Lisbon School of Economics & Management
Universidade de Lisboa

MASTER'S IN MANAGEMENT

MASTER´S FINAL WORK

DISSERTATION

ADOPTION AND IMPACT OF GREEN BONDS IN THE PORTUGUESE BANKING CONTEXT– AN INTERNATIONAL COMPARISON

ANA MARTA NEVES COSTA

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RESUMO

Esta dissertação analisa o impacto da emissão de obrigações de títulos "verdes" por um banco português sobre o desempenho financeiro, o risco de crédito e a solvência e como esses efeitos se comparam com outras instituições bancárias europeias. No contexto do Acordo Verde Europeu e dado que a regulamentação dessas emissões tem sido cada vez maior, é importante compreender as implicações que a adoção de títulos verdes pode ter para os bancos, reguladores e decisores políticos.

Para realizar este estudo, foi escolhida uma abordagem comparativa quantitativa. Utilizando uma amostra de quatro bancos (Millennium BCP, Novo Banco, BNP Paribas e Santander) e utilizando os anos entre 2015 e 2024 como período de referência, foi aplicado um modelo de dados em painel Diferenças nas Diferenças. Para este efeito, o Millennium BCP foi definido como banco tratado a partir de 2023, ano em que se observa um reforço relevante da emissão de obrigações "verdes". Os principais indicadores utilizados nesta análise foram o retorno sobre o capital próprio (*ROE*), o rácio *CET1* e o rácio de crédito não produtivo (*NPL*). O modelo econométrico escolhido não só considera os efeitos fixos do ano e do banco, como também inclui variáveis relevantes de sustentabilidade e controlo financeiro. Por fim, foi igualmente realizada uma simulação simples de um teste de esforço — uma análise de sensibilidade — para avaliar a resiliência do banco tratado na presença de choques adversos de solvência e crédito.

Embora os coeficientes para o *ROE* e o rácio *CET1* apresentem sinais positivos para o período pós-emissão, os resultados do teste não foram estatisticamente significativos, pelo que não há evidência estatística de que a emissão de obrigações melhore a rentabilidade e a adequação de capital a curto prazo. O rácio *NPL*, que mede o risco de crédito, mostra uma redução estatisticamente significativa. No entanto, este resultado pode ser espúrio, uma vez que pode refletir melhorias estruturais mais amplas no setor bancário europeu, ao invés de um impacto significativo da emissão de obrigações "verdes".

Importa ainda sublinhar que, na análise de sensibilidade, não se verificaram diferenças na vulnerabilidade entre bancos emissores e não emissores.

Em geral, esta dissertação fornece evidências sobre o setor bancário português, contribuindo, assim, para a literatura sobre finanças sustentáveis. Este estudo sugere que as emissões de obrigações verdes não geram ganhos financeiros imediatos, mas estão alinhadas com os objetivos estratégicos e regulatórios mais amplos da sustentabilidade, que é o futuro do setor bancário.

Palavras-chave: Obrigações Verdes; Finanças Sustentáveis; Desempenho Bancário; Risco de Crédito; Solvência; Diferença nas Diferenças.

ABSTRACT

This dissertation analyzes the impact of the issuance of green bonds by a Portuguese bank on financial performance, credit risk, and solvency, and how these effects compare with other European banking institutions.In the context of the European Green Deal and given that the regulation of these issuances has been increasing, it is important to understand the implications that the adoption of green bonds may have for banks, regulators, and policymakers.

In order to carry out this study, a quantitative comparative approach was chosen. Using a sample of four banks (Millennium BCP, Novo Banco, BNP Paribas, and Santander) and data covering the period between 2015 and 2024, a panel data model Differences-in-Differences was applied. To this end, Millennium BCP has been designated as the treated bank from 2023 onwards, a year in which there was a significant increase in the issuance of green bonds. The key indicators used in this analysis were Return on Equity (*ROE*), the *CET1 ratio* and the Non-Performing Loan (*NPL*) ratio. The econometric model chosen not only considers fixed effects of the year and the bank, but also includes relevant sustainability and financial control variables. Finally, a simple stress test simulation—a sensitivity analysis—was also performed to assess the resilience of the treated bank in the presence of adverse solvency and credit shocks.

Although the results for *ROE* and *CET1 ratio* are positive for the post-issue period, the test results were not statistically significant. Accordingly, there is no statistical evidence that the the issuance of green bonds improves profitability and capital adequacy in the short term. The *NPL ratio*, which measures credit risk, shows a statistically significant reduction. However, this result may be spurious, as it may reflect broader structural improvements in the European banking sector rather than a significant impact of green bond issuance.

It should also be noted that, in the sensitivity analysis, no differences in vulnerability were found between issuing and non-issuing banks.

Overall, this dissertation provides evidence on the Portuguese banking sector, thus contributing to the literature on sustainable finance. This study suggests that green bond issuances do not generate immediate financial gains, even though these issuances are aligned with the broader strategic and regulatory objectives of sustainability, which is the future of the banking sector.

Key-words: Green Bonds; Sustainable Finance; Banking Performance; Credit Risk; Solvency; Difference-in-Differences.

ABBREVIATIONS

CAB - Climate Awareness Bond

CET 1 – Common Equity Tier 1

CSRD - Corporate Sustainability Reporting Directive

DiD - Difference-in-Diffeerences

EBA - European Banking Authority

ECB – European Central Bank

EIB - European Investment Bank

ESG - Environmental, Social and Governance

ESRS - European Sustainability Reporting Standards

EU - European Union

EUGB - European Green Bond Standard

GAR - Green Assets Ratio

GBS - Green Bond Standard GBP - Green Bond Principles

ICMA - International Capital Market Association

NPL – Non-performing Loan

PRB - Principle for Responsible Banking

ROE – Return on Equity

SFDR - Sustainable Finance Disclosure Regulation

SDG – Sustainable Development Goals

UNEP FI - United Nations Environment Programme Finance Initiative

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CHAPTER 1 - INTRODUCTION

The importance of transitioning to a more sustainable and low-carbon economy has become increasingly relevant in current matters. The financial sector has acted as an enabler of sustainable development, as it has been able to allocate capital to environmentally sustainable projects and activities. This has led to the emergence of green bonds, financial instruments designed to finance projects that contribute to climate change mitigation and adaptation (Flammer, 2021).

In this context, this study is aligned with the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 ("Climate Action"), which aims to combat climate change and its impacts. By financing environmentally sustainable projects, green bonds contribute to climate mitigation and adaptation efforts, supporting the transition towards a low-carbon economy. Additionally, these instruments may also indirectly support other SDGs, such as SDG 7 "Affordable and Clean Energy" and SDG 9 "Industry, Innovation and Infrastructure".

