



Università
Ca' Foscari
Venezia

Master's Degree Programme
in Economics, Finance and Sustainability
(Sustainable Finance)

Final Thesis

**The Sustainable Transition of the
Banking Sector**

An Empirical Analysis of the European Banking System

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Matriculation No. 886423

Academic Year

2025/2026

Ringraziamenti

Mi sento in dovere di dedicare questa pagina del presente elaborato alle persone che mi hanno supportato in questo lungo percorso di crescita personale e professionale.

Innanzitutto, esprimo la mia più sincera gratitudine al Professor Francesco Scarpa, relatore di questa tesi, per la disponibilità, la professionalità e l'attenzione con cui mi ha seguito durante tutto il percorso di stesura. I suoi suggerimenti e la possibilità di poter contare su di lui per qualsiasi dubbio sono stati fondamentali per la realizzazione di questo lavoro.

Ringrazio infinitamente tutta la mia famiglia e soprattutto i miei genitori che da sempre mi sostengono nella realizzazione dei miei progetti. Non finirò mai di ringraziarvi per avermi permesso di arrivare fin qui.

Uno speciale ringraziamento va alla mia fidanzata Elisa per avermi trasmesso la sua immensa forza e il suo coraggio. Grazie per tutto il tempo che mi hai dedicato e se oggi posso festeggiare il completamento di questo percorso è anche grazie a te e al tuo costante supporto. Grazie perché ci sei sempre stata ed hai sempre creduto in me.

Grazie ai miei amici di sempre Alessio, Arianna, Gabriele, Samuele, Lorenzo, Filippo, Marco R., Marco C. e Rosa per i momenti di spensieratezza che hanno alleggerito ansie e preoccupazioni.

Un grazie sincero va ai miei amici e ai colleghi universitari, troppi da elencare singolarmente, che hanno condiviso con me questo percorso fatto di dubbi, soddisfazioni, crescita e momenti di festa. La loro presenza ha reso questo cammino più leggero e significativo.

Oggi, guardandomi indietro, non posso che provare un profondo senso di orgoglio e gratitudine per il cammino percorso. Ripenso a tutte le fatiche, ai momenti di incertezza, alle difficoltà che sembravano insormontabili e per questo sento di dover ringraziare anche me stesso, per aver avuto il coraggio di intraprendere questa esperienza, per non aver mollato nei momenti più duri e per aver creduto, fino alla fine, di poter raggiungere questo traguardo.

22 Giugno 2026

"Any cost linked to the transition to the green economy is enormously lower than the cost we will have to pay in the future if we choose to do nothing today"

Christine Lagarde.

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INTRODUCTION

In recent decades, the growing awareness of environmental, social and governance (ESG) challenges has permanently transformed the way financial institutions, businesses and governments operate. Sustainability has evolved from being perceived as a marginal concern to becoming an essential element in promoting long-term competitiveness and proper risk management. The instrument of this transformation is the ESG framework, which provides a multidimensional perspective including the environmental dimension, considering the management of natural resources and climate risks; the social dimension, concerning the treatment of employees, society and customers; and the governance dimension, which assesses the entity's transparency, accountability and ethical conduct. The combined use of these elements allows stakeholders to assess an institution financial strength, contribution to sustainable development and long-term adaptability.

The primary objective of this thesis is to analyze the evolution of sustainability in the financial sector, with a particular focus on the fundamental role that banking institutions play in the sustainable transition: they act as the crucial transmission mechanism of the real economy, meaning that, through their lending and investment decisions, they hold the structural power to drive capital flows toward eco-sustainable business models while simultaneously pricing the risks associated with carbon-intensive activities. This thesis aims to demonstrate their active commitment and progress in this domain through a rigorous empirical study, utilizing both semantic analysis and quantitative metrics, like the Green Asset Ratio, to evaluate the true maturity of the sector sustainable capital allocation and its efforts to combat greenwashing.

To achieve this objective, this Work is structured into three chapters: the first one outlines the regulatory framework concerning sustainability issues, highlighting the transition from voluntary reporting standards to the progressive development of binding legal requirements, because these regulatory developments are redefining both obligations and incentives for companies and financial institutions, requiring them to measure, disclose and manage ESG impacts in a standardized and comparable manner. The second chapter examines the crucial role played by the financial and banking sector in shaping the concept of sustainability. By definition banks act as key financial intermediaries, collecting resources from savers and reallocating them in the form of credit to households and businesses, positioning them as agents of change, capable of channeling capital towards projects that support the transition to a low-emission and socially inclusive economy through sustainable instruments such as Green, Social and Sustainability-Linked Bonds.

Finally, the third chapter represents the empirical core of the thesis, moving from the theoretical and macroeconomic framework, to a practical investigation of a selected sample of 20 European banks through a rigorous text mining analysis, with the objective of quantifying the semantic and structural evolution of their sustainability reports between the 2023 (NFRD) and 2024 (CSRD) fiscal years, measuring the magnitude of the regulatory shock on corporate disclosures. Subsequently, the analysis shifts from textual narratives to complex quantitative metrics by empirically assessing the Green Asset Ratio disclosed by the sampled institutions, with the aim of verifying whether the structural and methodological limits inherent in the current regulatory architecture, are directly reflected in market reality.

The methodology adopted for the development of this work is predominantly qualitative and descriptive-analytical in its initial theoretical phases, relying on a detailed review of academic literature, European directives (such as the CSRD and NFRD), institutional reports, and supervisory guideline, from the ECB and the Bank of Italy.

This approach is complemented in the final chapter by a robust quantitative methodology, utilizing a custom-built Python script for automated text mining and the manual extraction of empirical financial data from the official annual sustainability reports of the selected banking sample.

CHAPTER I. SUSTAINABILITY AND THE EVOLUTION OF ITS REGULATORY FRAMEWORK

Over the last two centuries humanity has gradually come to recognize the significant consequences of industrial and economic development on the natural environment, generated by the expansion of production and consumption systems driven by rapid technological innovation and global economic expansion. This situation has generated serious ecological and social repercussions through the persistent view of the Earth as an inexhaustible reserve of resources and an unlimited sink for waste generated by the world's population. For example the heavy dependence on fossil fuels and other finite natural resources has intensified greenhouse gas emissions and accelerated the depletion of ecosystems, or the rise of mass production and consumer culture has often been accompanied by unfair labor conditions like the excessive working hours and the use of child labor.

Today the environmental¹, social², technological³ and geopolitical⁴ risks have increasingly overtaken traditional economic and financial risks requesting the urgent necessity for global policies that recognize the close interdependence between human societies and the natural environment, in order to mitigate the negative effects of human activity and ensure a sustainable future for present and future generations.

The definition of sustainability includes the environmental sphere (called environmental sustainability) which aims to identify, on one hand, solutions that enable a harmonious coexistence between social and economic systems, and on the other hand, the regenerative capacity of natural ecosystems; and also the social sphere which aims, for example, to ensure the intergenerational equity and long-term sustainability of welfare systems, promote gender equality, reduce inequality, and provide equal access to digital technologies and opportunities for younger generations.

The increasing awareness of environmental degradation, climate change, social inequality and the growing demand for companies to disclose and manage their environmental and social impacts in a transparent and accountable manner, in addition to the mere generation of economic value, has deeply changed the expectations of investors, regulators, and society toward corporations, leading to a broader understanding of sustainability and its transformation from a voluntary corporate commitment into a central dimension of global

¹ Include for example air pollution, natural disasters and resource scarcity

² Food and water shortages and forced migration

³ Cybersecurity and artificial intelligence misuse

⁴ Global conflicts and terrorism

economic governance. This transformation has led to the gradual institutionalization of sustainability reporting, which now constitutes a fundamental component of corporate disclosure and strategic decision-making.

The objective of this chapter is to provide a comprehensive analysis of the evolution of sustainability reporting framework, with a particular focus on the transition from voluntary disclosure practices to mandatory regulatory regimes.

1.1 Voluntary Reporting Standards

Before sustainability reporting became subject to formal regulation, companies began to publish environmental and social information on a voluntary basis as a reaction to increasing public attention, stakeholder activism, and reputational pressures. These early reporting initiatives were called voluntary reporting standards and initially were designed to demonstrate corporate responsibility, enhance transparency, and build trust among investors, consumers and society, through the creation of structured methodologies useful for defining material issues, setting performance indicators and disclosing relevant qualitative and quantitative data.

However, the confidence in voluntary adoption also led to significant heterogeneity in reporting practices through firms of very different sectors due to the absence of binding requirements and because companies want to prioritize their image and compliance over accountability and comparability. As a direct result, investors and regulators began to question the credibility and reliability of information disclosed on this voluntary basis.

Frameworks such as the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), the Integrated Reporting Framework (IR), the Carbon Disclosure Project (CDP), and the Task Force on Climate-related Financial Disclosures (TCFD) will be discussed in relation to their origin, objectives, and methodological approaches.

1.1.1 Global Reporting Initiative: Foundations and Limitations

The Global Reporting Initiative (GRI), emerged in the late 1990s, is one of the most widely recognized and influential frameworks for sustainability reporting, serving as a global reference for the disclosure of environmental, social and economic performance which, through the standardized principles and indicators, had the objective of improving corporate accountability

for sustainable development, defined as the “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (GRI, 2002).

The GRI guidelines were originally built upon the Triple Bottom Line approach, which evaluates organizational performance across three dimensions: economic, environmental and social, emphasizing that company’s success must also consider ecological and societal outcomes.

According to GRI (2002), sustainability reports were meant to help organizations and stakeholders to “articulate and understand contributions of the reporting organization to sustainable development”, but on the other side, many analyses like Moneva et al. (2006), have highlighted recurrent limitations in the implementation of the framework often results in simplified and non-integrated reporting that fails to capture the systemic nature of sustainability. More precisely, Moneva et al. explain that the GRI risked reducing sustainability to an administrative or procedural exercise rather than fostering a transformation in corporate accountability, leading to “camouflage corporate unsustainability” for companies, with the direct effect of producing detailed but superficial reports.

But the biggest limitation of GRI framework concerns the voluntary nature of reporting, adherence and external assurance while the guidelines have encouraged transparency, stakeholder inclusiveness and accountability. If this limitation is not overcome through enforcement and uniform verification mechanisms, the comparability and reliability of sustainability reports varies considerably across organizations and generate the so called greenwashing⁵ phenomenon, if companies, particularly in sectors facing high environmental or social risks, underlying public relations and reputational gains rather than measurable sustainable outcomes.

Over time, updated versions of the GRI guidelines have aimed to correct past weaknesses and limitations through clearer definitions, stronger stakeholder engagement and a more structured focus on the new aspect of materiality, which is the process of identifying the most relevant sustainability topics⁶ for companies impacts and stakeholders⁷.

In 2021, the latest version of the GRI standards was drawn up with the aim of completing the transition to impact-based reporting, which refers to focus on significant impacts of a company on ESG aspects⁸.

⁵ The practice where a company makes misleading or exaggerated claims about its environmental efforts, making itself appear more eco-friendly and sustainable to the public than it actually is.

⁶ Topics that represent the organization’s most significant impacts on economy, environment and people including impacts on their human rights

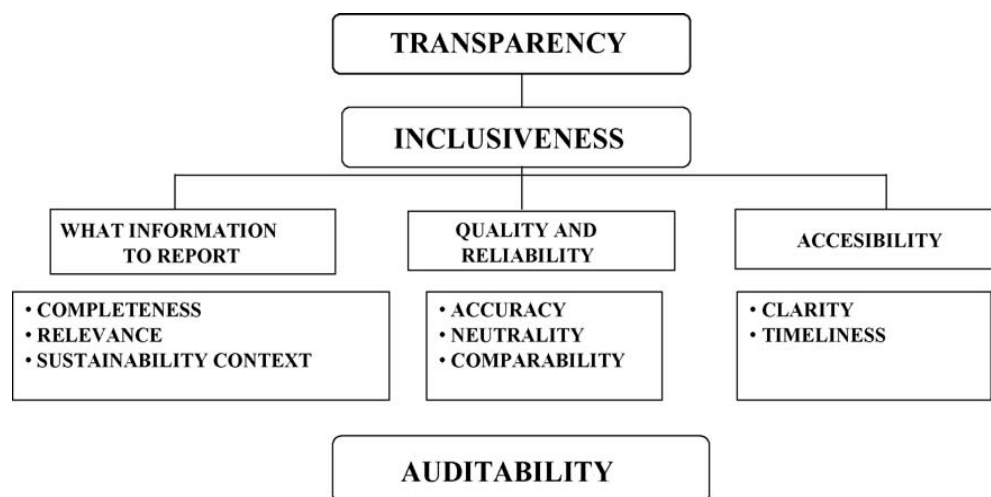
⁷ Detailed analysis of materiality reported in the second chapter

⁸ Inside-out perspective

This new framework is divided into three categories: Universal standards, which set out basis principles, general disclosures and guidance on determining material topics; Topic standards, which provide disclosures for organizations to report on their impacts in relation to specific topics such as energy or employment practices; and Sector Standards, which enhance the quality, completeness and consistency of sustainability reporting across specific industries, such as banking or mining.

This updated approach enhances both flexibility and comparability allowing organizations to adapt their disclosures while maintaining a consistent core structure across sectors reflecting the growing regulatory convergence between voluntary standards and mandatory ones, such as the EU Corporate Sustainability Reporting Directive and the European Sustainability Reporting Standards ESRS, both of which build upon and extend GRI principles.

Fig. 1. GRI reporting principles



1.1.2 Sustainability Accounting Standard Board framework: Financial Materiality in Sustainability Reporting

The Sustainability Accounting Standards Board (SASB) is a non-profit organization founded in 2011 with the objective of developing standards for the disclosure of financially material sustainability information to all financial capital providers of companies⁹.

It was designed to provide a framework for companies, initially especially the American ones, to report sustainability data that could directly influence financial performance and decision-

⁹ For example investors

making process, generating risks and opportunities¹⁰. So, compared to the GRI approach, this one emphasizes financial materiality, meaning that it identifies ESG factors who trigger or could be expected to trigger material financial effects of the firm and affect their value over the short, medium and long term.

As we can see in Figure 2, the structure of SASB reporting model is built around five pillars: environment, social capital, human capital, business model & innovation and leadership & governance. These pillars are applied across 77 industry-specific standards which include both qualitative and quantitative indicators designed to produce decision-useful data for financial capital providers, improving the consistency and comparability of ESG disclosures within, and across, companies. In 2021, SASB merged with the International Integrated Reporting Council (IIRC) to form the Value Reporting Foundation (VRF) with the objective of integrating two complementary perspectives: how an organization uses its capitals to create value over time (the idea of IIRC) and the emphasis on industry-specific, financially material sustainability factors of VRF. Finally, in 2022, the VRF was incorporated into the International Financial Reporting Standards (IFRS) Foundation under the newly established International Sustainability Standards Board (ISSB)¹¹.

The main differences between GRI and SASB fall into their purpose and the audience they address. Regarding the first aspect SASB focuses on financial materiality (outside-in approach) while the GRI on impact materiality (inside-out approach); regarding the second difference, SASB provides financially relevant data necessary for capital markets while GRI promotes a broader accountability framework for all stakeholders.

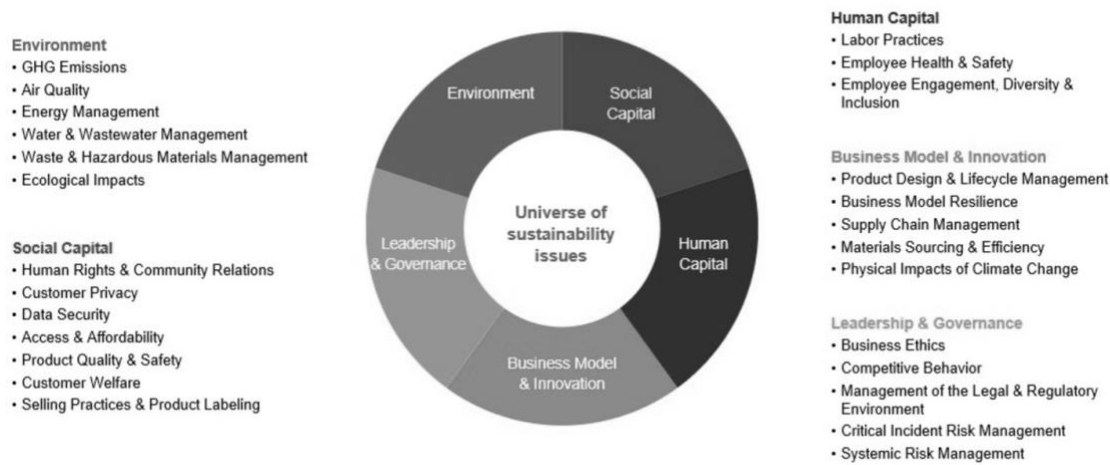
In conclusion we can anticipate that together they form the conceptual foundation for emerging standards which aim to integrate both perspectives under the principle of double materiality¹².

¹⁰ Outside-in perspective

¹¹ Discussed in the second paragraph

¹² The principle requiring a company to report on two fronts: how its activities impact the environment and society (impact materiality), and how environmental risks, like climate change, impact the company's own financial health (financial materiality).

Figure 2. Structure of SASB reporting framework



1.1.3 Integrated framework: a Forward-Looking model for Value Creation

The International Integrated Reporting Council was established as a coalition comprising investors, corporations, regulators, standard setters and non-governmental organizations, with the objective of promoting the evolution of corporate reporting through the development of a comprehensive framework designed to link financial and non-financial information into a single reality. So, it conceptualized an Integrated Report, which is a document intended to communicate how an organization's strategy, governance, performance and prospects interact with its external environment to generate value over the short, medium and long term.

This framework aims to communicate how the company's operations leads to the creation, preservation or erosion of value over time, so, compared to other frameworks, it broadens the traditional focus of financial reporting by incorporating all the resources and relationships that an organization relies upon, including six different elements in the concept of capital: Financial (availability of money), Manufactured (physical goods), intellectual (intangible resources), human (workforce), social and relationships between firms and stakeholders and natural resources used.

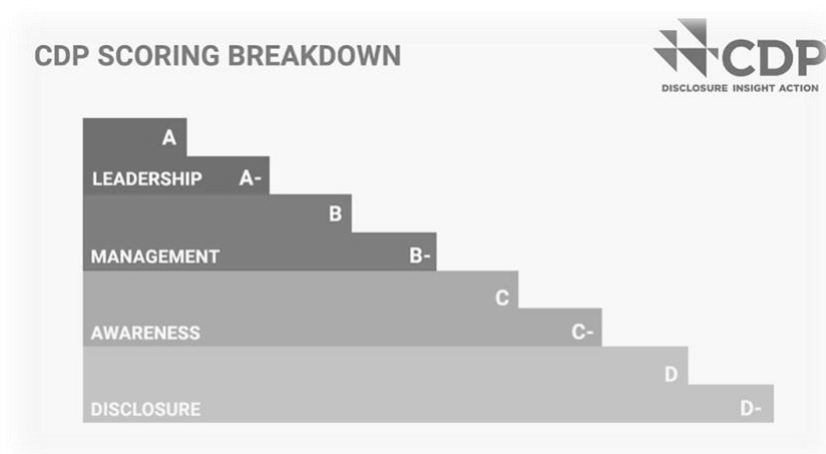
Another feature that distinguishes this framework from others is its forward-looking perspective, which is the analysis and communication of future opportunities and risks, offering stakeholders deeper insights into the organization's ability to sustain value creation over time.

