appealing to environmentally-conscious investors and customers (Porter & Kramer, 2006).

Bank credit to bank deposits reflects the amount banks are extending as loans compared to the deposits they hold. When this lending measure rises by one percentage, we expect a decline of €25.29 million in green loans. This observation is statistically significant with a p-value of 0.012. It suggests that when banks lend more compared to their deposits, they might allocate fewer resources to green loans, possibly due to perceptions of risk.

The Bank non-performing loans to gross loans ratio provides insight into loans that are not being repaid on time. An increase of one percentage in this non-performing loan ratio leads to a decrease of €15.76 million in green loans. However, this correlation is not strongly supported by data, given its p-value of 0.632. The Bank Z score represents bank stability. Improved banking stability correlates with an increase of 74.26 million in green loans. However, this finding is not statistically strong, evidenced by its p-value of 0.156. Lastly, the Government Effectiveness measure, which varies between approximately -2.5 and 2.5, suggests that for each unit improvement in government efficiency, green loans decrease by €1,517 million (€1.51 billion). But this association is not statistically robust, as reflected by its p-value of 0.115.

In the next section, we conclude our analysis by drawing two main policy implications derived from the findings of section 4.

## 5. Conclusion

This paper investigates whether any convergence occurred among European countries and the U.K. in the euro amount of green loans issued during the period of 2016-2022. To this end, a convergence log-t test has been performed on a panel of 20 European countries and the U.K. The results show that four clubs converge and one divergent. Hence, we perform an ordered regression model to capture potential drivers of club membership. Market maturity, environmental consumption, and banking structure appear to significantly influence the likelihood of club membership. By definition, the emergence of clubs signals the absence of a common European banking commitment for issuing green loans. Our results show that clubs of countries have adopted a common approach to green issued.

We attempt to shed light on the fragmentation of the EU green loan market by examining the economic, environmental consideration, and banking factors that contribute to it. As a result, our work addresses this issue directly from an inferential perspective. Countries with a higher stock market capitalization relative to their GDP are more likely to belong to Clubs 1 and 3 and less likely to be in Club 4. This could indicate that countries with more mature and larger stock markets relative to their economic size are typically among the more economically developed and influential green issuers. Countries with a higher ecological footprint per capita are less likely to be in Club 1 but more likely to be in Club 4. This may suggest that countries with a larger ecological footprint per person might be less stringent or less advanced in sustainable financial practices, aligning more with Club 4 countries. Bank concentration, higher bank concentration reduces the likelihood of a country being in Club 1 but increases it for Club 4. This might indicate differing financial structures among these clubs. Countries, where a few banks dominate, might have financial systems or regulations that are more characteristic of Club 4 nations. Bank cost-to-income ratio, a higher bank cost-to-income ratio, indicating possibly less efficient banking operations, increases the likelihood for a country to be in Clubs 1 and 3 and decreases it for Club 4. This suggests that Club 1 and 3 countries might have banking sectors facing higher operational challenges or different operational standards, with some banks prioritizing green financing even if it is operationally costlier compared to Club 4 countries.

Considering the presence of divergent characteristics among countries within the clubs outlined in sections 4.2 and 4.3, the policy implications derived from our empirical findings indicate a need for tailored policy approaches. While the one-size-fits-all approach may not be appropriate, policymakers should consider developing specific strategies for countries belonging to different clubs, applying a group policy perspective that accommodates the majority of countries within the clubs (paraphs a sort of one-size-fits most). Club 1 and 3 countries may benefit from policies that address operational challenges and standards in their banking sectors to encourage green financing despite potential operational costs. Meanwhile, Club 4 countries may benefit from policies aimed at strengthening the market capitalization of their financial system. Policymakers should be aware that in countries where a few dominant banks hold significant market share, there may be challenges in diversifying loan portfolios to include green loans. To address this, measures should encourage and facilitate the participation of a broader range of financial institutions in green financing initiatives, promoting competition and innovation within the banking sector. This approach can help overcome barriers related to bank concentration and foster a more diverse and sustainable lending landscape.

Furthermore, subsection 4.4 reveals insights into the dynamics of green loan issuance with respect to financial and economic factors. Firstly, it highlights that financial development, as it progresses from its lowest to highest levels, exhibits a (weak) negative correlation with green loans. Possible explanations for this observation could revolve around mature financial systems favoring conventional investments over environmentally conscious ones, potentially influenced by prevailing risk perceptions within the financial landscape. When delving into the metrics associated with private credit by deposit money, the data suggests a positive relationship, potentially reflecting increased financial capacity within the private sector, diversification strategies pursued by banks, and the conscious effort of certain financial institutions to build a reputable image through their commitment to green initiatives. Likewise, examining the inverse relationship between bank credit to bank deposits and green loans, we found that when banks extend their lending activities beyond the limits of their deposits, they allocate fewer resources toward green loans, possibly due to risk perceptions or a strategic shift towards conventional lending practices. However, we did not find any significant relationship among Bank Non-Performing Loans, Bank Z Score, and government effectiveness.

Considering the observed positive relationship between private credit by deposit money and green loans results of subsection 4.4, the policy implications derived from our empirical findings is promoting private sector involvement. This correlation underscores the pivotal role that the private sector can play in driving investments towards environmentally conscious initiatives. Thus, implementing measures that aim to enhance the financial capacity of the private sector. This can involve incentivizing private enterprises to invest in green projects, offering favorable terms and conditions for sustainable investments, and facilitating access to financing for environmentally friendly endeavors. Moreover, policymakers could work closely with financial institutions to develop strategies that promote a diversified portfolio of sustainable investments. This may include the creation of specialized green financing divisions within banks, offering training and guidance on green lending practices, and providing financial incentives for banks to allocate a certain portion of their resources to green loans. Additionally, the identified inverse relationship between bank credit to bank deposits and green loans in subsection 4.4 underscores the need for policymakers to carefully balance bank lending activities. While promoting green financing and sustainability is crucial, it is equally important to maintain a stable and resilient financial sector. Policymakers could mitigate the risk associated with an overconcentration of funds in any one lending category by incentivizing diversification.