Green bond markets began to grow quickly since the introduction of this metric by supranational institutions, such as the European Investment Bank, as well as due to growing demand from investors, the introduction of new market standards and increasingly wide-ranging regulatory frameworks in the European Union (Rees, 2016; Pyka, 2023).

Climate change has become an increasing concern for both financial regulators and supervisory authorities, as they increasingly recognize the risks and financial instability that can be generated by climate change. Banks' balance sheets, asset quality, and capital adequacy are subject to a number of risks. These risks can be classified as physical risks, when they are caused by extreme weather events, or transition risks, when they are associated with regulatory changes, shifts in consumer preferences, or technological developments (ECB, 2021). The composition of bank assets and means of financing have become very important in relation to financial stability, and banks, through their investment and loan portfolios, are highly exposed to these types of risks (BIS, 2025). Thus, many studies point out that banks, by reallocating capital to sustainable activities rather than carbon-intensive sectors, may mitigate their long-term climate risks (Fatica et al., 2021).

As mentioned above, green bond markets are growing fast, yet the economic and financial implications of these green bond issuances remain a key topic of debate. As much as these bonds may be associated with benefits such as reputation, improved investor perception, and potential reductions in financing costs (Flammer, 2021), they also have additional costs related to external verification, reporting, and continuous monitoring, which can sometimes outweigh the gains,

especially for smaller banks operating in less liquid and smaller markets (Pietsch & Salakhova, 2022).

Thus, the main research question addressed will be whether the issuance of green bonds affects the financial performance, credit risk, and solvency of Portuguese banks, and how this compares to what is observed in other European banking institutions. In the current European political context, this is a relevant analysis, as banks are expected to play an important role in financing the ecological transition through initiatives such as the European Green Deal and the

European Union's Sustainable Finance Framework (European Commission, 2021; Brühl, 2023). These analyses also help policymakers, bank managers and regulators understand whether these sustainable emissions are related to changes in the performance and resilience of banks, particularly in sustainable financial markets that are still in the very early stages of development.

Nowadays, there are several academic studies that provide us with relevant information about this new market and the behavior of its issuers. Academic literature reinforces the rapid growth of the green bond market, and several studies have even identified price advantages for green bonds compared to conventional bonds (Flammer, 2021; Pietsch & Salakhova, 2022). Literature reveals that, in the banking sector, the largest banks, which are also the most committed to sustainability and broader ESG strategies, are the most likely to issue green bonds (Fatica et al., 2021; Bedendo et al., 2022). These new issuances have been very well received by the market, leading to greater signs of environmental commitment and, consequently, increasing investor confidence (Sangiorgi & Schopohl, 2023).

However, the conclusions of academic literature continue to be contradictory. While some studies argue that the improvements observed may only reflect broader structural trends rather than the effects of the green bond issue itself, others contradict this and claim that this green issue may eventually be associated with lower risk exposure and improved asset quality (Lam & Wurgler, 2023). This issue is a very relevant subject of study, especially for credit risk indicators—such as Non-Performing Loan ratios—which have been showing structural declines in all European banking systems due to increased post-crisis regulatory pressure and balance sheet recovery commitments (ECB, 2021). In essence, in other words, it is crucial to separate macroeconomic scenarios from the actual impact of green bond issuance, which is one of the greatest challenges today.

This case study will focus on the Portuguese banking sector, which has been little explored in the context of empirical studies on sustainable finance. Due to the small size of the country and its lower liquidity in the capital market, even with growing regulatory pressure and an increase in

sustainable financing initiatives, there may be a discrepancy here in terms of the costs and benefits of green bonds when compared to larger and more liquid countries (Bank of Portugal, 2024a).

In order to answer this research question and taking into account all the limitations identified, a comparative quantitative approach was chosen that combines econometric analysis with sensitivity analysis. To analyze the short-term effects of green bonds on profitability, solvency, and credit risk, the Difference in Differences (DiD) methodology was selected. This methodology focuses on comparing the nominated financial indicators in two distinct periods—before and after the issuance of the green bond—while controlling for unobserved bank characteristics and common macroeconomic trends (Bertrand et al., 2004; Angrist & Pischke, 2009).

After the econometric analysis, a sensitivity analysis is also performed to ascertain whether the issuance of green bonds may or may not be related to banking resilience in adverse conditions—climate and financial shocks. This sensitivity analysis is based on the climate Stress Tests that the ECB has been conducting since 2021, but carried out in a more simplified manner (ECB, 2021).

Since the national banking system has not received much attention from new academic studies on green finance, this dissertation aims to contribute to the beginning of new studies that may become more detailed in the future. By combining econometric tests with possible sensitivity analyses, this research provides new evidence on green bond issuance and what may or may not be associated with it. By taking the analysis to an international level, it is possible to ascertain whether or not the effects of adopting green bonds depend on the size of the banks and the development of the markets in which they operate. Another important aspect to highlight with this study is that it may contribute to new academic and political debates on the role of sustainable finance in financial stability.

The disseratation is structured in five chapters. The first chapter introduces the research problem, research gaps, and research questions. Next, in the second chapter, the existing literature on the topic is analyzed, focusing particularly on banking institutions. Subsequently, chapter 3 describes the format and design of the research, presenting the data sources, variables, econometric methodology, and sensitivity analysis structure. Consequently, chapter 4 describes and discusses the results obtained. Finally, the last chapter presents the main conclusions, where it is possible to discuss their implications and outline directions for future studies

CHAPTER 2 - LITERATURE REVIEW

2.1. Theoretical and Regulatory Framework

At a global level, the development of sustainable finance has been supported by new initiatives that provide guidance to financial institutions. In 2003, the United Nations Environment Programme Finance Initiative (UNEP FI) was created in order to promote the integration of environmental and social considerations into financial decision-making. One of the principles created was the Principles for Responsible Banking (PRB), launched in September 2019, that provides global standards to align the Sustainable Development Goals (SDG) and the Paris Agreement (UNEP FI, n.d.). According to the PRB, signatory banks have a duty to assess the social and environmental impact of their operations, set measurable sustainability goals and targets, and report on their progress annually. In 2021, the Net-Zero Banking Alliance (NZBA) was created under the UNEP FI, which requires banks to align their portfolios with net-zero emissions by 2050 (UNEP FI, 2025).