1.1.4 The Carbon Disclosure Project and its Scoring System

Founded in the 2000s in London as an investor-led initiative, the Carbon Disclosure Project (CDP) was created with the aim of promoting the greenhouse gas emissions of large corporates. The organization's framework is based on a voluntary annual questionnaire, within which, initially, companies were asked to disclose only their GHG emissions and reduction strategies, then, the scope has been expanded to include issues such as climate change, water security, deforestation, and plastic pollution. This enables firms that use CDP framework to reflect a more holistic understanding of environmental sustainability, allowing for a deeper evaluation of environmental performance and strategy. The answers to this questionnaire are scored using a methodology aligned with the task Force on Climate-related Financial Disclosures: as shown in Figure 3 companies receive a grade ranging from "A" to "D-", based on the comprehensiveness and quality of their disclosure, or receive a "F" if they fail to provide necessary informations. These scores serve as benchmarks for investors and stakeholders to assess the robustness of an entity's environmental governance, risk management and progress toward a low-carbon transition.

Finally, CDP reports that with this transparency drives actions firms typically cut their direct emissions by 7% to 10%¹³ within two years, and emphasizes that disclosing through CDP provides a competitive advantage by helping companies get ahead of emerging regulatory requirements.

Figure 3. CDP Rating



¹³ Data reported by CDP website

1.1.5 Task force on Climate-Related Financial Disclosure

The TCFD was established in 2015 with the objective of improving the transparency of climate-related financial information, creating a framework for companies and financial institutions to disclose the financial implications of climate change (so it basically follows a financial perspective). The final report was published in 2017 providing disclosure recommendations grouped into four thematic pillars: governance, risk management, strategy and metrics & targets.

The first one highlights the board and management oversight of climate issues, ensuring accountability at the highest level; the second one explains how climate factors are integrated into the company's broader risk assessment and control processes; the strategy pillar focuses on how climate-related risks and opportunities influence the company's business model and long-term objectives; and lastly the metrics & targets component calls for the disclosure of key quantitative indicators, which demonstrate progress toward climate goals, such as greenhouse gas emissions and energy consumption.

The framework was initially voluntary, but as its adoption by companies and governments rapidly expanded, and several jurisdictions including the European Union and the United Kingdom, incorporated it into their regulatory frameworks, it has effectively become mandatory in some regions.

1.2 International Initiatives

Following the detailed presentation of voluntary disclosure frameworks, the analysis now shifts to the various mandatory models, both European and Extra-EU. The main motivation that led to the creation of these frameworks was the need for greater consistency and regulatory oversight, aimed at standardizing sustainability reporting.

Among these, the actions of the U.S. Securities and Exchange Commission (SEC) and the International Sustainability Standards Board (ISSB) stand out for their contribution to integrating climate and sustainability considerations into formal financial disclosure requirements.

1.2.1 International Sustainability Standard Board

The International Sustainability Standards Board was established by the IFRS Foundation in 2021 during the COP26 conference in Glasgow, with the aim of meeting the growing demand of investors, regulators and market participants for transparent and comparable information about sustainability-related risks and opportunities that can influence a company's financial performance and long-term value creation. In this sense, the ISSB plays an essential role in the global transition from voluntary sustainability reporting frameworks toward a harmonized and internationally recognized system of disclosure. Through its work, the ISSB has resolved the confusing regulatory situation that existed until now (also known as the "alphabet soup"), pursuing the goal of reducing fragmentation and facilitating the adoption of a single global framework. How? By consolidating various initiatives including: The Task force on climate related financial disclosures, the integrated reporting framework, the sustainability accounting standard board framework and the climate disclosure standard board.

In June 2023, the ISSB issued the first two IFRS Sustainability Disclosure Standards: IFRS S1 – General Requirements for Disclosure of Sustainability-related Financial Information, and IFRS S2 – Climate-related Disclosures. The first one provides a framework, which is aligned with the four core pillars introduced by the TCFD (set out in the previous paragraph), for identifying and communicating sustainability-related risks and opportunities that could reasonably be expected to affect a company's prospect. Moreover, IFRS S1 encourages the inclusion of industry-specific information to ensure the comparability and relevance of disclosures across sectors. The second one, specifies the information that companies must provide regarding their exposure to climate-related risks and opportunities, including both physical risks¹⁴ and transition risks¹⁵.

An important feature to highlight is the adoption of a proportional approach by the ISSB standards, allowing companies with different levels of resources and reporting experience to apply the standards appropriately, for example when quantitative data on the financial effects of a sustainability-related risk or opportunity cannot be obtained without excessive cost or effort, companies are permitted to provide qualitative information instead. The adoption of these standards offers several benefits for companies, like enhancing governance,

¹⁴ Refers to risk of damages of physical assets, natural capital and human lives resulting into economic output losses as a result of impacts of climate change

¹⁵ Changes in financial asset values that market players are not able to anticipate or hedge against, for example generated by technological developments

strengthening strategic planning and fostering stakeholder trust; and also, for investors providing a better assessment of how sustainability-related factors affect a company's value and performance over time.

Ultimately, the ISSB represents a significant step toward unifying sustainability reporting at global level, laying the groundwork for an integrated system that combines financial and sustainability disclosures in a way that enhances both market efficiency and corporate accountability, in fact from 2023 more than twenty jurisdictions have already expressed their support for, or are in the process of, incorporating these standards into their regulatory frameworks.

1.2.2 SEC and the Standardization of Climate-Related Reporting

The Securities and Exchange Commission plays a crucial role in shaping climate-related financial reporting within the United States, in fact in March 2022, it proposed new rules on climate risk disclosure aimed at enhancing the consistency, comparability and reliability of informations provided to investors. These rules mark a significant shift from voluntary environmental reporting to a more standardized approach under which publicly listed companies are required to disclose both qualitative and quantitative data on climate-related risks that could materially affect their business operations or financial performance.

Under this framework companies must report their governance and oversight of climate-related risks, describing the material impacts of these risks on their strategy and financial planning, and explain how such risks are identified, assessed and managed within their existing risk management processes. Additionally, firms are expected to provide detailed emissions data, including Scope 1 and Scope 2 greenhouse gas (GHG) emissions, while disclosure of Scope 3 emissions is required when are considered material or if the company has set relevant emission targets.

1.3 European Framework

After having examined the international mandatory disclosure models and the voluntary ones, the attention now shifts to the regulatory framework developed within the European Union, which stands today as one of the most advanced and comprehensive global approaches to sustainability reporting. A first fundamental step was the introduction of Regulation (EU) 2019/2088, also known as Sustainable Finance Disclosure Regulation (SFDR), which requires

financial market participants¹⁶ to disclose how ESG factors are incorporated into their investment processes and advisory services. Its main purpose is to enhance transparency for clients and investors by ensuring that sustainability-related information is clear, reliable and comparable, operating under a “comply-or-explain” approach, obliging entities either to demonstrate how sustainability factors are effectively integrated into their strategies or to provide a transparent justification when such integration is not applied. To complement this approach the EU subsequently adopted the Regulation (EU) 2020/852, better known as the EU Taxonomy Regulation, which establishes a unified classification system for environmentally sustainable economic activities with the ultimate goal of driving capital flows toward activities that substantially contribute to the EU long-term environmental objectives, including climate neutrality by 2050.

So, in this context, the Sustainable Finance Reporting Directive (SFDR), the EU Taxonomy and the modern Corporate Sustainability Reporting Directive (CSRD) represent the initiatives shaping the European sustainability reporting landscape, each providing detailed and binding requirements that guide companies in disclosing their sustainability performance and alignment with environmental objectives.

1.3.1 Sustainable Finance Disclosure Regulation: Regulation 2019/2088

As we mentioned previously, the Sustainable Finance Disclosure Regulation (SFDR), introduced through Regulation (EU) 2019/2088, represents one of the first pillars of the EU’s broader sustainable finance strategy and was designed to increase the transparency of how financial market participants incorporate sustainability considerations into their decision-making processes. A substantial difference that we can attribute to this regulation, compared to the previous ones, is the target involved: financial institutions instead of corporates.

To achieve the objective of the regulation, that is, to request the institutions concerned to disclose how sustainability risks may affect the value of the financial products they offer and the potential adverse impacts their investment decisions may have on environmental and social factors, it has been established a structured system of disclosure obligations operating at two levels: the first level is the “entity-level disclosures” and describe how sustainability risks are integrated into an institution’s investment and advisory policies; the second level is the

¹⁶ Banks, Asset managers, Insurers and Investment firms

“product-level disclosures” and clarify the sustainability characteristics or objectives of individual financial products.

Another characteristic of the regulation is the requirement for financial institutions to disclose “Principal Adverse Impacts”, a set of quantitative indicators intended to capture the negative effects that investment activities may have on sustainability factors such as greenhouse gas emissions, biodiversity, social matters and employee conditions. Through these indicators, investors gain a clearer understanding of how sustainability risks are managed and also insights of real impacts associated with their investment decisions.

Overall, the SFDR operates in close connection with the EU Taxonomy Regulation; the Taxonomy defines when an economic activity can be considered environmentally sustainable (as we will describe in the next paragraph), the SFDR requires financial institutions to explain the level to which their investment products are exposed to, or aligned with, such activities.

1.3.2 The EU taxonomy and the identification of Environmentally Sustainable activities

The EU Taxonomy, introduced as part of the 2018 Action plan on financing sustainable growth, responds to the need for a unified classification system capable of identifying when an economic activity can be regarded as environmentally sustainable, and the framework entered into force in July 2020 through the adoption of Regulation (EU) 2020/852. Functioning as a legally binding regulation, the Taxonomy lays the groundwork upon which subsequent sustainability-related directives have been developed, in particular the Corporate Sustainability Reporting Directive.

Based on this framework, an economic activity is considered environmentally sustainable when it satisfies four cumulative conditions: it must contribute substantially to at least one of the environmental objectives (which are climate change adaptation¹⁷, climate change mitigation¹⁸, sustainable use and protection of water and marine resources, protection and restoration of biodiversity and ecosystems, transition to a circular economy and pollution prevention); it must not significantly harm any of the remaining objectives (DNSH principle); it must be carried out in compliance with minimum social safeguards¹⁹; and it must meet the technical screening

¹⁷ All actions designed to manage or minimize the impacts of climate change already occurred or expected to occur (flood defenses for example).

¹⁸ All actions aimed at reducing or preventing the causes of climate change (reforestation for example)

¹⁹ OECD Guidelines for Multinational Enterprises, the UN Guiding Principles on Business and Human Rights and the International Bill of Human Rights.

criteria, which are thresholds and performance requirements aligned with EU environmental ambitions.

If an activity meets all these four conditions it can be considered “aligned”, and if it meets at least the technical screening criteria is considered “eligible”: eligibility alone does not provide any indication of the environmental performance of an activity, instead alignment provide it.

More specifically, for financial institutions, the Taxonomy serves as a reference point for assessing the environmental profile of their financing and investment portfolios, using two indicators: the Green Asset Ratio (GAR) and the Green Investment Ratio (GIR). The first one assesses the share of a bank’s assets financing Taxonomy-aligned activities, while the second one evaluates the alignment of investment portfolios.

Beyond compliance, the data presented by the European Commission shows that companies with higher levels of Taxonomy-aligned revenues or green capital expenditures have outperformed market benchmarks in recent years, suggesting that alignment with the Taxonomy may also be associated with improved financial performance.

1.3.3 The current European regulatory landscape for Sustainability reporting

To provide a comprehensive overview of the current European regulatory framework, it is necessary to begin with a look at the past, starting from the Non-Financial Reporting Directive (NFRD), then move with the introduction of the new Corporate Sustainability Reporting Directive (CSRD), designed to reflect the economic and environmental developments that have occurred in recent years, and finally by a brief reference to the recent Omnibus Directive.

1.3.3.1 The Non-Financial Reporting Directive (NFRD)

The Non-Financial Reporting Directive represents the first comprehensive European attempt to standardize the disclosure of non-financial information and to integrate sustainability considerations into corporate reporting practices, requiring large companies to disclose information necessary to understand their development, performance and position, as well as the impacts of their activities on environmental, social and governance topics. The reasons that led to the introduction of this directive were essentially two: the non-financial transparency was considered essential for managing the transition towards a more sustainable and inclusive economic model, helping to identify sustainability risks; and secondly, the lack of comparability

and reliability across existing reports highlighted the need for minimum and harmonized disclosure requirements across the EU, increasing stakeholders trust.

A fundamental feature of the Directive, which will later become the main reason for its revision, is the size requirement which imposes whether or not the company in question must comply with the various obligations contained therein. These companies were all large public-interest entities with more than 500 employees: large companies were defined as those with more than €20 million in total assets or more than €40 million in turnover; public-interest entities were defined as companies listed on EU regulated market, EU banks and insurance companies, for a total of approximately 11.000 companies.

Firms that meet these requirements were obliged to disclose on a defined set of thematic areas including environmental matters²⁰, respect of human rights, social and employees matters²¹, anti-corruption & bribery and company board diversity; then, for material thematic aspects²², will have to structure their disclosures around four reporting areas: business model, policies & outcomes, risk management and key performance indicators. These companies could choose the reporting framework they prefer among those discussed so far (GRI, SASB...), publish their non-financial statement²³ as a separate document or insert it into the management report, and finally were not subject to mandatory third-party assurance, unless required by national legislation like in Italy and France. This broad flexibility has contributed to the shortcomings later identified by EU institutions and stakeholders, generating the need for a comprehensive revision of the directive, resulted in the 2018 EU Action Plan which emphasized the importance of reorienting capital flows towards sustainable investments, integrating ESG risks into financial decision-making, and strengthening market transparency and long-termism. A subsequent public consultation revealed widespread dissatisfaction with the quality of disclosures produced under the NFRD in terms of comparability, reliability and relevance, so respondents expressed strong support for the adoption of a mandatory common standard, stricter audit requirements, the expansion of the directive's scope to certain categories of companies, and also further digitalization of sustainability information. These limitations prepared the basis for the development of the new Corporate Sustainability Reporting Directive (CSRD), which significantly expands the scope, marking a decisive shift from a mainly

²⁰ Pollution prevention, waste management...

²¹ Diversity and inclusion, working conditions...

²² A sustainability topic that is relevant enough to significantly influence a company's development or performance

²³ The term sustainability is not used in this model

qualitative and flexible regime to a more rigorous, standard-based and investor-relevant reporting framework.

Last but not least, the NFRD implicitly incorporated a double-materiality perspective, requiring companies to disclose both financially relevant information and the impacts of their activities on society and environment, but this principle was not effectively applied in practice because most companies, under this directive, used impact-materiality-oriented voluntary frameworks (commonly GRI), producing disclosures that rarely addressed financially material ESG risks in a systematic way, thus making the part relating to financial materiality useless.

1.3.3.2 The Corporate Sustainability Reporting Directive (CSRD)

The Corporate Sustainability Reporting Directive, approved in 2022 and progressively applicable from the 2024 financial year, marks a significant departure from the flexible and mainly qualitative regime of the NFRD to a more prescriptive model aligned with the growing informational needs of investors, society and supervisory authorities, addressing the previous limitations such as the lack of comparability, reliability and decision-usefulness of sustainability information disclosed.

The most important innovation introduced by the CSRD concerns the expansion of the scope of application, extending the mandatory sustainability reporting from a target of 11.000 companies to approximately 50.000. This extension had been planned in several steps starting from the financial year 2024 (means first reporting in 2025) with the same target applied under NFRD; from financial year 2025 (first reporting in 2026) it would have increased to include all companies that met one of the following three criteria: more than 250 employees, more than 50 million turnover and more than 25 million in total assets; from financial year 2026 (first reporting in 2027) also listed Small-Medium enterprises would have been included among the companies obliged to disclose, and finally, from financial year 2028 (first reporting in 2029) also Non-EU groups which generate more than 150 million turnover in EU and which have a subsidiary in EU, which is large or a listed entity, or a branch in EU which generates more than 40 million turnover.

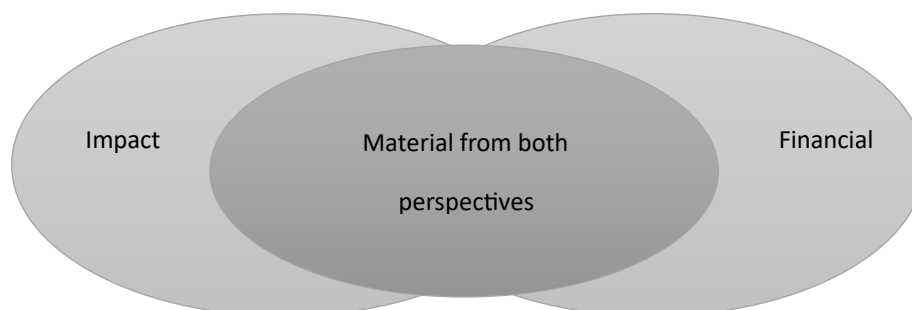
The CSRD also redefines the content and structure of sustainability disclosures, requiring companies to provide more detailed and forward-looking information on their business model and strategic orientation, the role of governance bodies, the policies adopted and actions taken, the risks and opportunities arising from sustainability matters, and the targets and metrics used to monitor progresses. Unlike what happen under NFRD, here all information must be

included within a dedicated section of the management report and digitally tagged, facilitating data accessibility and supporting the objective of building a coherent and machine-readable sustainability data ecosystem. Another difference from the previous directive was the introduction of a mandatory assurance of the Sustainability Statement, initially limited²⁴ and gradually evolving toward reasonable²⁵ ones, thereby improving the credibility and robustness of sustainability disclosures.

Another fundamental principle on which the CSRD is based is the explicit application of the double materiality principle: companies must assess and disclose both how sustainability matters affect their financial performance, position and cash flows (financial materiality), and how their activities generate impacts on people and the environment (impact materiality).

As we said, under NFRD, this dual perspective was only implicitly recognized and rarely applied in practice because most companies relied predominantly on impact materiality oriented voluntary standards like the GRI. This double materiality aspect is incorporated in the European Sustainability Reporting Standards (ESRS) which provides the guidance on the materiality assessment process.

Figure 4. Double materiality



The ESRS have been developed by the European Financial Reporting Advisory Group (EFRAG)²⁶ in 2023 with the aim of translating the principles of the Directive into disclosure requirements, providing a comprehensive framework for companies under consideration. These standards specify the information that companies shall disclose about its material impacts, risks and opportunities in relation to ESG sustainability matters, and are divided into three series: The

²⁴ Conclusion expressed in a negative form, obtaining only moderate confidence that no material misstatements are present.

²⁵ Conclusion expressed in a positive form, allowing the auditor to state that information are free from material misstatements.