Our main recommendations align with the EU's commitment to increasing private capital inflow into sustainable investments. They emphasize the importance of a more inclusive sustainable finance framework that facilitates access to sustainable financing, including green loans and mortgages, for households and small businesses, as expressed in the recent Call for Advice to the European Banking Authority (2022).

However, we remain cautious about interpreting our results in terms of causal effects. We emphasize the importance of further disentangling the green finance for the scholarly debate. We hope that future scholarship can build upon our results and refine the empirical analysis to ascertain the causality from financial institutions to countries' commitment to green finance. In a world characterized by growing environmental fragmentation, club decisions to issue green loans for ecological transition or adaptation are likely to persist in the future.

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## Appendix 1

What determines membership in the Green Loan Club? Marginal effects on probabilities with robust SE.

| | | Ordered logit model | | Ordered probit model | |
|---|---|---|---|---|---|
| **Variables** | **Club** | **dy/dx** | **Std. Err.** | **dy/dx** | **Std. Err.** |
| Market capitalization | 1 | 0.003*** | 0.001 | 0.003*** | 0.001 |
| | 2 | 0.002 | 0.001 | 0.001 | 0.001 |
| | 3 | -0.000 | 0.000 | -0.000 | 0.001 |
| | 4 | -0.004*** | 0.001 | -0.005*** | 0.001 |
| Ecological Footprint | 1 | -0.055*** | 0.016 | -0.060*** | 0.018 |
| | 2 | -0.028 | 0.019 | -0.024 | 0.017 |
| | 3 | 0.002 | 0.010 | 0.002 | 0.011 |
| | 4 | 0.081*** | 0.023 | 0.008*** | 0.024 |
| Bank concentration | 1 | -0.007*** | 0.002 | -0.007*** | 0.002 |
| | 2 | -0.003 | 0.002 | -0.003 | 0.002 |
| | 3 | 0.000 | 0.001 | 0.000 | 0.012 |
| | 4 | 0.001*** | 0.003 | 0.001*** | 0.003 |
| **Deposit money banks to GDP** | 1 | 0.003** | 0.001 | 0.003** | 0.001 |
| | 2 | 0.001* | 0.000 | 0.001* | 0.000 |
| | 3 | -0.000 | 0.001 | -0.000 | 0.001 |
| | 4 | -0.004** | 0.001 | -0.004** | 0.002 |

*** Significance at 1%, **Significance at 5%, *Significance at 10%.

## Appendix 2

Data description and source

| Indicator | Indicator Name | Source |
|---|---|---|
| GL | Green loans (in millions of euros) | Refinitiv |
| FD | Financial Development | IMF |
| BCBD | Bank credit to bank deposits ratio (%), measuring banking sector liquidity | World Bank |
| NPL | Bank nonperforming loans to gross loans ratio (%) | World Bank |
| PCDM | Private credit by deposit money banks to GDP ratio (%), measuring extent of financial intermediation | World Bank |
| Z-score | Bank Z-score, measuring banking stability | World Bank |
| GE | Government effectiveness | World Bank |

**Note:** The financial development index **(FD)** is constructed using a standard three-step approach found in the literature on reducing multidimensional data into one summary index: (i) normalization of variables, (ii) aggregation of normalized variables into the sub-indices representing a particular functional dimension, and (iii) aggregation of the sub-indices into the final index (Svirydzenka, 2016); The Bank credit to bank deposit ratio **(BCBD**) is the financial resources provided to the private sector by domestic money banks as a share of total deposits. Domestic money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits. Total deposits include demand, time and saving deposits in deposit money banks; The Bank nonperforming loans to gross loans ratio **(NPL)** is the ratio of defaulting loans (payments of interest and principal past due by 90 days or more) to total gross loans (total value of loan portfolio). The loan amount recorded as nonperforming includes the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue; The Private credit by deposit money banks to GDP ratio **(PCDM)** is the financial resources provided to the private sector by domestic money banks as a share of GDP. Domestic money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits; The Bank Z-score **(Z-score)** it captures the probability of default of a country's commercial banking system. Z-score compares the buffer of a country's commercial banking system (capitalization and returns) with the volatility of those returns. The Government effectiveness **(GE)** captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.

## Appendix 3

Pairwise correlation

| | GL | FD | BCBD | NPL | PCDM | Z-score | GE |
|---|---|---|---|---|---|---|---|
| GL | 1 | | | | | | |
| FD | 0.392 | 1 | | | | | |
| | (0.000) | | | | | | |
| BCBD | -0.066 | 0.236 | 1 | | | | |
| | (0.4884) | (0.0113) | | | | | |
| NPL | -0.156 | -0.213 | 0.011 | 1 | | | |
| | (0.1127) | (0.030) | (0.918) | | | | |
| PCDM | 0.310 | 0.724 | 0.727 | -0.074 | 1 | | |
| | (0.001) | (0.000) | (0.000) | (0.469) | | | |
| Z-score | 0.068 | 0.488 | 0.065 | -0.370 | 0.515 | 1 | |
| | (0.450) | (0.000) | (0.498) | (0.000) | (0.000) | | |
| GE | 0.076 | 0.576 | 0.363 | -0.465 | 0.637 | 0.563 | 1 |
| | (0.396) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | |

**Note:** The table shows the correlation coefficients between each pair of variables and their respective significance levels. The p-value is enclosed in parentheses.