With the aim of raising capital for activities related to the European Green Deal targets and meeting carbon neutrality commitments by 2050, the European Union has played a crucial leadership role in the development of sustainable financing instruments.

In this regard, the European Taxonomy is a classification system that defines some criteria for environmentally sustainable economic activities. For an economic activity to be established as sustainable, the Taxonomy sets out some explicit conditions in order to contribute to reducing the risk of *greenwashing* and also ensuring greater comparability and transparency between economic agents (European Commission, n.d.). According to the Article 9 of the *Regulation 2020/852/EU*, there are six core environmental objectives identified by the Taxonomy Regulation namely (European Parliament & Council of the European Union, 2020):

> (a) climate change mitigation; (b) climate change adaptation; (c) the sustainable use and protection of water and marine resources; (d) the transition to a circular economy; (e) pollution prevention and control; (f) protection and restoration of biodiversity and ecosystems.

In the financial sector, specific metric requirements began to emerge, leading the European Banking Authority (EBA) to establish and introduce the Green Assets Ratio (GAR) as the main indicator of alignment between the Taxonomy and credit institutions. The GAR analyzes the proportion of a bank's assets that finance sustainable activities in relation to its total covered assets, establishing a KPI for regulators and investors to assess the sustainability profile of institutions (Brühl, 2023). The main objective of this metric is to improve comparability between institutions so that investors can better assess the sustainability profiles of banks. It does not set

any regulatory targets or binding minimum limits. The GAR has also replaced certain metrics that are more relevant to non-financial companies (such as aligned *OpEx* or the *CapEx* ratio) and are not as suitable for the banking business model (European Banking Authority, 2022).

As part of the European Green Deal, the European Commission proposed a policy framework that was designed to support investments related to the environment and to give orientation to guide the transition to a sustainable economy (Pyka, 2023). In line with this commitment, the European Green Deal Investment Plan of 14 January 2020 announced the establishment of a Green Bond Standard (GBS). In December 2020, the European Council concluded that new global standards for sustainable finance needed to be developed. Therefore, it invited the European Commission to develop and present a legislative proposal for a standard for green bonds by June 2021.

The proposal presented by the European Commission aimed to (1) help identify credible green instruments in order to strengthen investor confidence in these investments, (2) facilitate issuance by mitigating reputational risks for issuers, and (3) standardize the necessary external review through a voluntary registration and supervision mechanism (European Commission, 2021).

In 2023, the European Union (EU) announced the creation of an European Green bond Standard (EUGB). This concept demonstrate the development that was done in the EU's sustainable finance agenda (European Parliament, 2023; Spielberger, 2025).

While the EU Green Bond Standard provides the regulatory foundation for sustainable finance in Europe, the European Investment Bank (EIB) has been a reference for green bond issuance.

Before these more recent efforts, the EIB became in 2007 the world's first issuer of green bonds (Rees, 2016) – named Climate Awareness Bonds (CAB) – and remains the world's largest issuer of green bonds to date (Spielberger, 2025). This organization has not only become the main leader in green bond certification, but has also played an active role in negotiations on voluntary Green Bond principles that took place prior to the EU agenda on green and sustainable finance. Recently, the EIB has committed to promoting the EUGB, while also maintaining a contributory position in the EU negotiations on sustainable development regulation (Spielberger, 2025).

The development of the European sustainable finance framework was subsequently reinforced by regulations focused on information disclosure — the Sustainable Finance Disclosure Regulation (SFDR) and the Corporate Sustainability Reporting Directive (CSRD).

On November 27, 2019, the SFDR was adopted by the European Parliament and Council. (European Parliament & Council of the European Union, 2019). As the Article 1 of the SFDR states,

> This Regulation lays down harmonised rules for financial market participants and financial advisers on transparency with regard to the integration of sustainability risks and the consideration of adverse sustainability impacts in their processes and the provision of sustainability-related information with respect to financial products.

The SFDR aims to ensure that financial institutions formally declare their level of compliance with their ESG disclosure and reporting obligations, in order to mitigate the increasingly frequent phenomenon of greenwashing (Dufays & Huybrechts, 2022).

Complementary to this, on 14 December 2022, the Corporate Sustainability Reporting Directive (CSRD) — formally Directive (EU) 2022/2464 — was adopted by the European Parliament and the Council as part of the European Green Deal's sustainable finance strategy. Companies subjected to this directive must submit their reports in accordance with European Sustainability Reporting Standards (ESRS). The CSRD expands sustainability reporting requirements for financial institutions and large companies operating in the EU. It introduces new, more detailed disclosure obligations, aligning corporate reporting with the EU Taxonomy and SFDR, replacing the previous Non-Financial Reporting Directive (NFRD) (European Parliament & Council of the European Union, 2022).

2.2 Green Bonds: Concept, Mechanisms, and Market Development.

In addition to the European framework, it is also crucial to take international standards into account. The *International Capital Market Association* (ICMA) defines the Green Bond Principles (GBP), which voluntarily regulate the global green bond market. The GDB sets guidelines regarding the use of funds, the project evaluation and selection process, revenue management and reporting, thereby ensuring the transparency and credibility of the green bond market, based on four core components: (1) use of proceeds; (2) process for project evaluation and selection; (3) management of proceeds; and (4) reporting (International Capital Market Association, 2025). The introduction of these principles is seen as a good practice for investors and issuers, promoting growth and confidence in the market.

In this context, we can define Green Bonds as "any type of bond instrument where the proceeds or an equivalent amount will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects aligned with the four core components of the GBP" (ICMA, 2025).

There are currently four types of Green Bonds:

TABLE I

TYPES OF GREEN BONDS DEFINED BY THE INTERNATIONAL CAPITAL MARKET ASSOCIATION

Type of Green Bond	Definition (ICMA, 2025)
Standard Green Use of Proceeds Bond	An unsecured debt obligation with full recourse-to-the-issuer only and aligned with the GBP.
Green Revenue Bond	A non-recourse-to-the-issuer debt obligation aligned with the GBP in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, fees, taxes etc., and whose use of proceeds go to related or unrelated Green Project(s).
Green Project Bond	A project bond for a single or multiple Green Project(s) for which the investor has direct exposure to the risk of the project(s) with or without potential recourse to the issuer, and that is aligned with the GBP.
Secured Green Bond	A secured bond where the net proceeds will be exclusively applied to finance or refinance.

(a) Definitions reproduced from *International Capital Market Association (2025).
Source: ICMA (2025), p. 7.