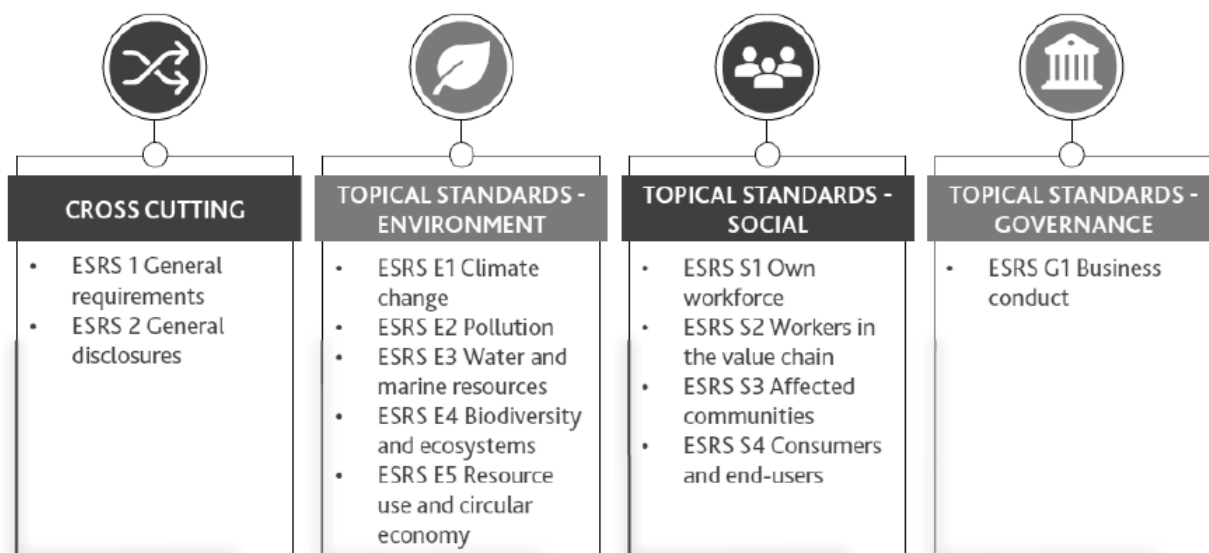
²⁶ An independent, multistakeholder advisory body with the task of drafting the ESRS and submit them to the European commission as an opinion.

Full ESRS, ESRS for listed Small and Medium enterprises and ESRS for third-country companies; nowadays only the first series has been adopted, which is further divided into Cross-cutting standards, Topical standards, and Sector-specific standards.

The first group contains the ESRS 1, which lists the general principles to be adopted for reporting (the information that must be disclosed is divided into numbered disclosure requirements, each containing various data points, which can be mandatory or voluntary), and the ESRS 2, which outlines the essential mandatory information to be disclosed.

The second group, Topical standards, is subject to double materiality assessment²⁷ and reflect the three dimensions of sustainable development: Environment, Social and Governance (each of which address related problems, listed in the Figure 5 below).

Figure 5. The Full ESRS



In its entirety, this Directive marks an important strengthening of the EU sustainability disclosure regime, addressing the structural weaknesses observed under the NFRD, aligning corporate reporting practices with the broader EU sustainable finance agenda and providing investors and other stakeholders with more reliable, comparable and comprehensive sustainability information.

²⁷ If a sustainability matter is material from an impact perspective or financial perspective or both, it should be considered for reporting.

However, all that glitters is not gold, and in fact the need has arisen to introduce various changes and adjustments to the provisions introduced by the CSRD, with the aim of smoothing the transition to the new sustainability reporting regime.

1.3.3.3 The Omnibus Directive

As we just said, the CSRD represents a substantial strengthening of the EU disclosure framework, broadening the scope of companies required to disclose, introducing mandatory assurance and requiring compliance with the ESRS standards, but its ambitious scale raised concerns regarding the operational complexity for companies, particularly for SMEs and non-EU undertakings entering the EU market. To address these concerns, the European Commission introduced, in 2025, the so-called Omnibus Directive, a complementary legislative act intended to recalibrate the implementation timeline and technical requirements established under the CSRD, with the aim of reducing administrative pressure and ensuring that companies have adequate time and resources to adapt to the new reporting obligations.

The directive aimed to focus on and address problems related to 3 aspects: a reduction of companies subject to mandatory sustainability reporting requirements, limiting the scope imposed under CSRD to those with more than 1000 employees and either 50 million turnover or 25 millions in total assets, reducing the number of companies obliged to report by 80%; A simplification of reporting requirements (ESRS) through the removal of sector specific reporting standards, a revision of the first set of ESRS reducing the number of mandatory data points and simplifying the structure of the standards and the possibility of moving from a limited assurance to a reasonable assurance, in order to avoid the increasing of assurance costs in future; Finally the commission introduce a prorogation of two years to the application of CSRD²⁸ for the second group (large undertakings that are not public interest entities) and third group (listed SMEs) with the aim of providing these companies with more time to adapt to new requirements and to avoid unnecessary costs.

Overall, the Omnibus Directive marks an important intermediate step in the evolution of EU sustainability reporting framework by recalibrating timelines and providing a more proportionate approach.

²⁸ Through Directive (EU) 2025/794 called “Stop the Clock” Directive.

CHAPTER II. THE ROLE OF THE BANKING SECTOR IN THE SUSTAINABLE TRANSITION

Building upon the foundations established in the first chapter, which mainly analyzes the regulatory evolution from voluntary to mandatory sustainability reporting, this section addresses the core research question of the thesis, which is to investigate how the banking and financial sector acts as the fundamental transmission mechanism required to foster a genuine sustainable transition instead as a merely passive participant.

Banks are the financial actors responsible for allocating capital within the real economy and, through their lending and investment decisions, they hold the structural power to drive financial flows toward eco-sustainable business models while simultaneously pricing the risks associated with carbon-intensive activities. So, without the active engagement of the banking sector, the regulatory milestones discussed in the previous chapter would remain theoretical exercises rather than drivers of real economic change.

This chapter examines the crucial role played by these institutions in the transition toward a more environmentally and socially sustainable planet, beginning by presenting their functions, including the integration of the ethical banking model; continuing with an analysis of the various green products currently managed with an increasingly marked focus on sustainability, specifically green bonds, social bonds, sustainability bonds and sustainability-linked bonds, while also exploring their respective levels of diffusion. Furthermore, the chapter discusses tests and research conducted by the ECB and the Bank of Italy regarding the nexus between climate change and financial risk, such as the 2022 Climate Risk Stress Test and the Bank of Italy's survey on the importance of insurance coverage in mitigating climate financial risk, coverage that has subsequently become mandatory for specific categories of firms.

Finally, it addresses the transition from voluntary to mandatory sustainability reporting, outlining the double materiality assessment process and the increasingly prevalent phenomenon of greenwashing.

2.1 Economic and Social Functions of Banks

The banking sector assumes a singular and crucial position within the modern economy, functioning primarily as a financial intermediary that serves as a connection for the gap between capital surplus, generated by those who spend and invest less than they earn, and deficit units, generated by those who spend and invest more than they earn, for investments or

merely for consumption. In an economy lacking such intermediaries, the process of capital aggregation and allocation would involve prohibitive costs, as individual businesses would need to raise funds directly from numerous savers, who, in turn, would face significant expenses related to information gathering, creditworthiness assessment and monitoring of the borrower's repayment capacity.

By undertaking this comprehensive due diligence on behalf of individual savers, banks drastically reduce the inherent costs associated with information asymmetry and liquidity management, simultaneously enhancing the overall efficiency and availability of financial resources to the wider economy. This process of financial intermediation also involves several crucial transformations of money, which enable efficient market functioning, starting from the transformation of them by scale, matching the large requirements of borrowers with the often smaller surpluses of creditors, then by spatial location, facilitating the movement of capital across geographies, and most critically, by duration (or maturity transformation), which sees banks collecting funds primarily through short-term withdrawable deposits, which they subsequently convert into less liquid long-term financial assets such as business loans or mortgages.

Furthermore, the capacity of banks to diversify risks is superior to that of individual savers, as banks can spread lending across a large and varied portfolio of borrowers mitigating the impact of localized default or sector-specific downturns. This inherent ability to assess and price risk combined with their central influence over the direction of credit flows grants banks an enormous potential role in contributing to sustainable development, precisely because their established and efficient credit approval systems are optimally equipped to weigh the risks associated with environmental and social factors and attach a corresponding price to them.

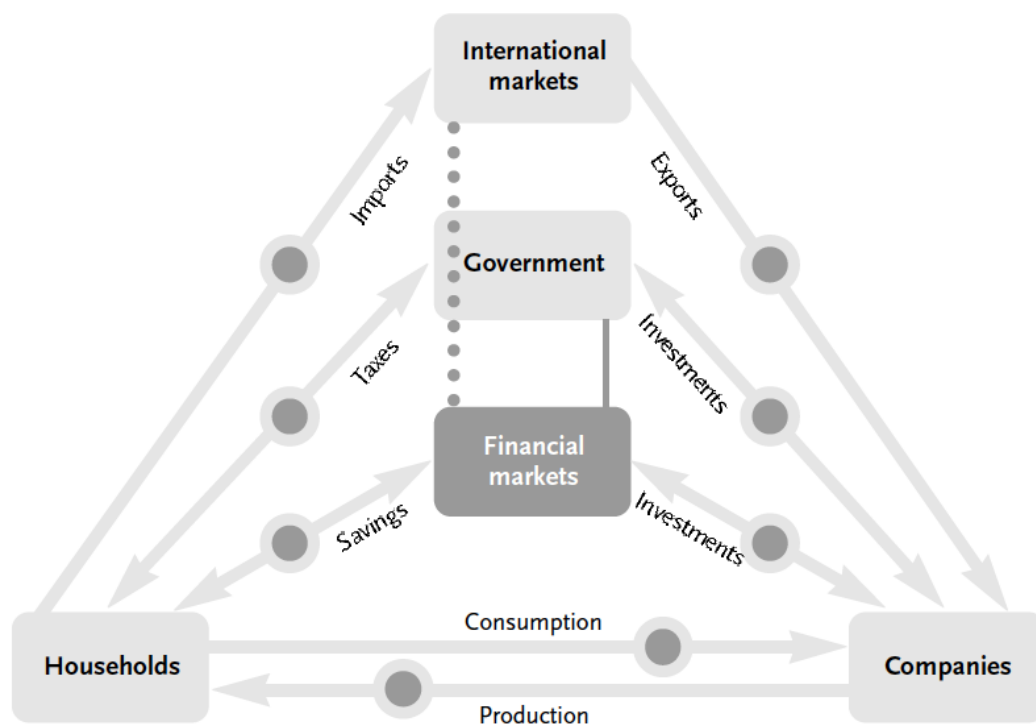
The systemic importance of banks is further illustrated by their influence across the entire macroeconomic system, and through Figure 6, we can better illustrate this cyclical process highlighting the central role of financial markets in facilitating money flows between households, companies, governments and international markets.

Banks manage the surpluses and shortages of capital across all these key actors through financial transactions and we can clearly see in the Figure 6 at which points in an economy banks are present (shaded areas). The arrows in the Figure represent money flows, so households pay taxes, consume, import goods and save money; companies produce, invest, export goods and receive investments; governments receive taxes, pay subsidies and invest; goods are traded through international markets and finally surpluses and shortages of all these

categories are dealt through the financial markets and we can therefore deduce the importance of this last category which includes banks.

Banks also have the function of risk evaluators, giving them a comparative advantage in knowledge regarding sector-specific information, legislation, and market developments, and allowing them to reduce the information asymmetry between market parties, which in the context of sustainability translates into an ability to differentiate between clients based on their ESG risk profile. By attaching a price to environmental and social risks, for example setting a higher interest rate for clients with high environmental risks, banks actively stimulate the internalization of external costs into market prices, positioning them as a natural partner of governments in promoting sustainable practices.

Figure 6. Cyclical process of a macroeconomic system



2.1.1 The Extended Social Mandate and the Ethical Banking Model

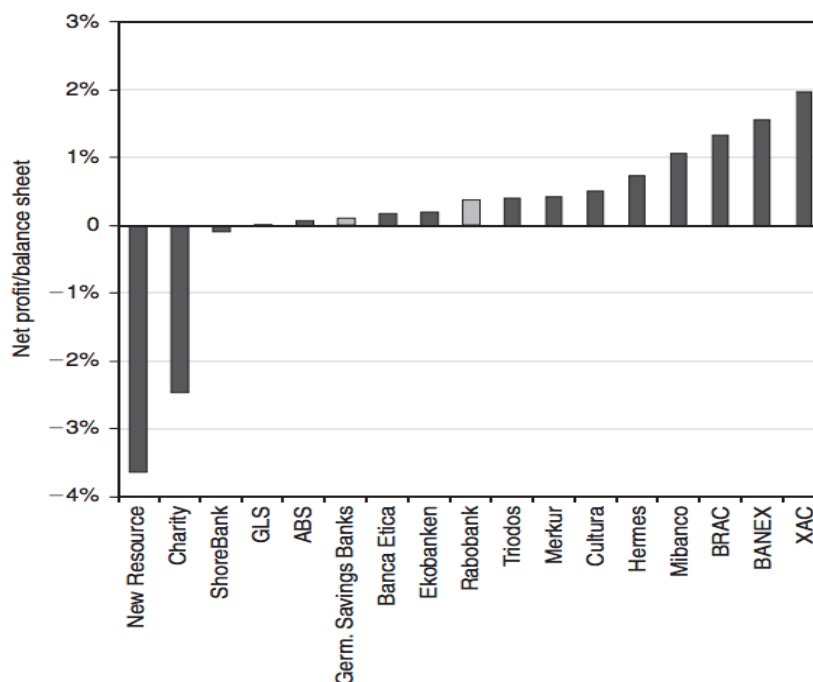
In addition to the economic function mentioned above the contemporary banking sector is subject to an extended social mandate, requiring institutions to consider also the ethical and societal outcomes of their financial decisions due to the increasing awareness of environmental

degradation and social inequality, intensified by stakeholder pressure from non-governmental organizations (NGOs) and society at large.

This philosophy is implemented by the Social Banking model, which aims to generate a positive impact on people, environment and culture through its products and services offered, such as green loans and sustainable investments. Social banks, typically smaller niche players like Banca Popolare Etica in Italy, Triodos Bank in the Netherlands or New resource Bank in the USA²⁹, are very different from traditional banks because they are focused on ethical and sustainable aspects operating under the explicit mission of utilizing finance to deliver sustainable development for communities and the environment. This approach may involve a qualitative step further than risk management alone, fostering projects at a higher risk or a lower financial rate of return, aiming instead for the highest sustainable rate of return while maintaining long-term profitability.

In Figure 7 we present the net profit per balance sheet sum and we can see that the two US based banks and the Charity Bank provide a net loss but all other social banks provide a net profit, being able to say that the operational viability of these niche players is demonstrated by their profitability, which, for many, is comparable to that of larger conventional banks.

Figure 7. Net profit per balance sheet of Social Banks



²⁹ Other social banks listed in Figure 7

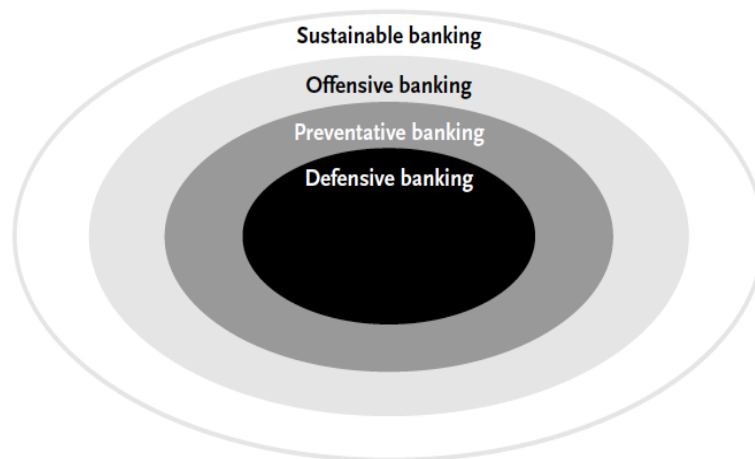
To further elaborate on the evolving role of financial institutions it is important to analyze the specific strategic pathways banks adopt when integrate sustainability into their core operations, categorizing them in four distinct stages depicted in Figure 8: defensive, preventative, offensive, and sustainable banking. While conventional institutions typically progress through these phases linearly, certain niche players (social banks) may bypass the initial stages entirely due to their foundational ethical missions.

In the primary stage, defined as defensive banking, the institution remains largely inactive and environmental management is perceived exclusively as an avoidable cost rather than a strategic opportunity, leading some banks to even oppose or delay new sustainability legislation to protect immediate profitability or the interests of their clients. As external pressures from regulators and non-governmental organizations intensify, institutions transit into preventative banking. This phase is characterized by the active pursuit of eco-efficiencies and internal cost savings, such as energy efficiency improvements, allowing banks belonging to this category to integrate environmental risks into their internal day-to-day operations, particularly through enhanced credit risk assessment processes that account for the potential financial impact of environmental issues on borrowers.

The shift toward a more proactive approach occurs in the offensive banking stage where the focus expands from internal process optimization to the development of external market opportunities, in fact in this phase banks are characterized by an innovative and creative attitude, actively marketing environmentally friendly products such as sustainable energy financing and environmental investment funds. While offensive banks seek "win-win" solutions that benefit both the environment and the bottom line, these efforts are often limited by a market price system that does not yet fully internalize all environmental costs.

Ultimately, the most advanced stage is sustainable banking, representing a holistic integration of sustainability into the corporate philosophy, seeking the highest sustainable rate of return even if this requires financing projects with higher risks, lower margins or longer payback periods. This stage remains primarily in the domain of niche players, such as Banca Popolare Etica, which utilize their specialized status to drive meaningful socio-economic and environmental change.

Figure 8. Typology of banking



2.2.2 The ESG Framework and the Generation of Financial Risk

The integration of ESG factors into the mainstream banking system is formalized by the recognition that environmental, social and governance issues are not merely moral concerns but issues that can significantly impact an entity's financial performance and solvency.

As defined by the European Banking Authority (EBA), ESG factors are those “environmental, social or governance issues that may have a positive or negative impact on the financial performance or solvency of an entity”, so they directly impact the banking activity generating new risks and they indirectly influence the behavior of financed entities incentivizing them to integrate sustainability into their business operations.

Consequently, the Basel Committee on Banking Supervision (2022) highlighted that the integration of ESG factors into financial consequences generates new risks that can influence traditional risk categories such as credit risk, market risk, liquidity risk and operational risk, defining them ESG risks and more precisely "any negative financial impact on the institution stemming from the current or prospective repercussions of ESG factors on its counterparty or on invested assets".

The growing awareness of climate-related financial risks drives financial institutions to integrate these considerations into their governance structures for effective monitoring and management, because the public sector alone cannot promote sustainability, so the financial sector, led by banks, is entrusted with guiding companies towards ecological and technological development.

2.2 Sustainable instruments provided by banks

This section begins by providing the definition of Sustainable finance, the main objective of which is encouraging investments that bring positive benefits to the environment and society, while still making a financial profit. It is not just one single product, but it includes several different strategies: first, there is Socially Responsible Investment (SRI), which uses ethical values to decide where to invest and usually means avoiding harmful industries (tobacco, weapons, or companies that pollute heavily); second, Impact Investing aims to achieve specific and measurable social or environmental results, such as better access to clean water, renewable energy or education, alongside financial returns as we said; and finally, Social Finance targets projects that help society, for example by reducing poverty or improving social inclusion.