It is also important to highlight the role of sovereign states in the progress of green bond markets. In the traditional bond market, sovereign issuances traditionally serve as a benchmark for corporate issuances, whereas in the green bond market sovereign issuances appeared later. However, there is evidence that sovereign green bond issuance can have a catalytic effect, increasing the size and number of corporate issuances. This reinforces reporting and verification standards, thereby contributing to increased liquidity and narrower market spreads. These results are more pronounced in countries with more robust climate policies, thus emphasizing that sovereign issuance can play a strategic role in promoting green bonds in the banking sector as well (Cheng *et al*., 2024).

Although the green bond market still represents only a small fraction of the global bond market - where the total outstanding global debt securities exeeds USD 150 trillion - it reached $2.9 trillion in market capitalization, representing an increase of almost 6 times compared to 2018. By 2024, its annual issuance had reached $700 billion, which is a fraction of the estimated $2 trillion in annual investment needed to help combat climate change. This increase in demand for sustainable instruments is reflected in the increase in ESG investment in the asset management

sector. On the investor side, many began by preferring green bonds whose environmental impact could be certified, leading to an increase in the supply side of green bond issuers, which now comprise a diverse group of sovereigns, financial institutions, municipalities, and private companies (BIS, 2025).

With the introduction of GBP by the ICMA (ICMA, 2025), the Green Bond market has grown exponentially since 2015 (see *Figure 1*). In 2018, the amounts in circulation were approximately $500 billion, while in 2024 approximately $3 trillion were already in circulation (*Figure 1.A*). This growth is due not only to increased demand for green assets from investors, but also to greater regulatory support, demonstrating increased investor awareness of financial risks associated with climate change (BIS, 2025).

About half of the outstanding volume of green bonds have been issued in advanced economies, namely the euro area member states and the United States (*Figure 1.A*). Among emerging market economies, China stands out with an equally significant share. In turn, this geographical origin is then reflected in the currency denomination of these bonds, with securities denominated in euros or dollars being the most prevalent, while those denominated in renminbi are gaining significant ground (*Figure 1.B*) (BIS, 2025).

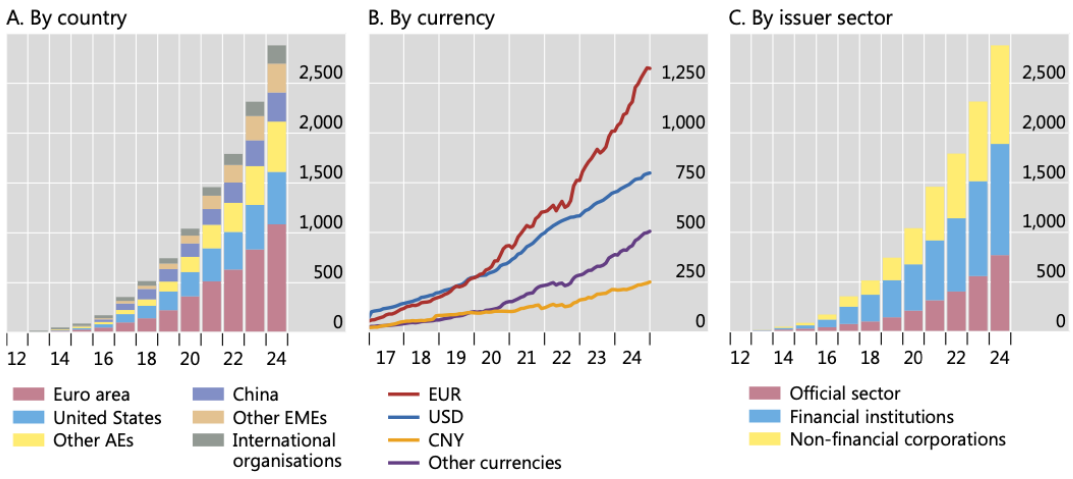

FIGURE 1 - Green Bond Volumes (in billions of US dollars)

(a) Amount outstanding is calculated using total cumulative issuance minus cumulative amount matured as of a givn year.
Source: BIS (2025), p. 55.

In the first half of 2025, the EIB was the largest issuer of aligned green bonds, with around $19 billion (between sovereign and non-sovereign), driven by its four Euro-denominated green bonds totaling around €17 billion ($18.3 billion) (see *Table II*). Accordingly, the EIB, in the first

two quarters of 2025, has already broken its own annual record for the volume of aligned green bonds, which in 2024 was around $16.6 billion (CBI, 2025).

TABLE II

TOP 10 NON-SOVEREIGN CBI-ALIGNED GREEN ISSUERS IN H1 2025

Bank	Country	USD bn
European Investment Bank (EIB)	Supranational	19.0
KfW	Germany	9.8
Agricultural Bank of China Limited	China	8.2
European Union (EU)	Supranational	7.3
Vantage Data Centers LLC	USA	5.0
Agricultural Development Bank of China	China	4.4
Electricite de France SA	France	4.2
Bank of Communications Co Ltd	China	4.1
Dayone Data Centers Singapore Pte Ltd	Singapore	3.5
PGE Polska Grupa Energetyczna SA	Poland	3.1
Total TOP 10		68.6

Source: CBI (2025)

Financial institutions play a dual role in the green bond market: they can act as both issuers and intermediaries. In order to facilitate the flow of capital to more sustainable projects, banks regularly underwrite, invest in, and structure green bonds. The participation of financial institutions in the green bond market increases credibility and liquidity, expanding the market and signaling a strategic shift towards sustainable financing (Fatica *et al*., 2021; Ehlers *et al*., 2023).

Several studies show that issuers of green bonds can benefit from lower financing costs compared to conventional bonds—this phenomenon is known as *greenium* (Caramichael & Rapp, 2022; Pietsch & Salakhova, 2022). According to Caramichael & Rapp, 2022, there is evidence that, on average, traditional bonds have spreads 8 basis points higher than green bonds. This suggests that the market values environmental credibility and transparency. According to Pietsch & Salakhova, 2022, there is also evidence that investor demand, reporting credibility, and liquidity are crucial factors in price differentiation .

International evidence shows that climate policies play a fundamental and crucial role in market development. A study conducted by the Bank for International Settlements (2025) highlights that the increase in green bond issuance is most noticeable in countries with more

demanding and rigorous climate targets, especially in sectors with higher carbon intensity (BIS, 2025).

2.3. Adoption of Green Bonds in the Banking Sector

Several authors argue that one of the main factors behind the issuance of green bonds is the desire to show that the issuer is committed to green projects. This is a valuable signal for the shareholders of the issuers, as it leads to a positive response in their stock prices (Flammer, 2021; Sangiorgi and Schopohl, 2023). According to Bedendo *et al*. (2022), banks are no exception. There have been increases in equity values for issuers of green bonds, including banks, thus confirming the hypothesis that this issuance of bonds promotes investor confidence in companies that are concerned about climate change (Bedendo *et al*., 2022).