This type of finance has experienced rapid and significant growth in recent years, driven by the increasing integration of environmental, social and governance (ESG) considerations into investment strategies by institutional investors and financial intermediaries. According to recent estimates by Bloomberg Intelligence and Fortune Business Insights, assets managed under ESG-oriented strategies exceeded USD 40 trillion globally in 2024 reflecting the growing relevance of sustainability criteria in portfolio allocation decisions, signaling a structural shift in financial markets, where sustainability considerations are no longer marginal but increasingly embedded in mainstream investment practices. Despite this positive momentum, the terminology and practical application of ESG factors continue to vary significantly across the financial sector due to the fact that ESG investing has transitioned from a niche set of socially responsible choices into a distinct and complex investment philosophy. In fact, sustainable finance was historically defined by negative screening, which is the explicit exclusion of specific sectors such as armaments, tobacco or gambling, but today it has been adapted to the multi-faceted demands of the modern financial system, which seeks the generation of long-term financial value alongside a precise alignment with the specific values and sustainability goals of the client.

As financial intermediaries, banks hold a unique position and a professional duty to allocate capital toward institutions, companies and general public through specialized sustainable instruments serving as the primary mechanism for redirecting capital from surplus units to deficit units that are actively contributing to the green transition. The following sections will provide a detailed examination of these sustainable instruments, analyzing their structures, their rapid diffusion across international markets and the role they play in the strategic reorientation of the banking sector.

2.2.1 Green bonds as a key driver for sustainable development

It is essential to analyze the primary financing instruments due to their market significance, specifically green bonds. In general, bonds are financial instruments issued by entities such as corporations or governments to raise capital and investors buy them effectively lending money to the issuer, who in return agrees to pay periodic interest and repay the principal amount at a specified maturity date. Green bonds are types of bonds committed to financing or re-financing investments, projects or assets helping to address climate and environmental issues, used by governments and companies to finance the transition to a more sustainable and low-carbon economy (ESMA).

However, despite the clear and comprehensive guidelines, companies do not always utilize Green Bonds for their stated objectives because the reputational benefits and positive market impact often incentivize them to practice Greenwashing, the misleading and fraudulent behavior that will be discussed in detail in the following section. To fully comprehend the operational mechanics and the credibility of Green Bonds within the global financial market it is essential to reference the prevailing international standard: the Green Bond Principles (GBP) established by the International Capital Market Association (ICMA). The architecture of these principles is built upon four essential Core Components that issuers must adhere in order to ensure compliance.

The first and most critical component is the Use of Proceeds. The key principle of a Green Bond is that the utilization of funds must be described in the legal documentation of the security ensuring they are dedicated to projects that provide clear, and where feasible, quantifiable environmental benefits. The ICMA identifies several broad categories of eligibility that contribute to environmental objectives such as climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation and pollution prevention, and some examples include renewable energy, sustainable water, clean transportation and green buildings.

The second component concerns the Process for Project Evaluation and Selection in which the issuer is required to clearly communicate to investors not only the environmental sustainability objectives pursued but also the internal decision-making process used to determine how the projects fit into the eligible categories.

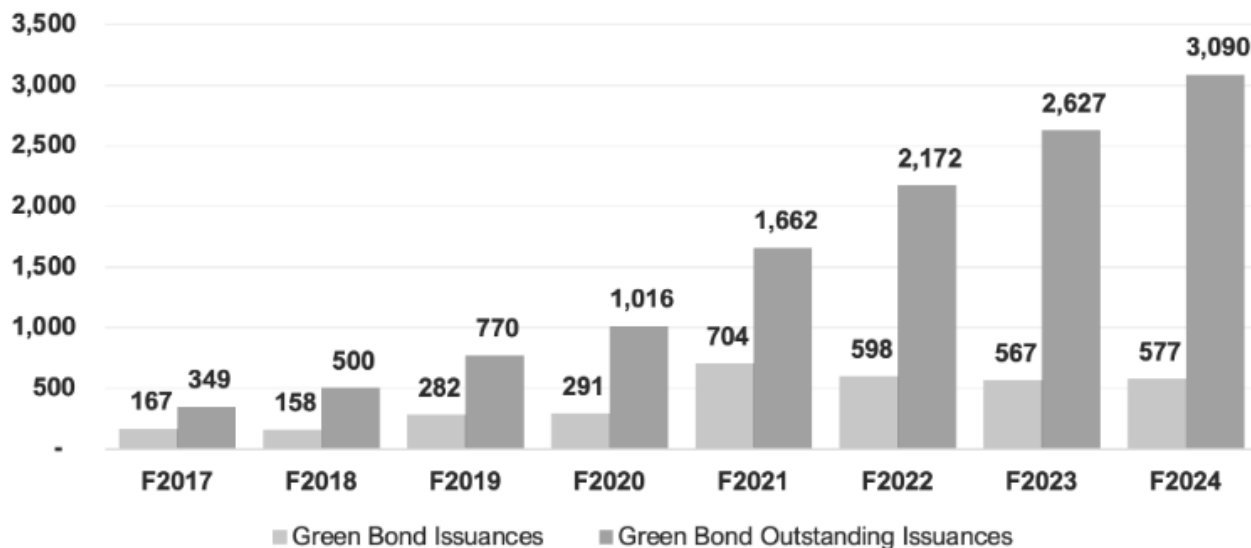
The third element is the Management of Proceeds, used to guarantee that the funds are not mixed with the company's general capital without distinction, the net balance of the proceeds

must be credited to a dedicated subaccount or otherwise tracked by the issuer in an appropriate manner.

The fourth and final pillar is Reporting. Issuers are expected to make, and keep, readily available up-to-date information on the use of proceeds to be renewed annually until full allocation and on a timely basis in case of material developments. This reporting should include a list of the projects to which Green Bond proceeds have been allocated, a brief description of the projects and the amounts allocated and their expected impact (for example energy capacity, electricity generation, greenhouse gas emissions reduced or avoided).

Looking at Figure 9, which represents the Green bond issuances and the total globally outstanding issuances, we can notice that in 2024 the aligned annual volume of green bond issuance hit USD 577 billion, crossing the half-trillion mark for the fourth consecutive year, while cumulative issuances surpassed USD 3 trillion globally and in general the trend highlights the progressive consolidation of this product as a key financing tool to support the transition toward environmentally sustainable economic activities.

Figure 9. Green bond issuances and outstanding issuances (in USD Billion)



Source: IMF/LSEG

To illustrate the growing relevance of these instruments within the domestic and European markets, the recent issuance of a €500 million European Senior Non-Preferred Green Bond by Banco BPM serves as a significant example. Demand peaked at €2,4 billion with orders coming mainly from asset and fund managers followed by insurance companies and pension funds.

In line with international guidelines and EU regulations the proceeds are designated for the financing or refinancing of "Eligible Green Loans" compliant with the EU Taxonomy, specifically, funds will support mortgages for the acquisition, renovation or construction of energy-efficient buildings and this operation brings the Group's total outstanding ESG bond volume to €7.5 billion.

2.2.2 Social bonds: a mechanism for reducing social inequalities

Parallel to the development of the Green Bond market a second category of thematic instruments has emerged as a fundamental pillar of sustainable finance, Social Bonds. Although the governance structure and operational mechanisms are the same as those established for green bonds, the four-pillar architecture promoted by the International Capital Market Association, the nature of the underlying projects and the objectives pursued present some differences.

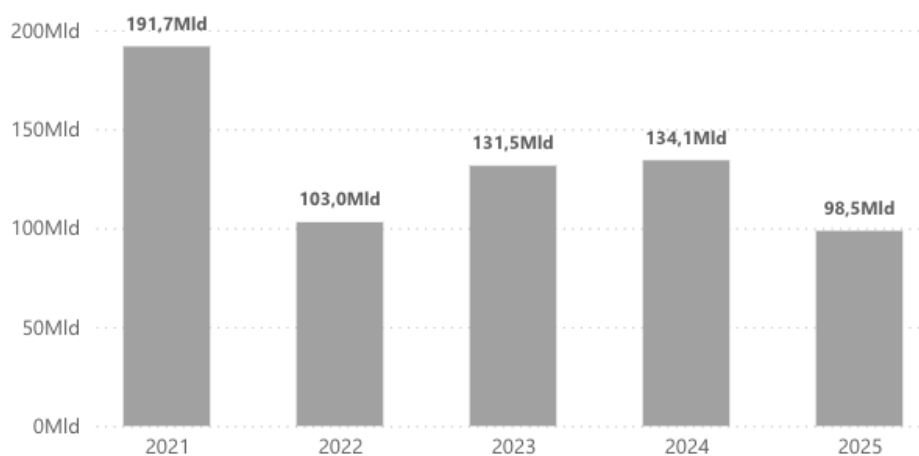
Historically the market is relatively young, in fact the first social bond, the "Banking on Women bond", has been launched in 2013 by the International Finance Corporation with the objective of attracting greater investment to support women's entrepreneurship in a profitable and sustainable manner. Since then the market has expanded rapidly, growing from less than USD 10 billion in 2019 to approximately USD 192 billion in 2021, highlighting the increasing appetite for instruments that generate positive societal impact. To understand the regulatory framework it is necessary to refer to the Social Bond Principles defined by the ICMA, which define Social Bonds in any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new or existing eligible Social Projects. These principles are voluntary process guidelines that promote integrity in the social bond market through transparency and disclosure, operating in harmony with the Green Bond Principles discussed in the previous section.

These Principles share the same four components as the Green bond one, with a divergence in the first component because Social bonds are committed to financing projects that directly aim to address or mitigate specific social issues and achieve positive social outcomes. The eligible project categories for Social Bonds focus on the provision of services and fundamental rights including affordable basic infrastructure (such as clean drinking water, sanitation and transport), ensure access to essential services (healthcare, education and financial services for underserved communities), affordable housing, food security and employment generation programs designed to prevent or alleviate unemployment stemming from socioeconomic crises.

A unique and defining element of Social Bonds, absent in the definition of Green Bonds, is the concept of Target Populations. For a project to be considered strictly social under the social bond principles it is not sufficient for it to finance a general public service, but it must inherently serve specific vulnerable or marginalized groups including those living below the poverty line, excluded or marginalized communities, people with disabilities, migrants, the unemployed, women, gender minorities, aging populations, vulnerable youth and groups affected by natural disasters or climate transition projects that exacerbate socio-economic inequity.

Looking at Figure 10 we can see how, after the explosive growth during the pandemic years with issuances peaking at USD 191.7 billion in 2021, the market has seen a period of adjustment dropping to USD 103 billion in 2022 before recovering to USD 131.5 billion in 2023 and reaching USD 134.1 billion in 2024. Despite the forecast suggesting a potential decrease to USD 98.5 billion in 2025, the overall trajectory confirms that Social Bonds have established themselves as a vital mechanism for channeling global capital toward the improvement of human well-being and the reduction of social inequalities.

Figure 10. Evolution of social bond issuance (USD billion)



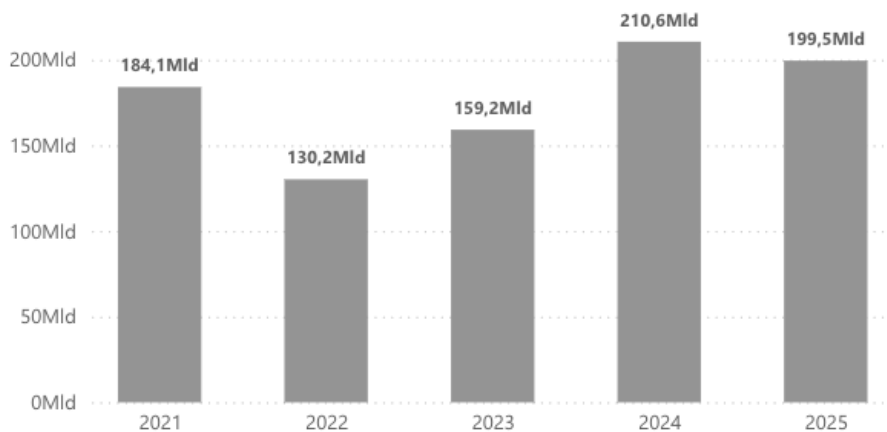
2.2.3 Sustainability Bonds: synergizing green and social objectives

Following the analysis of Green and Social Bonds, Sustainability Bonds represent a hybrid instrument that combines the features of the two previous categories and according to the Sustainability Bond Guidelines published by the ICMA, they are defined as instruments where the proceeds will be exclusively applied to finance or re-finance a combination of both Green and Social Projects.

The distinctive feature of these instruments lies in the simultaneously alignment with the four core components of both the Green Bond Principles and the Social Bond Principle, that is the Use of Proceeds, the Process for Project Evaluation and Selection, the Management of Proceeds and the Reporting. The classification of a use of proceeds bond as a Sustainability one is determined by the issuer based on its primary objectives for the underlying projects but, while it is recognized that certain Social Projects may have environmental co-benefits and vice versa, this specific category is reserved for cases where the proceeds are intentionally dedicated to a mix of both project types.

From a market perspective, these bonds have shown a significant evolution in recent years and, as shown in Figure 11, the market experienced a strong recovery after a contraction in 2022 growing progressively to reach a peak of USD 210.6 billion in 2024 and, even if there was a slight adjustment in 2025 with USD 199.5 billion, the overall trend confirms the consolidation of these instruments as a key driver for financing sustainable development goals.

Figure 11. Evolution of sustainability bond issuance (USD Billion)



2.2.4 Sustainability-Linked Bonds and the challenge of credibility

Unlike the Green, Social and Sustainability Bonds discussed previously which are defined by the specific designation of funds (Use of Proceeds), Sustainability-linked bonds are performance-based instruments and, according to the Sustainability-Linked Bond Principles published by the ICMA, are defined as any type of bond instrument for which the financial and structural characteristics can vary depending on whether the issuer achieves predefined Sustainability objectives. The fundamental innovation of these bonds lies in their flexibility, because the

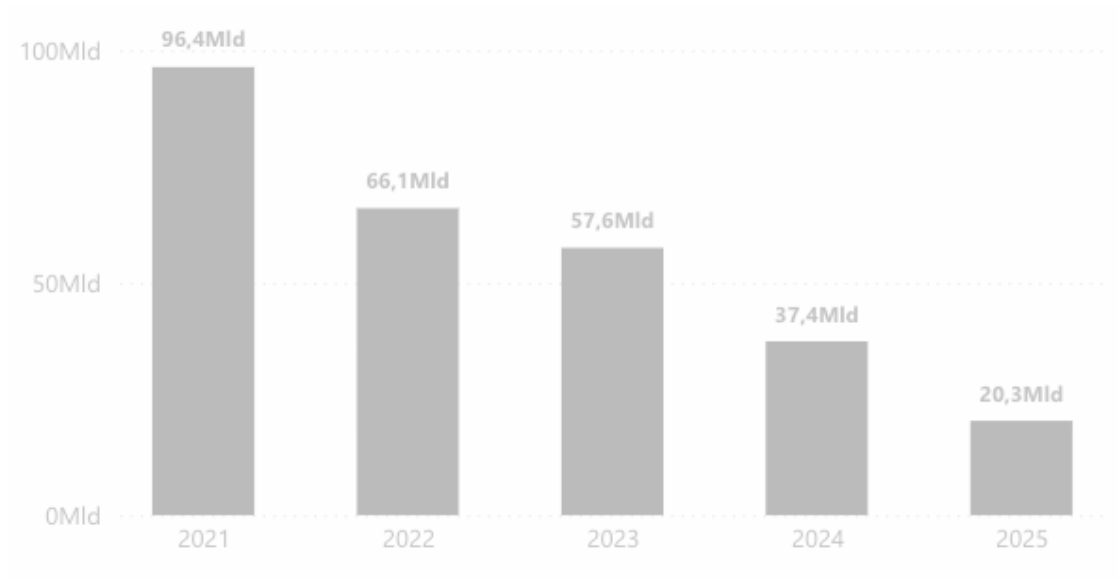
proceeds are intended for general corporate purposes and more precisely in achieving sustainability results within a predefined timeline, rather than being allocated for specific eligible projects as in the previous cases. This mechanism allows issuers from sectors that may not have sufficient green assets for a Green Bond, such as hard-to-abate industries³⁰, to access anyway sustainable finance by linking their cost of capital to their transition strategy.

The ICMA established five core components for this type of bonds to ensure the credibility and integrity of this market: the most critical are the Selection of Key Performance Indicators (KPIs), which must be relevant, core and material to the issuer's overall business and sustainability strategy; and the Calibration of Sustainability Performance Targets, which represent the specific levels of ambition the issuer commits to achieve by a set date. The other components are Bond Characteristics, Reporting and Verification, which govern how the bond's financial structure changes and ensure transparency through external assurance.

As illustrated in the issuance data in Figure 12, after a surge in popularity with USD 96.4 billion issued in 2021, the market has seen a steady contraction in the issuance volumes declined to USD 66.1 billion in 2022 and continued this downward trajectory to USD 20.3 billion in 2025. This because, despite the initial success with Italy and its national champion Enel leading the global market with over USD 31 billion in issuances, investor skepticism has grown regarding the credibility of these bonds, focusing primary on the difficulty in monitoring the achievement of objectives, the lack of transparency regarding progress, the insufficient ambition of the selected sustainability performance targets and the financial penalty mechanism (coupon step-ups). This last element is really important because the penalties imposed on defaulting issuers are often too low or economically convenient to pay rather than bearing the higher costs of actual decarbonization, exemplified in 2024 when Enel, which despite missing an emission reduction target it simply paid the step-up, highlighting the limitations of the deterrent effect. Furthermore, many accusations of greenwashing have eroded market confidence with a 2023 ICMA report revealing that 15 of the top 100 sustainability linked bond issuers had been involved in sustainability-related controversies.

³⁰ Energy-intensive industries such as cement factories, steel mills and chemical industry

Figure 12. Evolution of sustainability-linked bond issuance (USD Billion)



2.2.5 Critical perspectives and structural vulnerabilities of ESG Bonds

While the exponential growth of ESG bonds demonstrates the financial sector's capacity to mobilize capital, a purely descriptive view obscures several structural vulnerabilities, and in fact the environmental and social effectiveness of "Use of Proceeds" instruments (the first three categories) is frequently contested in academic literature due to the issue of Additionality. This term is central to evaluating the true macroeconomic impact of sustainable finance, indicating that these bonds are utilized to refinance existing projects rather than to fund new and impactful initiatives, diluting their actual net contribution to the sustainable transition. For example, when a bank allocates green bond proceeds to refinance an already operational asset, such as a renewable energy plant constructed several years prior, the environmental benefit (reduction of carbon emissions) has already been realized and absorbed into the real economy. Consequently, the issuer is labeled as "green", the investor believes he did something good by financing a sustainable development project, but in reality no new sustainable infrastructure has actually been created. We can argue that this dynamic approach is a systemic form of greenwashing, as the flow of capital is simply retroactively labeled to improve the issuer's financial metrics.

Another type of problem is the pricing mechanism, meaning that slightly lower cost of capital granted to green issuers is rarely significant enough to fundamentally alter a corporate issuer's long-term strategic behavior.

These criticalities become even more pronounced with Sustainability-Linked Bonds due to the fact that issuers may strategically select Key Performance Indicators that are not strictly material to their core business environmental footprint and, as previously mentioned, the financial penalties (coupon step-ups) applied in the event of missed targets are often too modest to act as a genuine deterrent against non-compliance.

2.3 Climate change as a structural source of financial risk

As highlighted by recent economic research and supervisory guidance the uncertainty surrounding the timing and severity of climate-related events poses a direct threat to the safety of financial institutions and the stability of the entire financial system, manifested through two transmission channels: physical risks and transition risks, both of which can induce significant adjustments in asset values and creditworthiness.