Generally, when a bank has financing needs and have regular access to the bond market, the alternative usually chosen is to issue a conventional bond. However, in the study conducted by Bedendo *et al*. (2022), it was found that, taking all samples into account, the largest banks and those most likely to be members of UNEP FI are the ones most likely to issue green bonds. In other words, large banks and banks that have previously publicly recognized the role of green investments in helping to create a more sustainable economy are the ones most likely to issue green bonds (Bedendo *et al*., 2022).

In the Portuguese reality, the Bank of Portugal plays a crucial role in encouraging and monitoring sustainable financing. Through the Bpstat portal, it provides regular information on ESG bond issues and portfolios. This information makes it possible to distinguish green bonds from other sustainable debt groups. According to the Bank of Portugal (2025), in 2024, ESG assets were around 12.8% of the bank's total investment portfolio (more than €1 billion invested in green bonds). This intensification was accompanied by the publication of the Decarbonization Program (2024) and the revision of the Charter of Principles for Responsible Investment, which reaffirm the institutional commitment to integrating environmental, social, and governance factors into the management of financial assets (Bank of Portugal, 2024a, 2024b). This demonstrates an increase in the Portuguese financial sector's positioning regarding sustainability, even in the face of challenges of regulatory alignment and market scale.

Green bonds, in addition to their diversification and signaling effects, can also strengthen banks' resilience to market and climate shocks. Banks can mitigate transition risks and physical risks associated with climate change by financing environmentally sustainable projects and reducing exposure to carbon-intensive assets (ECB, 2021).

Despite all these advantages, there are also some barriers and costs. For example, auditing, external certification and continuous reporting entail additional administrative costs, which may offset the benefit of greenium, especially in less developed markets or for smaller issuers (Pietsch & Salakhova, 2022). This is something that is present in the Portuguese context, since this capital market is small and less liquid.

It is also important to mention that, in many cases, certain projects are labeled "green" more for *marketing* and reputation reasons than because they are truly "green," since they would be carried out anyway (Lam & Wurgler, 2023) —a form of greenwashing, defined as the "intersection of two firm behaviours: poor environmental performance and positive communication about environmental performance" (Delmas & Burbano, 2011).

Given this evidence, it is important to explore how green bond activity actually affects the performance and resilience of Portuguese banks when compared to institutions operating in other countries. The following section outlines the methodology used to examine these relationships, applying a stress-testing approach supported by financial and sustainability data from Bloomberg.

CHAPTER 3 - METHODOLOGY

3.1. Research Design

This study adopts a quantitative comparative design, as it will examine the impact of green bonds on the financial performance and resilience of Portuguese banks compared to international banks. This research will combine descriptive analyses, stress test simulations, and an econometric model in order to assess how profitability, solvency and credit risk are influenced by green financing.

The methological approach is adapted to an academic and data-driven context, inspired by the stress tests conducted by the ECB (Borio *et al*., 2014; ECB, 2021). This model also explores not only temporal dynamics but also differences between banks, thus offering a more robust perspective on the potential impact of adopting green financing.

A quasi-experimental and quantitative approach will be used to conduct this study, employing the Difference-in-Differences (DiD) method. This methodology analyzes not only the impact that green bonds have on financial performance, but also their impact on the banking risk profile.

The DiD approach is particularly suitable as it enables the identification of the possible causes associated with a specific event, comparing the bank to non-issuing banks, as well as before and after the event occurred (Bertrand *et al*., 2004; Wooldridge, 2010). In this case, the base event used in this study will be the issuance of the first green bond by Millennium BCP in 2023.

3.2. Sample Selection

The sample consists of four banks operating in the Portuguese and European banking sectors: Millennium BCP, Novo Banco, BNP Paribas, and Santander.

Three criteria were taken into account when selecting this sample (Fatica *et al*., 2021):

1. Availability of data on Bloomberg and in annual reports;
2. Comparability in the business model and regulatory environment;
3. Relevance to the European sustainable finance framework.

The period selected for analysis was 2015-2024, as it corresponds to the post-introduction phase of the GBP by ICMA and the consolidation of the European Green Deal.

The dataset includes 40 observations (4 banks × 10 years). The sample provides sufficient variation to perform a fixed-effects panel regression and a simplified stress test analysis.

In this sample, Millennium BCP is the treated institution in question. According to Millennium BCP's Sustainability Report, the first ESG bond was issued in 2021, but it was considered as Social Bond and therefore not a Green Bond. According to the same report, the "green"/environmental dimension began to be explicitly integrated and operationalized in the bank's strategy from 2023 onwards. Thus, this will be the classification used to define "treatment period" (Millennium BCP, 2023). Within this, the year of 2023 is the start of the treatment period, while the pre-treatment period covers the years 2015 to 2022. In the pre-treatment period, all banks in the sample will be considered a control group (including Millennium BCP). From 2023 onwards, Millennium will no longer be considered a control group. Novo Banco, BNP Paribas, and Santander are considered a control group throughout the sample period.

The choice of listed (Millenium bcp) and unlisted Portuguese banks (Novo Banco) will not affect comparability, since the focus will be on financial indices and sustainability indicators rather than stock market metrics.

3.3. Data Sources

Both financial and environmental data are sourced from Bloomberg, as it provides information on banks' financial statements, capital ratios, ESG indicators, and data on green bond issuances.

The data collected includes annual observations on solvency, profitability, credit risk, leverage, balance sheet size and other relevant indicators. Choosing a single data provider will minimize the risk of inconsistencies and also increase the reliability of comparisons between the selected banks.

3.4. Variables

A detailed definition of each variable, its calculation and analytical purpose is presented in the Appendix I.

3.4.1. Dependent Variables

In order to better capture the performance and stability of banks, three dependent variables were selected: *ROE*, *CET1 ratio* and *NPL ratio*.

Empirical literature on green bonds and banking was used to choose the variables to be used. Existing studies analyzing green bond issuance typically use financial indicators that employ accounting-based profitability measures. One example is the work by Flammer (2021), who used *ROA* as an indicator of post-issuance effects in his approach. Following this logical thinking, it

was decided to use *ROE* in this case study, since it is an alternative measure of profitability that is more appropriate for the banking sector, knowing that this indicator captures returns to shareholders and, at the same time, reflects the leveraged nature of banks.

Since the focus of the analysis is on banking institutions, one of the main indicators reflecting regulatory capital strength is the *CET1 ratio*. In addition to bank solvency, this ratio measures banks' loss absorption capacity and resilience (Gropp & Heider, 2010).

Next, to complement the two previous indicators, the NPL ratio was chosen as a direct measure of credit risk and asset quality. According to Louzis *et al*. (2012), this ratio is widely used to assess the banking sector and the deterioration of the loan portfolio.

This approach makes it possible to ascertain whether the issuance of green bonds may be associated with changes in risk, profitability, and solvency (Flammer, 2021; Fatica *et al*., 2021).

3.4.2. Main Explanatory Variable

Based on the DiD model, the main explanatory variables can be defined as *treated* (an indicator of treatment), *post* (na indicator of time) e *treated* × *post* (an interaction term between the two variables).

The *treated* variable takes the value 1 when banks issue green bonds, and takes the value 0 when they do not issue them, thus capturing the differences that do not vary over time between non-issuing and issuing banks.

The variable *post* takes the value 1 for the period after the issuance of green bonds, and takes the value 0 for the period before the issuance, thus capturing the temporal effects common to all banks.

The *treated* × *post* interaction term measures how much the banks that issued green bonds changed, compared to those that did not issue them. The coefficient associated with this interaction between the *treated* and the *post* is called the "average treatment effect", i.e., assuming that both groups followed the same trends before treatment, this coefficient measures the causal impact of green bond issuance (Angrist & Pischke, 2009).

3.4.3. Control Variables

The models explored include control variables related to bank's finantial structure, size and sustainability orientation, namely *Leverage*, *ln(Total Assets)*, and *ESG Disclosure Score*, respectively.

These three indicators were chosen for the following reasons. Starting with *Leverage,* this explains possible differences in capital structure and risk exposure, which in turn influences solvency, profitability, and risk behavior (Gropp & Heider, 2010). The variable chosen to determine bank size was the logarithm of *Total Assets*, which captures the effects of scale and structural differences between banks (Demirgüç-Kunt & Huizinga, 2010). The *ESG Disclosure Score* will reflect the banks' focus on sustainability and transparency (directly linked to the issuance of green bonds) (Tang & Zhang, 2020).

3.5. Econometric Model

The econometric model is specific to the context of green bond issuance, but follows the standard DiD panel data models used in the empirical literature on banking and finance described by Angrist and Pischke (2009) and Bertrand *et al*. (2004).

The econometric specification is defined as:

$$(1)\ Y_{it} = \alpha_i + \delta_t + \beta(Treated_i + Post_i) + \gamma X_{it} + \varepsilon_{it}$$

where, Y_{it} denotes the dependent variable (*ROE*, *CET1*, or *NPL*) for bank *i* in year *t*, α_i represents bank fixed effects (which controls unobserved and time-invariant heterogeneity), δ_t expresses time fixed effects (wich capture common macroeconomic effects), X_{it} is a vector of control variables, and ε_{it} is the error term.

The objective of this model is to compare the financial results obtained by banks that issued green bonds with the performance of banks that did not issue them, before and after the issuance. This model incorporates fixed bank and time effects, which makes it possible to eliminate structural differences between the selected banks and macroeconomic shocks. The interest coefficient (β) will then measure whether or not the banks that issued green bonds underwent any change after the issuance compared to those that did not issue them (Angrist & Pischke, 2009).

3.6. Robustness checks

In order to reinforce the credibility of the identification strategy, – description of how the model identifies the effect of green bond issuance between issuing and non-issuing banks (before and after issuance) - robustness checks are performed.

Alternative sets of financial and prudential control variables were included, different dependent variables were used and a placebo test was also implemented, following Bertrand *et al*. (2004). The placebo test is used to simulate the occurrence of treatment in a period prior to issuance (no green bonds had yet been issued). This makes it possible to verify whether these

effects were statistically significant prior to issuance. If there are no significant placebo tests, this confirms that the main results are not capturing differences that already existed between the groups prior to issuance, nor existing trends. Thus, with the implementation of this test, it will be possible to reinforce the idea that the estimated effects effectively reflect the impact of the issuance.

3.7. Stress Test Framework

This section will analyze whether exposure to green bonds increases banks' financial resilience, taking into account adverse macroeconomic conditions.

For this simulation, two scenarios are considered. First a credit risk stress scenario is performed, simulated through an exogenous increase in the *NPL ratio*, followed by a solvency stress scenario which is simulated through a reduction in the *CET1 ratio*.

$$(2)\ NPL_{it}^{stress} = NPL_{it} + \Delta\text{NPL}$$

$$(3)\ CET1_{it}^{stress} = CET1_{it} - \Delta\text{CET1}$$

The following expression will be used to measure stress-induced deterioration:

$$(4)\ \Delta Y_{it} = Y_{it}^{stress} - Y_{it}$$

As discussed by the European Central Bank (2021), rather than predicting absolute losses, these scenarios make it possible to assess the relative vulnerability and resilience between banks.

This stress test will mainly assess the financial resilience of banks that have issued green bonds, seeing whether they are more resilient than banks that have not issued them. This will be done by applying exogenous shocks to credit risk (increase in the *NPL ratio*) and solvency (reduction in the *CET1 ratio*). In order to be able to say that exposure to green bonds is associated with greater financial resilience, issuing banks must show less deterioration than non-issuing banks under the same shocks.

CHAPTER 4 - RESULTS

4.1. Descriptive Statistics

The descriptive statistics for the financial and sustainability variables used in the analysis are presented in the table below.

In 2023 (before the issuance of green bonds), Millenium BCP presented financial performance indicators comparable to those of the control group. However, it is clear that there were some substantial fluctuations in the variables of profitability, asset quality, and solvency. These variations are related to changes in the macroeconomic environment and also to regulatory developments that affected the entire European banking sector during the period observed.

TABLE III

DESCRIPTIVE STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min	Max
ROE	40	2.23	14.97	-47.34	18.83
CET1 Ratio	40	12.91	1.86	11.00	20.80
NPL Ratio	39	4.61	3.02	0.80	15.03
Leverage	40	11.23	5.20	4.11	19.47
Total Assets	40	1,005,129	1,005,698	42,413	2,704,908
ESG Scores	30[1]	56.81	3.92	49.48	65.13

(a) The minimum ROE value is related to observations recorded during 2020, a period that had exceptional shocks to bank profitability (COVID-19 crisis).
Source: STATA - Own elaboration

4.2. Difference-in-Differences Results

4.2.1. Profitability (ROE)

The results of the DiD regression using *ROE* as the dependent variable are presented in Table IV. The coefficient of the *Treated* × *Post* variable is always positive, but it is not statistically significant.