The first type of risks refers to the economic costs and financial losses resulting from tangible climate-related trends and extreme events, and can be divided in acute (such as increased frequency and severity of hurricanes, floods or wildfires) and chronic (such as higher temperatures and arising sea levels). The financial materialization of this category of risk is a direct problem because the destruction of immobilized productive capital and real estate assets leads to a deterioration of collateral value, impacting the credit risk of banks exposed to affected borrowers and finally, as the frequency of natural disasters increases, the insurance gap widens leaving households, businesses and their lenders to absorb the financial shock.

The second type of risk arises from the revaluation of assets induced by three main drivers: sudden changes in climate policy (such as the introduction of a carbon tax), technological shocks (such as the rapid cost decline of renewable energy) and shifts in market sentiment or consumer preferences. The biggest problem for financial institutions is the phenomenon of "stranded assets", which are investments in carbon-intensive sectors (such as fossil fuels) that may suffer premature write-downs or become liabilities before the end of their economic life and a critical distinction in this context is between orderly and disorderly transition. In the first one clear and early policy signals allow investors to anticipate changes and reallocate capital efficiently, but in the other one, late and unexpected policy interventions lead to sudden asset price volatility and potential systemic instability because financial actors are unable to assess risks in advance.

Addressing these two risks requires a paradigm shift in financial risk modeling. Traditional economic and financial models rely on backward-looking historical data and assume normal

distributions of shocks, but climate risks are characterized by deep uncertainty, non-linearity and "fat tails"³¹, meaning that past performance is no longer a reliable predictor of future stability. The concrete implications of deploying these forward-looking models are significant and directly impact the banks balance sheets and core operations. Firstly, by projecting future scenarios, such as the introduction of aggressive carbon taxes, banks must quantitatively adjust the Probability of Default (PD) and Loss Given Default (LGD) of their corporate clients, leading to a direct repricing of credit risk: carbon-intensive industries inevitably face higher borrowing costs or stricter collateral requirements. Secondly, these forward-looking projections translate into tangible capital requirements and, as climate stress tests reveal potential future losses, regulators may require banks to set aside more capital and hold larger reserves to absorb climate-related shocks.

Ultimately, the systematic application of these models transforms climate risk from a purely descriptive sustainability topic into a rigorous and numerical variable that fundamentally shapes a bank's lending decisions, accelerates the strategic withdrawal of funds from environmentally harmful sectors, and strictly determines the overall financial solidity of the institution.

To bridge the gap between climate science and finance, recent academic contributions have introduced various methodologies, such as the CLIMAFIN tool developed by Battiston et al., which represents an advancement as it integrates forward-looking climate scenarios (such as those provided by the IPCC) directly into financial valuation, solving the problem just mentioned. Unlike standard models CLIMAFIN allows for the pricing of climate transition risks in the value of individual financial contracts, such as sovereign bonds or equities, by conditioning the probability of default on specific climate policy shock scenarios, using two operational metrics: Climate spread and Climate value at risk (Var). The first one measures the change in the yield of a bond conditional on a climate policy shock, while the second one estimates the worst-case loss in a portfolio under future climate scenarios. By adopting such forward-looking approaches, financial institutions can better identify their exposure to Climate policy relevant sectors and assess potential losses that would remain invisible to traditional risk management frameworks.

Overall, this framework supports the broader argument developed in this thesis that climate change represents a source of systemic financial risk and that banks, due to their intermediation function and exposure to long-term investments, are particularly affected. Integrating forward-

³¹ Means that extreme events are more probable than normal distributions predict

looking climate risk assessments into banking practices is not only a regulatory requirement but also a necessary step to preserve financial stability and to support an orderly transition towards a low-carbon economy.

2.3.1 Supervisory Approaches of the ECB and the Bank of Italy to Climate Risk

The European Central Bank (ECB) and the Bank of Italy (Banca d'Italia) have established comprehensive frameworks that obliges financial institutions to treat climate-related risks not as reputational factors, but as core financial risks to be integrated into their governance, strategy and risk management frameworks.

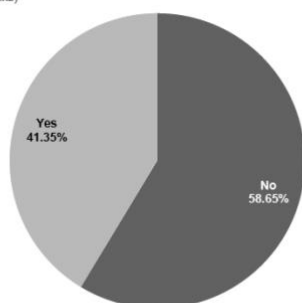
The cornerstone of the European supervisory approach is the Guide on climate-related and environmental risks, published by the ECB in 2020, which expects institutions to understand the impacts of climate risks on their business environment in the short, medium and long term, requiring these institutions to integrate these risks into their traditional risk management categories (credit, operational and market risk) and enhances their disclosure standards.

To verify the sector's preparedness the ECB conducted a Climate Risk Stress Test in 2022, structured around three modules: Module 1 refers to a qualitative questionnaire on governance, Module 2 refers to an assessment of climate metrics and revenue reliance on carbon-intensive sectors and Module 3 refers to a stress test with long-term projections.

Unfortunately, as we can see in Figure 13, until the year 2022 most of the institutions have not yet implemented a climate risk stress-testing framework that is integrated into their ICAAP³² or broader stress-testing frameworks.

Figure 13. Is climate risk currently included in the institution's stress test framework?

(percentage share of participating banks)



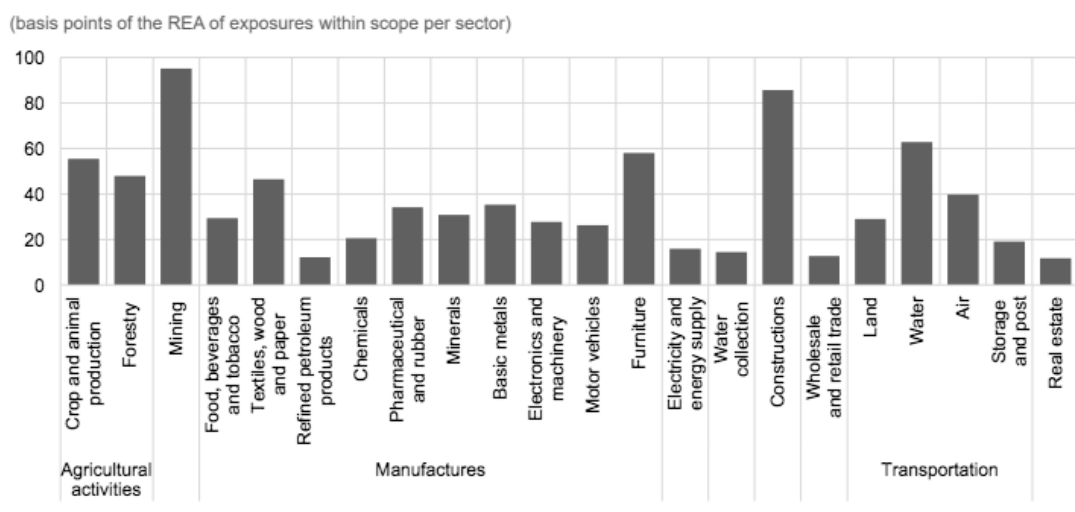
Sources: Bank submissions and ECB calculations.

³² The Internal Capital Adequacy Assessment Process is an internal framework that financial institutions are required to establish to allow banks to assess and maintain the amounts, types, and distribution of internal capital that they consider adequate to cover the nature and level of all material risks to which they are or might be exposed

The core of the analysis focused on the resilience of the banking sector under three specific long-term scenarios: the first one is called "orderly transition" and indicates a situation where climate policies are introduced early and gradually (based on the NGFS net zero 2050 scenario, in which global warming is limited to 1.5°C) ; the second one is the "disorderly transition" and indicates a situation characterized by delayed and unexpected policy interventions (limit warming to below 2°C); and finally the "hot house world" indicates a scenario with unchanged policies leading to severe physical risks (leading to about 3°C of warming).

The results provide empirical confirmation that climate risk generates financial risk, confirming the fundamental concept of the thesis, highlighting specific transmission mechanisms particularly regarding physical risk, in relation to which the stress test revealed severe potential impacts on the Eurosystem's balance sheet, especially in the "Hot House World" scenario where losses are concentrated in specific geographical areas exposed to more frequent climate-related disasters. These areas face two main types of risk: Drought and Heat risk (extreme temperatures), under which the projections showed severely impact labor productivity particularly in the construction, mining and agricultural sectors, increasing the probability of default (PD) and Loss Given Default (LGD) for exposed counterparties, thereby increasing the credit risk for lending banks (see Figure 14); and the other type is Flood risk, under which the projections demonstrate a direct correlation with collateral value and the real estate sector is assumed to experience severe physical damage, leading to a negative shock on property prices which pushes up Loan-to-Value (LTV) ratios and finally generate an increase of the Loss Given Default and the expected losses for banks holding these mortgages.

Figure 14. Accumulated loan losses under the drought and heat scenario

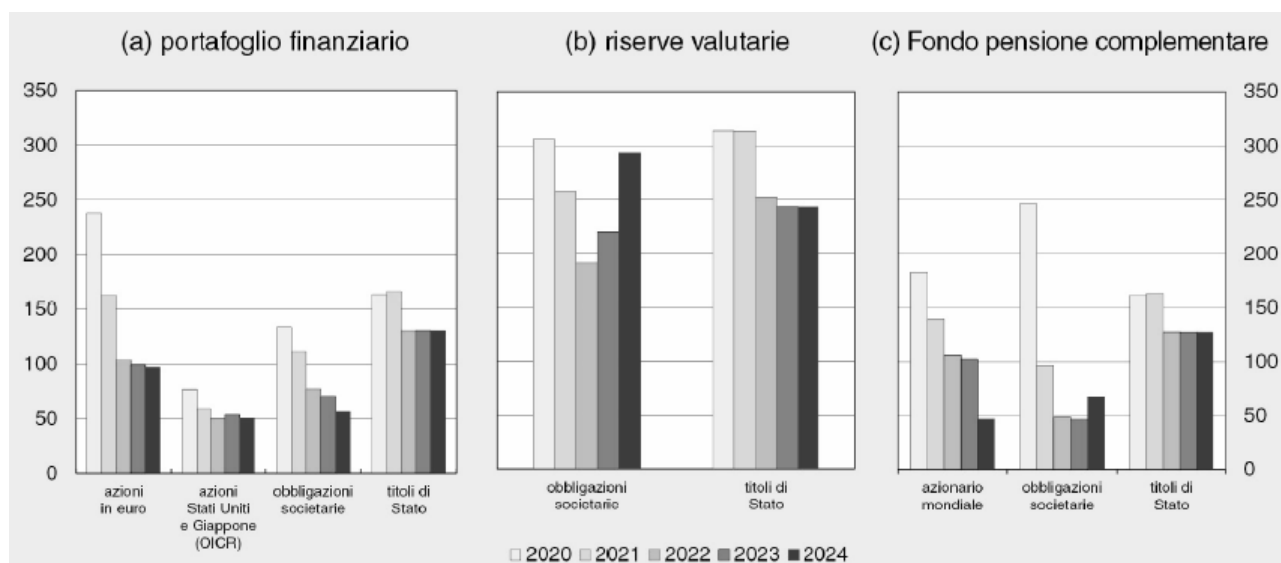


Sources: Bank submissions and ECB calculations.
Note: REA stands for risk exposure amount.

Parallel to the ECB's oversight of significant institutions, the Bank of Italy has extended a similarly rigorous supervisory approach at the national level in 2022 publishing its "Supervisory Expectations on Climate and Environmental Risks", addressed to Less Significant Institutions and non-bank financial intermediaries, which are largely aligned with the ECB's standards and aim to foster the progressive integration of climate-related and environmental risks into intermediaries business strategies, governance, internal control systems, risk management frameworks and disclosure practices. Italian intermediaries, in line with the principle of proportionality, are required to map their exposure to ESG risks and to assess their potential impacts on business models and risk profiles, asking them to implement concrete Action Plans setting out timelines, responsibilities and remedial measures to achieve full alignment with supervisory expectations by 2025. The supervisory process has been supported by thematic surveys, structured dialogues with institutions boards of directors and the dissemination of good practices, with the objective of strengthening awareness and ensuring a consistent and forward-looking integration of climate and environmental risks across the Italian financial system.

In support of what we just said, the Bank of Italy reinforces its supervisory credibility by applying these same standards to itself, detailed in its "Annual Report on Sustainable Investments and Climate Risks" in which the central bank manages its own financial portfolio by prioritizing issuers with strong ESG ratings and decarbonization commitments. By monitoring metrics such as the weighted average carbon intensity (WACI) of its equity and corporate bond portfolios, which has seen a consistent reduction in recent years as shown in Figure 15, the Bank of Italy demonstrate to the market that integrating climate variables into portfolio management is not only a regulatory obligation but a necessary strategy to preserve long-term value.

Figure 15. Trend in the WACI of investments in the period 2020-2024
(tCO2 eq per million euros of turnover for (a) and (b) or GDP for (c))

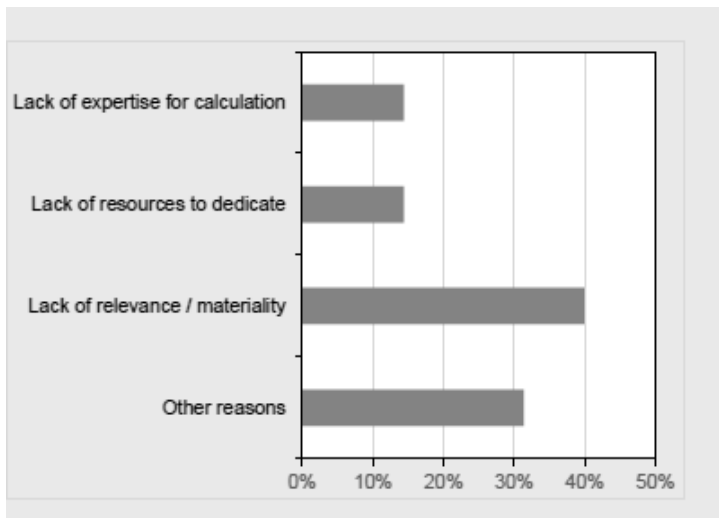


2.3.2 Insurance as a Shock Absorber for Climate Risk

As discussed in the previous sections, physical risks such as floods, droughts and extreme weather events, directly impact the balance sheets of financial institutions through the deterioration of collateral value and the default of borrowers, making insurance coverage essential because it acts as a buffer that absorbs financial shocks, preventing natural disasters from turning into business insolvencies and, consequently, into bad debts for banks. To assess the actual level of protection of the Italian productive sector we analyzed the findings of a 2024 survey conducted by the Bank of Italy on a sample of 1102 medium and large non-financial corporations, which reveal a worrying gap between the exposure to risk and the measures adopted to manage it.

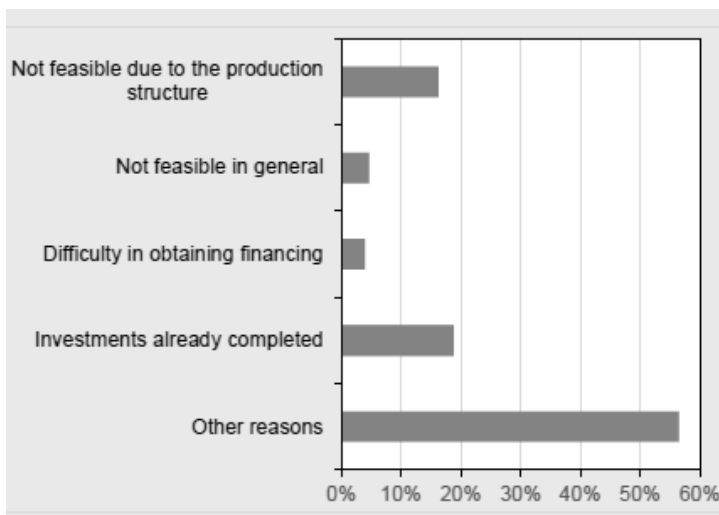
The results highlight widespread shortfalls in three critical areas: emission reporting, investment barriers and insurance culture. The first critical area translates into a gap in emissions accounting, in fact the survey highlights that only 44% of the interviewed firms track their Scope 1 and 2 emissions with a higher prevalence in the manufacturing sector and among the companies who communicate that they do not track emissions, the main reason as we can see in Figure 18, lies in the lack of relevance and significance followed by the lack of skills and resources to be able to carry it out, making it clear that climate metrics are perceived as a bureaucratic burden rather than a strategic risk indicator and revealing a significant cultural gap that banks must address when assessing clients ESG profiles.

Figure 16. Reasons for not reporting



The second critical area concerns the transition strategy and the relative barriers to Eco-sustainable investments. From Figure 17 we can understand how 16% of the respondents state that these investments are not feasible due to the specific nature of their production process, but the majority cites “other reasons” including regulatory uncertainties as main barrier, confirming that the lack of a clear and stable legislative framework acts as a powerful deterrent, freezing capital allocation even among solvent firms.

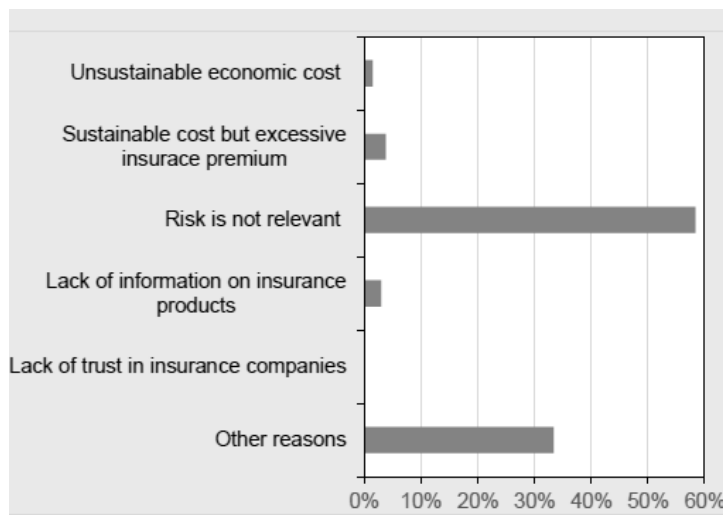
Figure 17. Reasons for no eco-sustainable investments



The last critical area concerns the exposure to physical risks, with a 25% of firms suffering direct damage from extreme weather events in the past five years but without an increase in the level of insurance protection; and the underestimation bias, which means that firms tend to underestimate the probability of catastrophic events until they occur, as shown in Figure 18,

which indicates that for 58% of companies without insurance coverage the reason is that climate risk is not considered relevant for their operations. This widespread phenomenon of underinsurance, often referred to as the “climate protection gap”, creates a critical vulnerability that ultimately transfers physical climate risks directly to the banking system balance sheet. When corporate clients or retail borrowers lack adequate insurance coverage against extreme weather events, the cost of recovery after a climate disaster falls entirely on their own capital and, an uninsured firm is highly likely to face severe business interruption and asset destruction, leading to a sharp and sudden deterioration in its debt-servicing capacity. Through this mechanism, the physical damage suffered by this uninsured borrower immediately evolves into credit risk for the lending bank, the Probability of Default increases due to the borrower's impaired cash flows, while the Loss Given Default (LGD) simultaneously increases because the physical collateral (such as real estate or industrial machinery) backing the loan may have been destroyed or severely depreciated. In this vicious cycle, banks unintentionally become the “insurers of last resort” for the real economy, absorbing losses for risks they are not designed and compensated to underwrite.

Figure 18. Reasons for not having an insurance coverage



We can say that, from a banking perspective, this survey suggests a crucial implication for credit risk assessment and, even if companies made climate sustainability commitments but they are not accompanied by measurable progress and concrete risk transfer mechanisms like insurance coverage, the firm’s creditworthiness will not necessarily improve and consequently neither their access to credit. This information is now being integrated into the Bank of Italy’s In-house

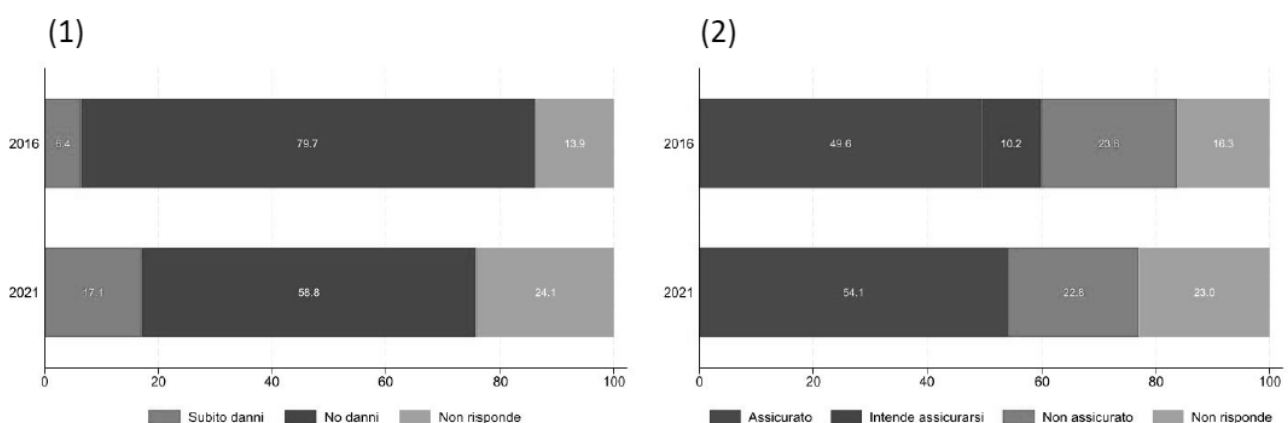
Credit Assessment System confirming that the lack of insurance is becoming a penalizing factor in accessing credit.

This phenomenon extends beyond national borders and, according to the European Insurance and Occupational Pensions Authority (EIOPA) and the European Central Bank, only 35% of losses related to catastrophic natural events in Europe were insured in 2019 and only one-quarter of climate-related damages between 1980 and 2021 were covered by insurance reimbursements.

The literature identifies two main drivers for this market failure, on one hand moral hazard, which occurs when companies choose not to pay for private insurance (ex-ante) because they rely on the expectation that the government will step in with financial assistance after a disaster (ex-post); on the other hand adverse selection, which occurs when high risk firms purchase insurance while low risk ones opt out³³ generating a negative spiral where only risky firms seek insurance, driving up premiums and further reducing widespread adoption.

To investigate the historical evolution of this dynamic in the Italian context we can cite the “Invind survey” conducted by the Bank of Italy in 2021 on a sample of 5000 industrial and service firms, which shows that, through a comparison of data from 2016 to 2021 (shown in Figure 19), although the percentage of firms reporting significant damages caused by natural events more than doubled over the period, the share of insured companies remained substantially stagnant.

Figure 19. Insured companies that have suffered damages attributable to climate risks



The Italian legislator, recognizing these structural inefficiencies and the under-insurance effect, has intervened decisively within the 2024 budget law, introducing mandatory insurance

³³ In the context of climate change, firms located in vulnerable areas like flood plains are highly motivated to buy coverage, whereas firms in safe areas find the premiums unnecessary

requirement against physical risks derived from natural disasters, to all companies required to register in the Business Register with the specific exclusion of Agricultural firms.

For this important innovation to be effective and produce the desired effects, some conditions must be met, such as risk mutualization, which is the widespread provision of insurance coverage to all companies and not just to the most vulnerable, reducing the risk of adverse selection and consequently also of insurance premiums; then the certainty and speed in reimbursements in the case of disasters, essential to guarantee business continuity and avoid serious damage to the country's economy; and finally, this obligation must not be perceived as an unnecessary induced cost but as a lever for cultural change.

2.4 From Reporting Obligation to Market Discipline: Mitigating Greenwashing through Taxonomy-Based Ratios

As discussed in detail in Chapter One, sustainability reporting has undergone a radical metamorphosis evolving from a voluntary practice, often relegated to mere reputational marketing strategies or documents disconnected from operational reality, into a stringent and codified regulatory obligation comparable to traditional financial reporting.

This shift is directed by the Corporate Sustainability Reporting Directive approved in 2022, which represents the culmination of a process aimed at addressing the shortcomings of the previous NFRD, which had proven limited due to excessive flexibility and a scope restricted to approximately 11.000 large public-interest entities. Nevertheless, as previously highlighted, the scope of application has undergone a recent and significant recalibration through the Omnibus Directive of 2025, which raised the thresholds initially set by the CSRD, restricting the reporting requirement to companies with an average of more than 1000 employees and a net turnover of over €450 million.

This, drastically reduced the number of companies involved from approximately 50.000 to approximately 9000 large groups aiming to alleviate the administrative burden on medium-sized enterprises while postponing the implementation of sector-specific standards to allow operators sufficient time to establish adequate data collection processes.

At the heart of this regulatory revolution lies the principle of double materiality, which establishes that companies can no longer limit themselves to evaluating how external factors impact their financial statements, nor solely how their activities affect the environment; instead, they must simultaneously adopt both perspectives. On one hand, financial materiality analyzes how sustainability issues, such as climate change or resource scarcity, generate risks

and opportunities capable of influencing an enterprise's cash flows and financial position. On the other hand, impact materiality requires reporting on the significant positive or negative effects that the company and its value chain produce on people and the environment.

Following the conceptual framework previously established, the implementation of the Double Materiality Assessment constitutes a structured and strategic process that involves the entire organizational framework and its stakeholder ecosystem. The starting point is the mapping of the Value Chain and the identification of relevant stakeholders³⁴, not stopping at the company's legal boundaries, but exploring the entire supply chain (both upstream and downstream), where the most significant risks and impacts often lie, as seen in the complexities of Scope 3 emissions or human rights protections within raw material sourcing. Following this contextualization, companies are required to define a comprehensive universe of potentially relevant ESG topics, starting from the predefined list provided by the European Sustainability Reporting Standards³⁵ and supplementing it with industry and company specific issues.

The core of this assessment resides in the evaluation of Impacts, Risks and Opportunities (IRO). For each identified topic the company performs a dual assessment: impact materiality is measured through gravity criteria (severity) combining scale, scope and irremediability; while financial materiality is determined by evaluating the probability of occurrence alongside the potential financial magnitude of risks and opportunities. The process culminates in the determination of a materiality threshold and the topics that exceed this threshold in either or both dimensions are categorized as Material Topics and must be reported in accordance with the relevant ESRS requirements. Conversely, for topics classified as non-material companies may be required to provide a robust justification, particularly for high-priority areas like climate change which are often presumed to be material by default, thereby ensuring transparency and accountability in the selection process.

2.4.1 Greenwashing and Reputational risk

Despite the rigorous architecture of the CSRD and the comprehensive nature of the Double Materiality Assessment, the transition towards absolute corporate transparency is continuously threatened by opportunistic behavior, in fact the strict codification of these reporting obligations was the European regulator's direct response to a pervasive market failure: the manipulation of sustainability disclosures under the previous voluntary regimes.

³⁴ Employees, customers, local communities and investors

³⁵ Covering Environmental, Social and Governance dimensions

When the flexibility of unstandardized reporting is exploited to project an eco-friendly image that lacks substantive operational backing, the gap between narrative and reality becomes a systemic threat and it is fundamental to understand why such stringent market discipline is now required, particularly within highly exposed industries like the banking sector.

Greenwashing is when an organization makes vague, deceptive or even false claims about their positive environmental impact. Many companies are greenwashing their products in this historical period because growing numbers of people are looking for sustainable and ethically produced products while firms also have to meet higher standards and requirements that are being set by governments. One way some companies use greenwashing is to make a true statement, but in a way that doesn't tell the whole story, not reflecting their actions on the ground or distracting attention away from their main business of pollution, like Coca Cola, which is one of the world's biggest producer of single use plastic bottles (in particular it increases their production of single use plastic every year fueling the plastic and climate crisis) but they advertise the following mission: "We have a responsibility to help solve the global plastic waste crisis". This discrepancy highlights the gap between symbolic communication and substantive greening conduct, where verbal mechanisms are used to manage perceptions without altering the underlying business model and, in recent years, this issue has critically extended into the banking sector.

Banks, as key intermediaries in the transition to a low-carbon economy, face intense pressure to meet ESG targets and demonstrate a commitment to sustainable finance, even if in many cases they claim environmental stewardship while continuing to provide substantial funding to fossil fuel projects and other ecologically damaging activities generating a significant reputational risk. The motivation for such conduct is substantially the same as for other companies, the temptation to secure stakeholder legitimacy: by projecting a green image banks aim to appeal to a growing demographic of eco-conscious investors and customers, enhancing market share and profitability.

The integrity of a bank's reputation is further complicated by five challenges: the first one is the lack of standardized definitions for "green" or "sustainable", allowing institutions to use vague terminology that can misleads stakeholders; the second one is the lack of transparency in standardized reporting, which leaves room for the development of greenwashing; the third one is the presence of indirect impacts, meaning that banks can, from one side, over-promote specific green initiatives, and from the other side, not disclose the broader environmental impact of their overall financing portfolios; the last one is the absence of reputable third-party

certification systems, making impossible for clients to distinguish between genuine sustainable practices and marketing maneuvers.

To provide a concrete illustration of the reputational and operational risks associated with deceptive ESG disclosures, we can cite the case of DWS Group³⁶, an entity managing approximately 928 billion euros in assets, which in 2023 faced regulatory investigations and enforcement actions by the U.S. Securities and Exchange Commission and BaFin³⁷, following allegations that it had misled investors regarding the actual extent of its green investment portfolio. The case generates significant negative reactions from both the public and institutional investors, who have reduced their positions due to the loss of confidence and also led to the resignation of the company's CEO, highlighting how greenwashing is no longer viewed merely as a marketing error but as a major failure in corporate governance and ethical procedures.

To provide an empirical foundation for the theoretical risks and strategic temptations discussed above, it is important to analyze how greenwashing can be operationalized and measured, such as through the framework developed by Lee and Raschke (2023) which offers a significant contribution to this field by identifying three pillars designed to evaluate the drivers and consequences of corporate greening. The first pillar is the Stakeholder Legitimacy, which is measured through satisfaction levels in areas like firm culture, work-life balance and compensation, utilizing data from Glassdoor to capture the degree to which a firm meets broader stakeholder expectations.

The second pillar is ESG and Financial Performance, where ESG one is assessed through standardized Refinitiv scores covering over 500 metrics, and financial one is represented by the net profit margin adjusted for industry averages to ensure comparability across the sample. The third pillar is Greenwashing Metric, which is defined as the ratio of positive ESG communication relative to actual ESG performance. The data contained in Figure 20 provides the quantitative foundation for detecting greenwashing within the firm sample, utilizing an advanced text-analysis to determine the importance that a company places on Environmental, Social and Governance themes within its official reports.

By comparing the frequency of specific ESG related keywords (qualitative focus) against the quantitative scores provided by rating agencies (like Refinitiv), a ratio is established, and if it is positive, means that the firm is overstressing its sustainability through verbal mechanisms and

³⁶ Deutsche Bank's asset management arm

³⁷ Germany's independent federal financial regulatory authority

imagery, indicating the presence of greenwashing practices; if it is negative, indicates that the company is not trying to present itself as something that does not truly reflect its identity. This quantitative evidence illustrates that firms under high pressure for stakeholder legitimacy but lacking the immediate capacity for real transformation often increase the frequency and intensity of ESG keywords in their reporting to mask a lower quantitative ESG score, reinforcing the argument that current regulatory initiatives, such as the CSRD, are essential to align corporate narratives with verifiable data and mitigate the moral hazard inherent in voluntary disclosures.

Figure 20. Greenwashing in sample firms

Firm	Refinitiv ESG score	E text weight	S text weight	G text weight	Text-weighted ESG score	Greenwashing? Text-weighted score > Refinitiv score
Tesla	7	0.47	0.25	0.28	8.0	✓
Toyota Motor	10	0.45	0.30	0.25	10.0	
Volkswagen Group	11	0.27	0.35	0.38	10.5	
Daimler	12	0.25	0.33	0.41	11.6	
Ford Motor	10	0.41	0.37	0.22	10.5	✓
General Motors Company	10	0.39	0.32	0.29	9.8	
BMW Group	11	0.32	0.38	0.30	11.0	
Hyundai Motor	9	0.34	0.40	0.26	9.3	✓
Nissan Motor	9	0.43	0.31	0.27	9.1	✓
Volvo Group	11	0.11	0.36	0.53	10.8	
Tata Motors	11	0.24	0.56	0.20	10.8	
Ferrari	8	0.32	0.40	0.28	7.7	
Alphabet	9	0.81	0.13	0.06	9.9	✓
Intel	11	0.36	0.36	0.27	11.2	✓
Oracle	7	0.52	0.37	0.11	9.2	✓
Adobe	9	0.46	0.29	0.25	9.3	✓
IBM	9	0.19	0.46	0.35	9.5	✓
Hewlett Packard Enterprise	9	0.46	0.31	0.24	8.7	
Naver	7	0.18	0.43	0.39	6.2	
Cadence Design	9	0.24	0.43	0.33	9.2	✓
Ansys	7	0.26	0.39	0.35	7.8	✓
Splunk	5	0.17	0.40	0.43	5.6	✓
Citrix Systems	6	0.32	0.43	0.25	7.2	✓
Alkami Technologies	7	0.72	0.17	0.11	7.6	✓
Coca-Cola	8	0.58	0.27	0.15	7.8	
PepsiCo	11	0.66	0.23	0.11	10.5	
Nestlé	11	0.31	0.50	0.19	11.4	✓
Kraft Heinz Company	8	0.35	0.36	0.30	8.4	✓
Mondelez International	9	0.36	0.39	0.25	9.4	✓
Danone	11	0.50	0.33	0.18	10.6	
Tyson Foods	9	0.29	0.44	0.27	8.5	
Archer Daniels Midland	10	0.41	0.35	0.23	10.1	✓
Anheuser-Busch InBev	8	0.19	0.30	0.51	9.3	✓
Keurig Dr Pepper	8	0.45	0.37	0.18	7.7	
Diageo	11	0.14	0.36	0.50	11.4	✓
Kirin Holdings	9	0.62	0.11	0.27	9.7	✓
Asahi Group Holdings	10	0.20	0.32	0.48	10.5	✓
Grupo Bimbo	10	0.18	0.44	0.38	9.7	
Bunge Ltd.	10	0.45	0.31	0.24	10.6	✓

2.4.2 Green Asset Ratio and Green Investment Ratio

The Green Asset Ratio (GAR) has been established by European regulatory authorities as a primary Key Performance Indicator for credit institutions (banks in particular) to measure the proportion of Taxonomy-aligned on balance sheet exposures relative to their total assets. This metric is designed to enhance transparency, mitigate greenwashing, and provide stakeholders with a clear understanding of a bank's sustainability profile and strategy.

$$\text{GAR} = \frac{\text{Aligned Green Assets (Taxonomy-aligned)}}{\text{Total Covered Assets}}$$

As we can see from the formula, the aggregate GAR is mathematically defined as the ratio of Taxonomy-aligned assets (Green Assets), calculated as the sum of Taxonomy-aligned proportions of loans, advances, debt securities, equity holdings and repossessed collaterals, to the Total Assets Covered, which includes all the categories just mentioned without limitations. However, financial assets held for trading and derivatives are excluded from the numerator and exposures to central banks, central governments and supranational issuers are excluded from both the numerator and the denominator due to the absence of a standardized Taxonomy-alignment methodology for such issuers. A significant feature of this framework is its ability to be disaggregated into partial ratios, facilitating a multidimensional analysis of a bank's portfolio, differentiating from non-financial undertakings, retail exposures (considers taxonomy-aligned residential real estate loans, house renovation loans and car loans) and financial undertakings, but it also has limitations regarding its restricted scope.

The GAR current methodological framework presents rigid structural limitations that risk providing a distorted picture of credit institutions actual commitment to the ecological transition.

The first and most impactful implication concerns the regulatory calculation perimeter and, although the transition from the NFRD to the CSRD has expanded the scope of counterparties subject to taxonomy disclosure, the Ratio still excludes exposures to entities not falling within the limits defined by this legislation, such as most SMEs³⁸, from the numerator, which may continue to underestimate banks' real sustainability performance (as we can see from Figure 21). For example, even if a bank were to grant a loan to a SME specifically for the construction of a photovoltaic plant, this exposure would be counted in the denominator but not in the numerator, generating a severe dilution effect penalizing traditional commercial banks and ethical banks whose core business is oriented toward supporting local enterprises, and conversely, rewarding large investment banks which have massive exposures to multinational companies already compliant with reporting obligations.

A second critical limitation is the regulatory prohibition on the use of internal estimates (proxies), meaning that banks are not authorized to estimate their clients degree of Taxonomy alignment but they must rely exclusively on official data published by the clients themselves, triggering a profound data availability problem. For example if a client company experiences

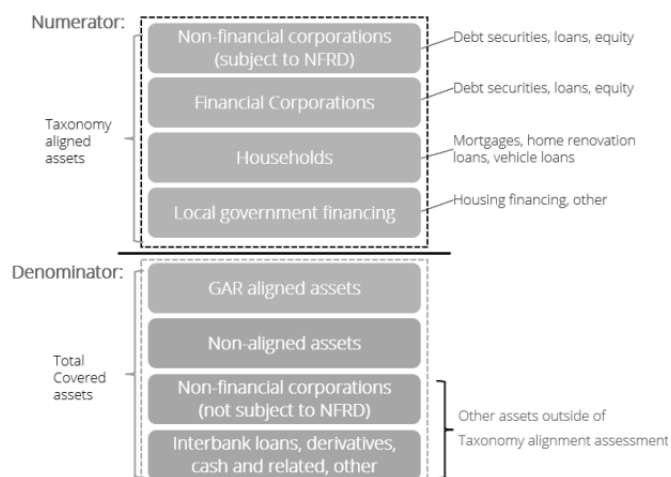
³⁸ Small and medium enterprises

reporting delays or publishes incomplete data, the entire bank exposure is downgraded to non-aligned, underestimating the bank's true volume of sustainable investments.

Finally, the exclusion of Sovereign Exposures (loans to governments and central banks) from the calculation perimeter prevents banks from valuing the purchase of government Green Bonds within the ratio, even though these represent one of the primary vehicles for financing large sustainable public infrastructures.

Recent EU Omnibus proposals aim to address the first problem by allowing the exclusion of non-CSR D exposures from the denominator of the Ratio, although these changes are still subject to the legislative process and therefore not yet fully effective. Looking to the future, regulatory discussions suggest that future developments may include the establishment of minimum GAR thresholds to accelerate green financing and an expansion of the boundaries including other environmental objectives beyond climate change, as well as social and governance dimensions of ESG.