TABLE IV

DID RESULTS: ROE

	ROE (with ESG)	ROE (without ESG – robustness)
Treated × *Post*	5.261 (2.753)	1.439 (8.011)

[1] The ESG disclosure score is available for a reduced number of observations due to data availability.

Leverage	-0.220 (0.569)	-1.088 (1.447)
Ln(Total Assets)	28.997 (20.437)	-61.364*** (9.762)
ESG Score	0.227 (0.394)	-
Bank Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	30	40
Within R^2	0.605	0.619

(a) Robust standard errors clustered at the bank level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
(b) The Within R^2 indicator measures the proportion of the bank's internal variation over time that can be explained by the model, after controlling for fixed effects. Consequently, it is not directly comparable to the traditional R^2 of pooled OLS models.
Source: STATA - Own elaboration

The results obtained shows that the estimated coefficient of the *Treated* × *Post* interaction is positive on both occasions, which in turn suggests that there is a potential increase after the issuance of green bonds. However, the results show that Millenium BCP's issuance of green bonds is not statistically significant in either model in terms of changing short-term profitability, i.e., the observed variation in *ROE* cannot be distinguished from a random variation. Thus, we can state that there is no robust evidence to suggest that there are short-term causal effects of green bond issuance on bank profitability.

This outcome is consistent with existing literature, which states that the financial benefits of sustainable financing instruments often do not immediately translate into higher profitability.

4.2.2. Solvency (CET1 Ratio)

TABLE V

DID RESULTS: CET1 RATIO

	CET1 (with ESG)	CET1 (without ESG – robustness)
Treated × *Post*	1.393 (1.344)	1.987 (1.070)
Leverage	0.086 (0.211)	0.311 (0.335)
Ln(Total Assets)	-5.850 (11.460)	-6.326 (3.234)
ESG Score	-0.082 (0.044)	-
Bank Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	30	40
Within R^2	0.537	0.653

(a) Robust standard errors clustered at the bank level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
(b) The Within R^2 indicator measures the proportion of the bank's internal variation over time that can be explained by the model, after controlling for fixed effects. Consequently, it is not directly comparable to the traditional R^2 of pooled OLS models.
Source: STATA - Own elaboration

Table V shows the values for the CET1 ratio. Since the DiD coefficient has always been positive, the issuance of green bonds may be associated with an increase in this ratio after the issuance.

However, the coefficient on the *Treated* × *Post* interaction is not statistically significant at conventional levels, since the standard errors are large compared to the estimated coefficient. Nevertheless, we can say that it is an economically significant effect and consistent with the model specifications. In other words, we can draw a possible conclusion that green bonds may be associated with better capital adequacy and bank resilience.

4.2.3. Credit Risk (NPL Ratio)

The following table presents the DiD estimates for the NPL ratio.

TABLE VI

DID RESULTS: NPL RATIO

	NPL (with ESG)	NPL (without ESG – robustness)
Treated × *Post*	-3.227* (1.223)	-4.265*** (0.424)
Leverage	-0.014 (0.393)	-0.125 (0.431)
Ln(Total Assets)	-4.787 (14.864)	3.469 (4.017)
ESG Score	-0.421 (0.237)	-
Bank Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	30	40
Within R^2	0.705	0.687

(a) Robust standard errors clustered at the bank level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
(b) The Within R^2 indicator measures the proportion of the bank's internal variation over time that can be explained by the model, after controlling for fixed effects. Consequently, it is not directly comparable to the traditional R^2 of pooled OLS models.
Source: STATA - Own elaboration

The coefficient of the *Treated* × *Post* term is negative and statistically significant, which may indicate a reduction in credit risk for Millenium BCP in the post-issuance period of the green bond.

Although statistically significant, this result may be spurious, since the issuance of green bonds coincided with a time when the European banking sector, due to regulatory pressures and balance sheet recovery efforts, was experiencing declines in non-performing loans. In other words, it cannot be said that this reduction is solely due to the issuance of green bonds.

4.3. Sensitivity Analysis

In order to complement the results described above, a simplified stress test was also formulated. The reference year used was 2022, and an adverse shock of +2 percentage points to the NPL ratio and -1.5 percentage points to the CET1 ratio was applied to all banks. The results are shown in the following table:

TABLE VII

SENSITIVITY ANALYSIS RESULTS (BASELINE YEAR: 2022)

Group	CET1 (baseline)	CET1 (stressed)	Δ CET1	NPL (baseline)	NPL (stressed)	Δ NPL
Control Banks	12.74	11.24	**-1.5**	2.39	4.39	**+2.00**
Millennium bcp	12.60	11.10	**-1.5**	3.95	5.95	**+2.00**

Source: STATA - Own elaboration

The analysis of the results indicates that both groups, in stress situations, suffered an identical deterioration in both capital adequacy (CET1 ratios declined 1.5 percentage points in both groups) and asset quality (NPL ratios increased 2 percentage points in both groups). Therefore, the magnitude of the shock is comparable between the control group and the treatment group, even though BCP started from a higher level of non-performing loans.

Based on these results, it can be said that the issuance of green bonds is not associated with greater vulnerability to adverse shocks.

CHAPTER 5 – CONCLUSION

The main objective of this dissertation was to analyze the impact of green bond issuance on the financial performance, solvency and credit risk of Portuguese banks. To this end, key indicators such as *ROE*, *CET1 ratio*, and *NPL ratio* were selected. A Difference-in-Differences

approach was then applied for the period from 2015 to 2024, using Millennium BCP as the treated bank and comparing its performance with Novo Banco, BNP Paribas, and Santander, named as control group. Additionally, in order to ascertain whether the issuance of green bonds is associated with differences in the resilience of banks in adverse scenarios, a sensitivity analysis was performed using the *CET1* ratio and the *NPL ratio*.

This dissertation contributes to the existing literature on sustainable finance by providing empirical evidence on the impact of green bond issuance within the Portuguese banking sector, which remains relatively underexplored. By focusing on a small and less liquid market, this study complements prior research that has predominantly examined larger and more developed financial systems.

The empirical results obtained in this dissertation do not provide statistically significant evidence of how green bonds impact profitability and capital adequacy in banks. The estimated results for Return on Equity (*ROE*) and *CET1 ratio* coefficients, despite generally positive in the post-issue period, were not statistically positive, i.e., these results suggest that the financial effects of issuing these bonds are not immediately apparent in the short term.