Figure 21. Gar Numerator and Denominator



On the other hand, the Green Investment Ratio (GIR) has been introduced by European regulatory authorities as a key disclosure indicator for asset managers and insurance companies, measuring the share of investments in their managed portfolios that are aligned with the EU Taxonomy.

While the GAR focuses on credit institutions balance sheet exposures, this one captures the sustainability profile of investment portfolios extending the taxonomy-based transparency framework to the broader financial sector. This Ratio is calculated on the basis of the EU Taxonomy KPIs reported by portfolio companies, namely Turnover, CapEx and OpEx, which determine the taxonomy-aligned share of the financial instruments held by investors.

In the same way as the previous ratio, the GIR enhances transparency in sustainable finance markets, supports comparability across investment products, contributes to reducing greenwashing risks and helps channel capital toward environmentally sustainable economic activities, aligning portfolio allocation strategies with investor demand for greener assets and with EU climate and environmental policy objectives.

2.5 *Concluding remarks*

In conclusion, this chapter has demonstrated that the banking and financial sector is the indispensable engine for achieving a genuine sustainable transition and acts as the primary transmission mechanism that translates European regulatory frameworks into real-economy impact. Through the issuance and management of ESG instruments, banks actively steer capital towards sustainable objectives, and the formal recognition of climate change as a structural financial risk has forced credit institutions to adopt forward-looking models, altering credit pricing methodologies and highlighting the systemic dangers of the insurance protection gap, where physical climate risks inevitably morph into credit risks for the banking sector.

Furthermore, the analysis has highlighted how the threat of greenwashing and the resulting reputational risks have necessitated a shift from voluntary corporate narratives to strict market discipline. The introduction of the EU Taxonomy and taxonomy-based quantitative metrics, such as the Green Asset Ratio and the Green Investment Ratio, represent a mandatory and necessary step to unmask deceptive practices and ensure that sustainability claims are supported by verifiable data.

Having established this comprehensive theoretical and regulatory framework, the following chapter will transition from a macroeconomic perspective to an empirical analysis, introducing a practical case study to evaluate how these complex dynamics and quantitative metrics are actually implemented and reported by specific banking institutions.

CHAPTER III. EMPIRICAL ANALYSIS OF CLIMATE RISK DISCLOSURE AND QUANTITATIVE METRICS IN THE EUROPEAN BANKING SAMPLE

This chapter represents the empirical core of this thesis, marking the crucial transition from the theoretical and regulatory framework outlined in the previous chapters to a practical and field-based investigation of the European banking sector. The primary objective of this analysis is to evaluate how the new European legislative wave, specifically the transition from the Non-Financial Reporting Directive (NFRD) to the Corporate Sustainability Reporting Directive (CSRD), has been concretely transposed, internalized and communicated by credit institutions. To achieve this goal, the chapter is structured into three consequential sections. First, it establishes a solid theoretical baseline through a targeted literature review, exploring the causal link between climate risk reporting and the mitigation of greenwashing, while also analyzing the historical operational vulnerabilities of the banking system. Second, it conducts a rigorous text mining analysis on a selected sample of 20 European banks, comparing their 2023 and 2024 sustainability reports to quantify the semantic and structural evolution triggered by the new mandatory reporting standard. Finally, the chapter transitions from textual narratives to quantitative metrics, presenting an empirical assessment of the Green Asset Ratio (GAR) disclosed by the sampled institutions and, by comparing the Turnover-based and CapEx-based ratios across the two fiscal years, aims to verify whether the structural limits and data availability challenges identified at a systemic level are directly reflected in the market reality, ultimately determining the true maturity of the sector's sustainable capital allocation.

3.1 Introduction and literature review

As extensively discussed, the European banking sector has been affected by an unprecedented regulatory wave in recent years, culminating in the introduction of the Corporate Sustainability Reporting Directive (CSRD), the EU Taxonomy and recently the Omnibus Directive, which do not merely impose new compliance obligations but rather they aim to radically transform the role of credit institutions, elevating them to the actual "financial engine" of the ecological transition. However, the effectiveness of such regulations cannot be evaluated only on the basis of their theoretical soundness, because the most significant criticalities, primarily information asymmetries and greenwashing practices, arise within the gap between the imposition of the rule and its concrete corporate application. Therefore, the primary objective of this chapter is to apply an empirical study to understand how these complex directives and the related quantitative metrics, especially the Green Asset Ratio (GAR), are transposed, internalized and

communicated by the main market players. So, the research shifts from a macroeconomic and legislative level of individual banking institutions to a microeconomic and strategic one.

In this perspective, before delving into the textual and quantitative analysis of the sustainability reports of the selected sample of European banks, it is methodologically essential to define the academic and historical context of reference, because every empirical investigation requires solid theoretical foundations to correctly interpret the collected data.

To this end, this first section is dedicated to a targeted literature review, structured along two closely interconnected analytical directions: on one hand, exploring the causal link connecting climate risk reporting to the mitigation of greenwashing, scientifically demonstrating how a rigorous Climate Risk Disclosure (CRD) represents the primary and fundamental tool to unmask purely symbolic sustainability narratives, justifying the very nature of the investigation conducted in this chapter.

On the other hand, looking to the historical baseline of the banking system with a particular focus on the Italian landscape, analyzing the pre-CSR challenges related to internal governance architecture and the severe fragmentation of data availability. Understanding the operational limitations of the past is the only way to critically and objectively evaluate the real progress, or persistent gaps, that will emerge from the examination of the sustainability reports of our selected sample.

3.1.1 Climate Risk Disclosure as an Antidote to Greenwashing

As highlighted in the concluding remarks of Chapter 2, the pervasive threat of greenwashing and the consequent reputational risk have necessitated a radical paradigm shift, pushing the legislator to obtain a transition from purely voluntary sustainability reporting, often characterized by symbolic or ambiguous narratives, to a rigid market discipline based on the Directives and objective quantitative metrics. However, before proceeding with the empirical examination of banks' communication strategies, it is essential to pose a fundamental question: does a rigorous and detailed Climate Risk Disclosure (CRD) effectively represent an efficient tool to mitigate greenwashing practices?

The most recent academic literature provides significant empirical confirmations in this regard and a crucial contribution is offered by the recent study carried out by Battisti et al. (2025), published in the *International Review of Economics and Finance*, which directly examines the relationship between Climate Risk Disclosure and the greenwashing phenomenon. Through a

rigorous quantitative investigation conducted on a vast sample of listed companies³⁹ covering the period between 2016 and 2022, and drawing on data extracted from primary international databases such as LSEG (formerly Refinitiv), the research empirically demonstrates that an increase in climate risk disclosure has the potential to actively mitigate and reduce corporate greenwashing practices.

The authors highlight the specific mechanisms through which CRD acts as a greenwashing deterrent. Firstly, an increase in climate reporting transparency levels drastically reduces the information asymmetry between companies and their stakeholders because, by providing analytical data on the physical and transition risks impacting the business model, these firms expose themselves to greater and more careful external supervision, raising the costs associated with information manipulation and strongly limiting the capacity and the temptation of management to undertake purely superficial ESG initiatives.

Furthermore, the study provides two empirical findings that are particularly relevant to the analysis of the banking sector to be conducted in this chapter: the first one is that the inhibitory effect of CRD on greenwashing emerges more prominently in large enterprises which, having a higher capitalization, are subject to significantly greater public pressure and regulatory scrutiny compared to smaller corporate entities; and the second one is the crucial role of corporate governance, which demonstrate how the composition of Boards of Directors and in particular the non-linear moderating effect of gender quotas, actively influences the effectiveness of CRD in combating greenwashing, confirming, from an academic standpoint, that climate transparency is not solely a matter of published data but is inseparable from the corporate governance architecture tasked with managing and reporting those risks.

Starting from this solid academic framework, which qualifies climate reporting not merely as an administrative obligation but rather as a true structural "antidote" against misleading claims, this chapter aims to transfer these findings to the specific context of the European banking sector. If the literature confirms that a robust climate disclosure disincentivizes greenwashing practices, especially in large-cap companies with complex governance safeguards, it becomes fundamental to empirically measure how leading credit institutions are integrating these rationales into their sustainability reports, and with the following analysis we will explore whether the current climate risk reporting by banks is truly driving a tangible transformation in capital allocation or if areas of purely symbolic compliance persist.

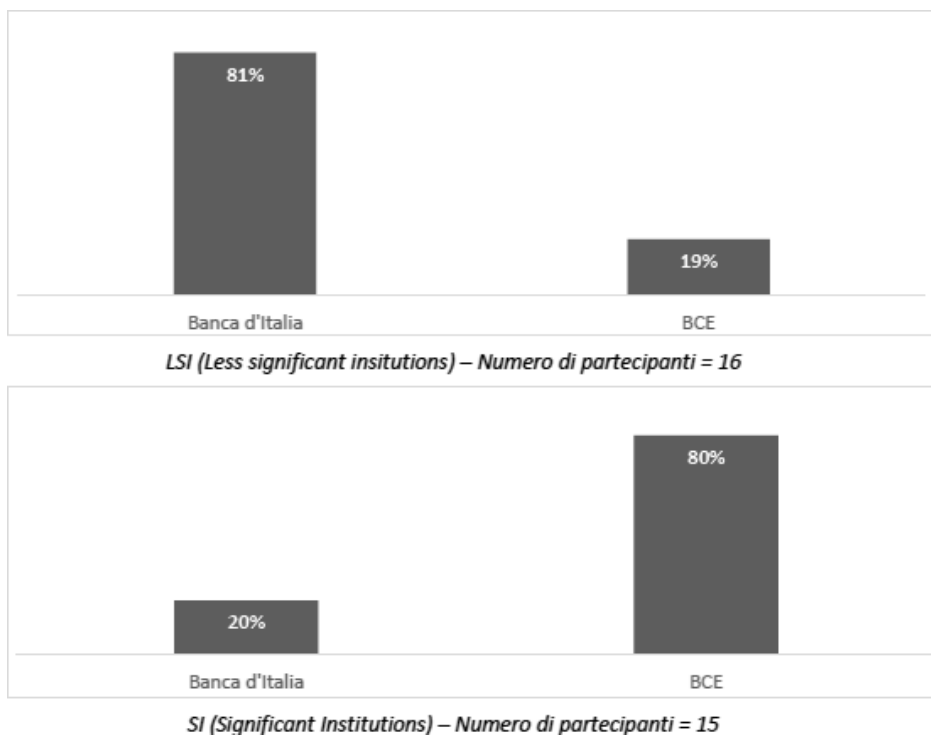
³⁹ In particular Chinese A-share market

3.1.2 The Italian Banking System Baseline: Challenges and Governance

In order to fully evaluate the impact of recent European regulations, such as the CSRD and the introduction of the Green Asset Ratio, it is methodologically imperative to outline a historical baseline of the banking system, with the objective of understanding the structural framework and operational vulnerabilities of credit institutions in the period immediately preceding the entry into force of the new and stringent taxonomic obligations, who provides the necessary benchmark to measure the actual evolution of reporting practices. In this context, the survey conducted in 2021 by AIFIRM (Italian Association of Financial Industry Risk Managers) offers an empirically invaluable cross section of the state of integration of ESG factors within the Italian banking system.

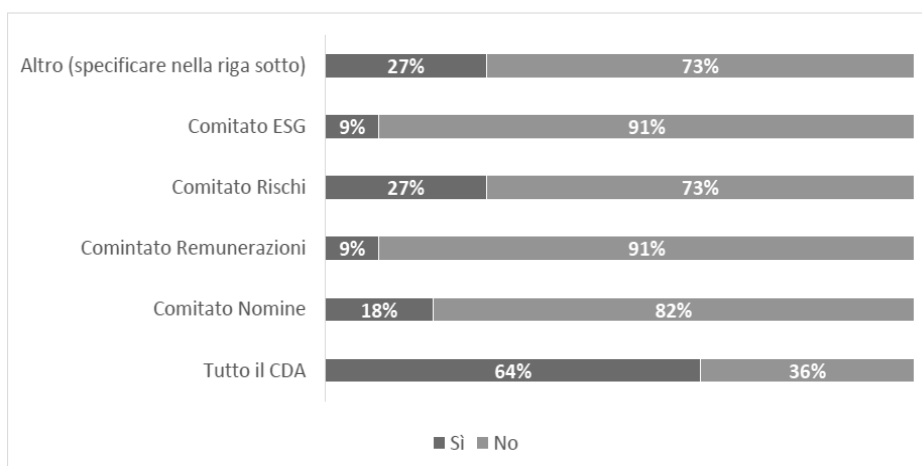
The absolute relevance of this study lies in its exceptional sample coverage, which involved 31 credit institutions, divided between 15 Significant Institutions (SI), subject to direct supervision by the European Central Bank, and 16 Less Significant Institutions (LSI), supervised by the Bank of Italy.

Figure 22. The Sample

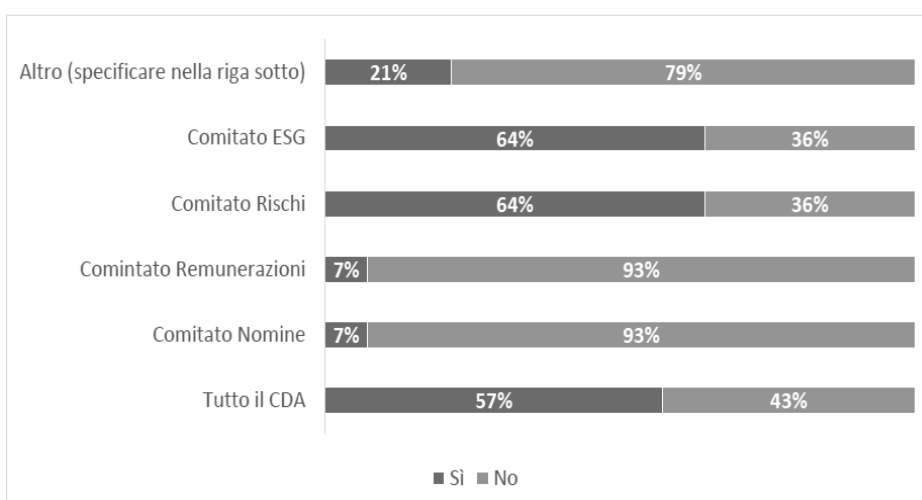


Overall, the sample represent approximately 95 % of the total assets of the national banking system, thereby conferring an almost total statistical validity and systemic representativeness to the results. The first to discuss concerns the architecture of climate governance, a determining factor in translating strategic goals into actual operational practices, as a system in full transition characterized by marked dimensional asymmetries. As we can see from Figure 23 relevant banks (SI) tend to prefer a specialization of delegations, allocating formal responsibilities on ESG issues predominantly to technical bodies such as the Risk Committee and a dedicated ESG Committee, which operate in synergy with the Board of Directors; and conversely, in smaller institutions (LSI) the management of climate risks appeared still highly centralized, with 60% of banks attributing such responsibilities exclusively to the Board of Directors, highlighting a lower maturity in the technical fragmentation of oversight.

Figure 23. Formally responsible bodies for ESG-related matters



LSI (Less Significant Institutions) – Numero di partecipanti = 11

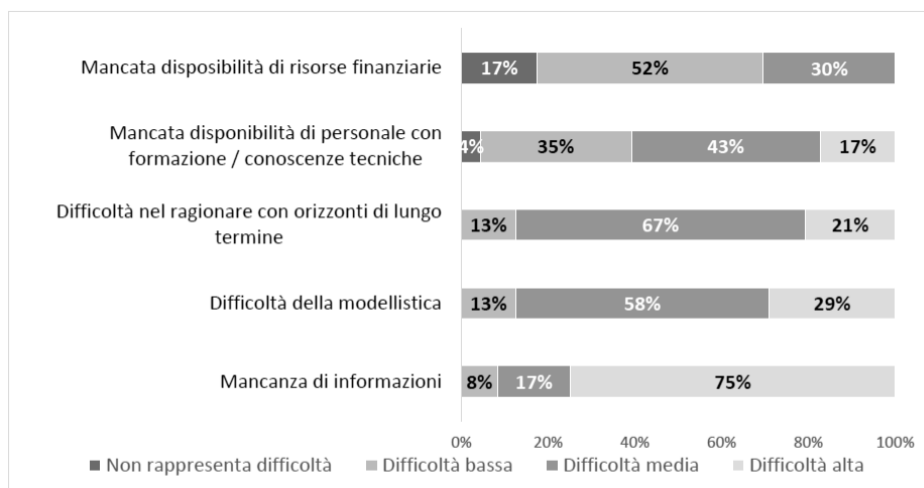


SI (Significant Institutions) – Numero di partecipanti = 14

A further element of vulnerability, closely connected to the capacity for independent and long-term assessment of climate risks, emerged from the analysis of the Board composition itself, highlighting, despite a median of independent directors equal to 57%, broad margins for improvement regarding diversity, with a percentage of female directors that, in some institutions, did not exceed 8%.

This framework demonstrates that the integration of sustainability into corporate governance processes is still an evolving structural adaptation rather than an inherent characteristic of the banking system. However, the most empirically disruptive aspect emerging from the pre-CSR landscape, which constitutes the underlying thread of the current challenges related to the Green Asset Ratio, is the problem of Data availability and quality, as we can see from Figure 24 which reports the elements that have generated the greatest difficulties for the banks in the sample under examination in generating the scenarios, or have led to not doing so at all. Despite the progress made on the governance front, the main obstacle perceived and declared by Italian Risk Managers did not reside in the absence of strategic willingness or internal methodological limitations, but rather in the chronic shortage of reliable, granular and standardized data sourced from client.

Figure 24. Barriers to scenario development and reasons for non-adoption



All Institutions – Numero di partecipanti = 25

The inability to obtain timely information on the environmental performance of financed enterprises, especially Small and Medium Enterprises historically excluded from non-financial reporting obligations, represented an insurmountable barrier for the correct measurement of climate risk in loan portfolios and, without certain primary data such as the Scope 1, Scope 2

and Scope 3 emissions of counterparties or the Energy Performance Certificates⁴⁰ of real estate collaterals, even the most sophisticated Risk Management models and best-structured internal board committees were effectively compromised. This upstream information asymmetry prevented the full integration of ESG factors into credit pricing policies⁴¹, often limiting sustainability initiatives to sectoral exclusion logics⁴² or mere reputational risk defenses, instead of rewarding sustainable companies with better conditions, or penalizing brown companies.

The analysis of this historical baseline demonstrates that current methodological challenges, from low GAR values to structural uncertainties in sustainability reports, are not unexpected anomalies, but the result of existing systemic criticalities and, the regulatory pressures culminating in recent years aim to force the resolution of this deadlock, convincing banks to take an active role in the extraction and validation of data coming from the real economy through empirical analysis and text mining of the sustainability reports of the selected sample. It will be empirically evaluated whether the progressive formalization of Risk Committees has effectively generated a more mature and transparent disclosure and, above all, to what extent the European banking system is succeeding in bridging that gap in Data availability which, in 2021, represented the main limitation on the ecological transition of the financial sector.

3.2 Empirical analysis of sustainability in the European banking sector

This section represents the operational heart of the empirical research, translating the theoretical and regulatory premises into a structured investigation of the European banking sector, providing a comprehensive examination of how leading credit institutions are navigating the transition from the Non-Financial Reporting Directive (NFRD) to the Corporate Sustainability Reporting Directive (CSRD) assessing the evolution of their environmental commitment from textual narratives to quantitative taxonomic metrics.