The *NPL ratio*, which measures credit risk, showed results indicating a statistically significant reduction for the bank in question after its green bond issuance. However, these results may be spurious, as the timing of the issuance coincided with a time when the European banking sector was reducing its NPL ratios due to regulatory pressures, balance sheet recovery, and favorable macroeconomic conditions. Thus, although this coefficient is statistically significant, it is not possible to say that the observed reduction in credit risk was exclusively influenced by the issuance of the green bond, since we cannot exclude the common trends recorded during that period.

Subsequently, in the sensitivity analysis performed, the results obtained corroborated the conclusions previously drawn. This analysis showed that, under the same adverse credit and solvency shocks, both groups of banks (the treated and the control) showed identical tendencies to the shocks. Thus, it can be conclude that the issuance of green bonds does not increase the vulnerability of banks in adverse conditions.

From a practical perspective, the findings of this study suggest that investors should not expect immediate financial gains from banks issuing green bonds. Instead, green bonds should be interpreted as part of a broader long-term strategic commitment to sustainability.

For bank managers, the results indicate that the issuance of green bonds may serve as a signaling mechanism of environmental commitment and alignment with regulatory frameworks, even in the absence of immediate financial returns. As such, green bonds can play an important role in strengthening institutional reputation and positioning within increasingly sustainability-oriented financial markets.

For policymakers and regulators, the findings highlight the importance of distinguishing between the direct effects of green bond issuance and broader sectoral trends. In particular, improvements in credit risk indicators, such as reductions in non-performing loans, should be interpreted with caution, as they may reflect ongoing structural adjustments in the banking sector rather than the impact of sustainable finance instruments alone.

Overall, this study suggests that green bonds should be viewed not as a tool for short-term financial optimization, but as part of a long-term transition towards a more sustainable and resilient financial system.

Despite all the results obtained in this dissertation, it is also necessary to highlight some limitations. First, it should be noted that the sample size is small, due to the fact that the post-treatment period is short, which greatly limits statistical power, restricting the analysis to the short term. Another limitation here is that there is only one Portuguese bank treated. This is due to the characteristics of the Portuguese banking sector, since Millennium BCP is the only Portuguese bank listed on the stock exchange during the period covered by the study and which issued green bonds with consistent pre- and post-issue data available. Being listed on the stock exchange, BCP provides more detailed and standardized financial information, thus allowing for the identification of a clear and consistent treatment date for Differences-in-Differences. The other banks that make up the control group for this analysis either did not issue green bonds during the period considered or did not provide data on their issuance.

As a result, the analysis had to focus on a single treated bank, which limits the external validity of the results. This also means that the analysis focuses on only one banking system and cannot be generalized to other banking systems and institutional contexts. Finally, it is also important to note that the sensitivity analysis was a simplified one and cannot replace more comprehensive stress and supervisory tests. Therefore, this analysis should be interpreted as a comparative sensitivity analysis rather than a predictive analysis.

For future research, we recommend some adjustments to address the limitations presented, such as expanding the sample to include a larger number of banks and countries and extending the time horizon as data becomes available over time. For additional studies, it could also be

interesting to incorporate new sustainability-related indicators, such as the *Green Asset Ratio.* With these new additions, it would be possible to conduct a more in-depth long-term analysis.

That said, we can conclude that this dissertation can contribute to the literature on sustainable finance by providing some empirical evidence on the banking sector in Portugal, a sector that has been scarcely explored in the literature. Even though there is no evidence of immediate financial benefits from issuing green bonds, these issuances are in line with sustainability goals and current regulatory developments, thus reinforcing a strategic position in a financial system that is increasingly focused on climate-related considerations.

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DECLARATION

During the preparation of this manuscript, the author used DeepL to assist with translations and to improve the wording of the text. All translated content was carefully reviewed and revised to ensure accuracy, appropriate terminology and consistency of meaning. ChatGPT was also occasionally consulted to help organize certain sections. All content was critically reviewed and edited by the author. The author assumes full responsibility for the final version of the text.

APPENDICES

APPENDICE I

DEFINITION AND PURPUSE OF VARIABLES IN THR EMPIRICAL ANALYSIS

Variable	Definition/Calculation	Analytical Purpose
ROE (Return On Equity)	Ratio between net income and shareholders' equity. Measures profitability generated per unit of equity capital.	Dependent variable — indicator of financial performance.
CET1 Ratio (Common Equity Tier 1)	Core capital divided by risk-weighted assets, as per Basel III standards.	Dependent variable - proxy for solvency and resilience; used in the stress test simulation.
NPL Ratio (Non-Performing Loans)	Non-performing loans as a percentage of total loans.	Dependent variable — measures credit risk and asset quality.
Leverage Ratio	Total assets divided by shareholders' equity	Control variable — measures balance sheet risk exposure and capital structure.
Ln(Total Assets)	Total book value of the bank's assets. In the regression, transformed into natural logarithm (*ln*).	Control variable – proxy for bank size; larger institutions may have more diversified portfolios.
Green Bonds Outstanding	Total nominal amount of green bonds issued and outstanding.	Component of the main explanatory variable (GreenShare).
ESG Disclosure Score	Composite index (0–100) measuring the transparency and completeness of ESG reporting.	Control variable — captures sustainability commitment and reporting quality.
Treated	Binary variable equal to 1 for Millennium BCP and 0 for control banks.	Treatment indicator — identifies the bank exposed to the green bond issuance event.
Post	Binary variable equal to 1 from 2023 onwards and 0 otherwise.	Time indicator — identifies the post-issuance period.
Treated × Post (DiD)	Interaction between Treated and Post.	Main independent variable — captures the average treatment effect of green bond issuance.

Stressed NPL	NPL ratio after applying an exogenous positive shock.	Stress test variable — used to assess vulnerability to credit risk shocks.
Stressed CET1	CET1 ratio after applying a negative capital shock.	Stress test variable — used to assess solvency resilience under adverse scenarios.
Δ NPL / Δ CET1	Difference between stressed and observed values.	Stress test outcome — measures deterioration under stress and relative resilience.

(a) Variable definitions follow standard banking and finance literature. Capital and risk indicators (*CET1*, *Leverage ratio*, *NPL*) are defined according to the Basel III framework and ECB supervisory methodology. Stress test variables are based on ECB stress testing practices. The Difference-in-Differences variables (*Treated, Post, Treated* × *Post*) follow standard DiD identification strategies used in the empirical literature.

Source: Own elaboration