To achieve this, the analysis is organized into a sequential framework beginning with the Sample description, which details the rationale behind the selection of the sample; subsequently, the Analysis method description part will outline the rigorous text mining methodology used to evaluate the semantic evolution of sustainability reports across three key

⁴⁰ In Italian “Attestati di Prestazione Energetica” (APE)

⁴¹ For example the decision on the interest rates to be applied

⁴² Negative screening procedures

macro-categories; and finally the Obtained results part will quantify the linguistic shift, highlighting the magnitude of the regulatory shock on corporate disclosures.

3.2.1 Sample description and motivation

The structural integrity of an empirical investigation concerning climate-related disclosure is strictly dependent on the methodological rigor applied during the sample selection process and, through the selection of specific and highly representative group of institutions, we can provide the basis necessary to ensure that the collected results are not interpreted as random or isolated cases, but as clear evidence of systemic trends driven by the new regulatory landscape.

In a context defined by rapid legislative changes and the increasing technical complexity of environmental data, as our case, the quality of the sample acts as a crucial bridge between theoretical concepts and actual evidence, providing the scientific robustness needed to validate the research hypotheses regarding the transition toward more transparent reporting models. For the purposes of this research, a sample of 20 European Credit Institutions has been selected, ensuring that the selection is not arbitrary but rather guided by four fundamental pillars designed to capture the current dynamics of the European Union banking sector.

The first pillar governing the selection process is identified in the systemic relevance and the so-called "Size Effect" of the institutions because, as extensively documented in the literature and specifically by Kraus (2024), exists a significant positive correlation between a bank's dimensional scale and the granularity of its climate-related reporting. Large-scale institutions⁴³ which possess greater internal resources and specialized expertise, tend to produce disclosure of superior quality compared to smaller market participants and, this fact, allows for an observation of innovative practices that are destined to influence the entire financial system. To confirm the economic weight of the sample analyzed, Table 1 shows the market capitalization data recorded in 2024, confirming the systemic dominance of the selected operators, with the exception of 2 institutions (RaboBank and Triodos Bank) that were selected for their ethical governance model.

⁴³ Entities classified as Significant Institutions (SIs) and subject to the most stringent supervisory expectations and climate stress tests conducted by the European Central Bank (ECB)

Table 1. Market capitalization and geographical distribution of the selected European banking sample (2024)

Bank Name	Country	Market Capitalization (2024)
BNP Paribas	France	~ 74,5 bn
Santander	Spain	~ 72,1 bn
Intesa San Paolo	Italy	~ 67,8 bn
UniCredit	Italy	~ 61,5 bn
BBVA	Spain	~ 58,9 bn
ING Group	Netherlands	~ 53,2 bn
Crédit Agricole	France	~ 52,3 bn
Nordea Bank	Finland	~ 37,4 bn
CaixaBank	Spain	~ 36,8 bn
Deutsche Bank	Germany	~ 30,6 bn
KBC Group	Belgium	~ 27,5 bn
Svenska Handelsbanken	Sweden	~ 18,7 bn
Erste Group	Austria	~ 18,2 bn
Commerzbank	Germany	~ 16,9 bn
ABN AMRO	Netherlands	~ 13,5 bn
Fineco Bank	Italy	~ 9,6 bn
Banco BPM	Italy	~ 9,1 bn
Raiffeisen Bank	Austria	~ 5,7 bn
Triodos Bank	Netherlands	Unlisted (ethical player) ⁴⁴
Rabobank	Netherlands	Unlisted (cooperative player)

The second pillar guiding the selection process is the geographical coverage, which has been carefully calibrated to reflect a comprehensive European focus, this because EU acts as a global pioneer in the institutionalization of sustainable finance. Selecting in particular institutions from the core Eurozone markets such as Italy, France, Germany, Spain and the Netherlands, while also including representative entities from non-Eurozone but highly aligned markets like Sweden and Finland, permitted us to assess how common regulatory frameworks, notably the

⁴⁴ While Triodos Bank is not publicly listed on a regulated stock exchange, its Depository Receipts (DRs) have been traded on an alternative Multilateral Trading Facility (MTF) since July 2023, generating a fluctuating theoretical market capitalization of around 400 million

CSRD and the EU Taxonomy, are internalized across different socio-economic contexts, thereby ensuring a holistic view of the convergence toward unified reporting standards.

Another distinctive element of this research design lies in the intentional comparison of different business models, specifically contrasting traditional commercial giants with specialized ethical players, such as Triodos Bank and Rabobank, with the objective of evaluate whether the disclosure evolution observed in traditional banks represents a genuine strategic integration of ESG factors or if it remains confined to a defensive exercise in formal compliance identifying potential greenwashing patterns or, conversely, validating an effective transition toward sustainable capital allocation.

Finally, the selection ensures that all sampled institutions are subject to the same trajectory of regulatory obligations, transitioning from the NFRD framework in 2023, which already mandated the inaugural disclosure of the aligned Green Asset Ratio (GAR), to the more rigorous CSRD framework for the 2024 fiscal year, characterized by the mandatory adoption of the European Sustainability Reporting Standards (ESRS), which serves as the quantitative foundation for the second part of this chapter. To maintain scientific neutrality and prevent analytical biases during the text mining process, another clarification is necessary: for the 2024 Fiscal Year the EFRAG Knowledge Hub was utilized to find the official disclosures published under the new CSRD regime, which are all complete annual reports since the new directive requires the integration of sustainability reporting within the Management report. However, to ensure the accuracy of the linguistic analysis, the sustainability sections were isolated and extracted from the complete report, preventing financial terminology from diluting the frequency of ESG-related keywords. Instead, for the 2023 Fiscal Year Individual Sustainability Reports or Consolidated Non-Financial Statements were directly sourced from the institutions official websites.

This methodological separation is crucial because if we had compared a full 2024 financial report with a 2023 sustainability report we would have obtained skewed results, but focusing exclusively on the dedicated sustainability sections for both periods this study can objectively measure the evolution of transparency, narrative depth and strategic priority assigned to climate issues during the transition to a more disciplined market era.

3.2.2 Analysis Method Description (Text Mining Methodology)

The empirical investigation conducted in this study is based on a rigorous text mining methodology aimed at systematically examining and quantifying the contents of the sustainability reports of the selected banking sample, with the primary objective of examining the evolution of non-financial reporting by comparing the documents published in 2023, drafted under the supervision of the Non-Financial Reporting Directive, with those published in 2024, which are the first to comply with the more stringent requirements of the Corporate Sustainability Reporting Directive. The theoretical premise of this comparison is that the transition from the NFRD to the CSRD does not represent a mere formal update, but a true paradigm shift, imposing a more granular, standardized and binding reporting framework and introducing key concepts, such as Double Materiality, which transform sustainability from a predominantly narrative exercise into a strictly strategic and quantitative one.

The research hypothesis is that this regulatory strengthening is directly reflected in corporate language, determining a significant increase in the frequency and specificity of the terms used in the 2024 reports compared to those of the previous year. To structure the analysis, the research framework proposed by the study of Brescia et al. (2025) was replicated and adapted: the text of every report was queried using a set of keywords divided into three strategic macro-categories which capture the essence of the ongoing transition.

The rationale behind this precise terminological selection is driven by the necessity to strictly isolate the regulatory and strategic dimensions of climate reporting from generic corporate marketing, preventing statistical noise and the counting of false positives. The included keywords were selected to reflect the binding technical vocabulary introduced by the new European frameworks, whereas excessively broad environmental terms and ambiguous adjectives, such as “green” or “recycling”, or generic references to “nature”, were intentionally excluded from the query lexicon.

The first category investigates the substance of the banks' ecological commitment, measuring the transition from generic declarations of intent to quantifiable and measurable commitments regarding sustainability and climate change. Under the NFRD regime, financial institutions could limit themselves to the description of initiatives to mitigate their direct environmental impact⁴⁵, but the real carbon footprint of a bank lies in its credit and investment portfolio. With the advent of the CSRD, the regulatory attention radically shifts to indirect emissions in the

⁴⁵ For example reducing energy consumption in branches or purchasing renewable energy

value chain and it becomes essential for banks to report the financed emissions, or Scope 3, to outline structured transition plans and to define intermediate targets for achieving net-zero. The keywords selected for this category serve precisely to intercept this evolution, moving from the simple concept of sustainability to the complex engineering of portfolio decarbonization, and specifically include sustainability, sustainable, climate, emissions, financed emissions, transition, impact, energy, ESG, taxonomy, environmental, scope 3, net-zero, and decarbonization.

The second category focuses on governance, strategy and organizational structure, with the objective of highlighting how credible climate reporting cannot exist without strong and structured governance, and this ecological transition requires a profound internal organizational transformation. The main objectives of the CSRD is to force the integration of ESG issues directly into the top management, overcoming the uncoordinated approach in which sustainability was relegated to a single isolated department, stating the role of the Board of Directors in supervising climate risks, the presence of dedicated committees, the appointment of top figures such as the Chief Sustainability Officer, and, crucially, the link between management remuneration policies and the achievement of specific ESG targets. The keywords in this category therefore measure the level of penetration of sustainability into the strategic and decision-making DNA of the bank, tracking terms such as governance, board, directors, management, policies, remuneration, compensation, strategy, integration, CSO, sustainability officer, and committee.

The third category focuses on reporting and compliance, representing the true barometer of regulatory adaptation and indicating the area where the sharpest discontinuity between the 2023 and 2024 reports is expected. The transition to the CSRD marks the end of the era of voluntary and fragmented frameworks, imposing the adoption of the European Sustainability Reporting Standards with the introduction of the concept of Double Materiality, meaning that banks must no longer limit themselves to explain how their activities impact the environment and society (impact materiality) but they must also report how climate change and ESG risks impact their balance sheets and financial stability (financial materiality). Furthermore, the search for terms related to assurance and audit is fundamental, as the CSRD introduces the obligation of external review on sustainability data, elevating the non-financial compliance to the same level of rigor and credibility as financial ones. To capture this dimension, the analyzed keywords include double materiality, assurance, audit, report, alignment, regulation, consolidated, material, aligned, ESRS, GAR, GRI, CSRD, NFRD.

From an operational perspective, the data processing procedure required a methodological approach capable of guaranteeing absolute mathematical precision, transparency and scientific replicability, so, while artificial intelligence "Gemini" assumed a position of central importance in this phase, it was not used to directly scan and semantically evaluate the reports, because it is a method subject to approximate counts or statistical hallucinations. Instead, the AI Gemini was utilized to architect and develop a tailored and highly rigorous Python script (which we report in Figure 25), with the purpose of performing accurate and reliable text mining and overcoming the structural limitations of both manual word-counting software and purely semantic AI interpretations.

The Python algorithm was specifically developed to process the complex PDF documents of the banks sustainability reports through a strict and multi-step framework: initially, the script utilized the "PyMuPDF" library to extract the raw text from each document, then an advanced "Data Cleaning" phase was applied to purify the textual dataset converting the entire corpus to lowercase, and implementing Regular Expressions (Regex) to identify and neutralize hidden line breaks and anomalous multiple spaces typically caused by the complex multi-column layouts of financial PDFs. This normalization step was crucial to ensure that compound phrases, such as "double materiality" or "financed emissions", were captured accurately even when physically split across two separate lines of text.

After the text purification phase, the actual frequency counting was performed utilizing an exact-match logic, the script employed the Regex "Word Boundary" function (`\b`) to isolate each specific keyword within the text, guaranteeing that the algorithm only counted exact standalone terms, completely filtering out false positives, for example preventing the sequence "board" from being erroneously counted within the word "onboarding".

Finally, the script aggregated the extracted absolute frequencies according to the three predefined macro-categories (Climate change, Governance and Compliance) and the corresponding fiscal years (2023 and 2024), and leveraging the "pandas" and "openpyxl" data manipulation libraries, the algorithm dynamically matched the extracted textual data for each specific bank, programmatically structuring and exporting the final output into a comprehensive Excel matrix. Once this perfectly ordered quantitative database was established, the percentage variations (VAR) between the pre-CSR (2023) and post-CSR (2024) reporting cycles were subsequently calculated directly within the spreadsheet environment, thereby setting the stage for the final analytical evaluation of the European banking sector.

A further methodological clarification is required regarding the potential "report size effect" inherent in the transition between the two legislative frameworks. Given that the quantitative comparison relies on absolute keyword frequencies, it is important to acknowledge that the significant variations observed are physiologically influenced by the differing lengths and informational densities of the analyzed documents. However, no mathematical normalization, such as calculating relative frequencies based on the total word count of each individual report, was applied during the data processing phase. This analytical choice was entirely intentional, as the sheer expansion in the overall volume of the isolated sustainability sections is not considered a statistical distortion to be mitigated, but rather it represents the direct empirical manifestation of the "regulatory shock" imposed by the CSRD, which legally mandates a substantially broader, more granular, and comprehensive disclosure compared to the previous NFRD regime.

Finally, while this automated text mining procedure ensures absolute mathematical precision and neutralizes human error, it is important to explicitly recognize its inherent limitation before proceeding to the empirical results. In fact, the simple counting of keyword frequencies acts as a proxy for regulatory focus and structural preparation, and it doesn't necessarily imply that concrete actions and corrective measures have been actively implemented by these banking groups to genuinely improve their environmental impact.

Figure 25. Python code used to perform the text mining analysis

```
# 1. Install necessary libraries to read PDFs and export to Excel
!pip install pymupdf pandas openpyxl

import fitz # PyMuPDF to read PDFs
import pandas as pd
import re
import io
from google.colab import files

# 2. Define our categories and keywords
categories_words = {
    "Category 1 (Climate Change)": [
        "sustainability", "sustainable", "climate", "emissions", "financed emissions",
        "transition", "impact", "energy", "ESG", "taxonomy", "environmental",
        "scope 3", "net-zero", "decarbonization"
    ],
    "Category 2 (Governance)": [
        "governance", "board", "directors", "management", "policies", "remuneration",
        "compensation", "strategy", "integration", "CSO", "sustainability officer", "committee"
    ],
    "Category 3 (Compliance)": [
        "double materiality", "assurance", "audit", "report", "alignment", "regulation",
        "consolidated", "material", "aligned", "ESRS", "GAR", "GRI", "CSRD", "NFRD", "taxonomy"
    ]
}

def extract_pdf_text(pdf_bytes):
    """Extracts all text from a PDF file"""
    document = fitz.open(stream=pdf_bytes, filetype="pdf")
    full_text = ""
    for page in document:
        full_text += page.get_text("text") + " "
    return full_text.lower() # Convert everything to lowercase

def count_frequencies(text, keywords):
    """Counts the exact occurrences of keywords in the text"""
    results = {}
    for word in keywords:
        # Use \b to search for the exact word (e.g., avoids counting "material" inside "materiality")
        pattern = r'\b' + re.escape(word.lower()) + r'\b'
        count = len(re.findall(pattern, text))
        results[word] = count
    return results

# 3. File upload interface
print("=== TEXT MINING ANALYSIS FOR THESIS ===")
print("Select the Sustainability Report PDF files you want to analyze from your computer.")
uploaded = files.upload()

# 4. File processing
final_data = []

for file_name, file_content in uploaded.items():
    print(f"\nAnalyzing file: {file_name}...")
    pdf_text = extract_pdf_text(file_content)

    file_results = {"File Name": file_name}

    for category, words in categories_words.items():
        counts = count_frequencies(pdf_text, words)
        # Add results specifying the category for clarity in the Excel file
        for word, count in counts.items():
            file_results[f"[{category}] {word}"] = count

    final_data.append(file_results)

# 5. Creation and export to Excel
df = pd.DataFrame(final_data)
excel_filename = "Text_Mining_Results.xlsx"
df.to_excel(excel_filename, index=False)

print("\nAnalysis completed successfully! Downloading the Excel file with the exact results.")
files.download(excel_filename)
```

3.2.3 *Obtained results*

The quantitative text mining analysis conducted on the sustainability reports of the 20 selected European banking groups generated a robust dataset, allowing for a precise evaluation of the semantic and structural evolution triggered by the transition from the NFRD to the CSRD framework, and in fact, the empirical findings not only confirm the theoretical premises outlined in the previous sections, but also quantify the magnitude of the reporting shock experienced by the European banking sector.

To fully comprehend the magnitude of the structural shift triggered by the new European regulatory framework, it is crucial to first analyze the aggregate volumes of banking disclosures and Table 2 illustrates the total absolute frequencies of the selected keywords across the entire sample segmented by the three core macro-categories of investigation, and comparing the final reporting cycle under the NFRD (2023) with the inaugural transition to the CSRD (2024).

The most emblematic finding emerges from the overall volume of sustainability-related terminology, which have increased from 75,655 to 109,341 occurrences, representing a sharp +44.53% increase in a single fiscal year, which does not reflect a mere organic evolution of corporate narratives, but provides decisive empirical evidence of what can be defined as a "regulatory shock". The CSRD has driven a drastic intensification of the informational density required from credit institutions, convincing them to disclose data with an unprecedented level of technical and quantitative granularity compared to historical reporting cycles.

Disaggregating this upward trend, both the Climate Change and Governance category exhibit a robust consolidation, signaling a progressive internalization of these strategic dimensions within the banks core business models, but the most disruptive evidence of this legislative wave resides within the Compliance category which recorded the highest variation. This data validates the central hypothesis of this research: sustainability within the banking sector has permanently ceased to be a voluntary and reputation-driven exercise, shifting toward a regime of strict legal compliance, based on standardized, auditable and enforceable metrics under the supervision of regulatory authorities.

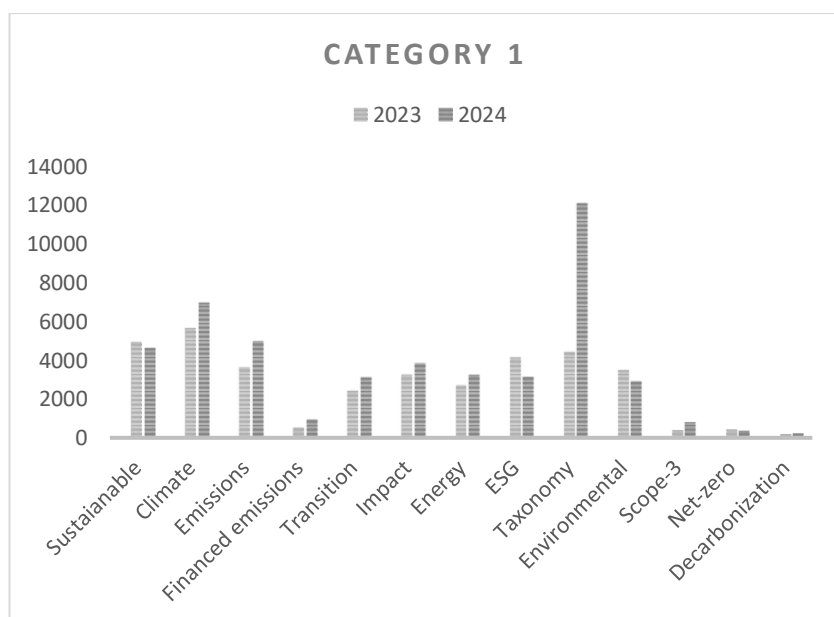
Table 2. Aggregate frequency across the sample

Macro Category	2023 (NFRD)	2024 (CSRD)	Variation Δ %
Climate change	42.332	55.310	+ 30,7 %
Governance	18.157	22.958	+ 26,4 %
Compliance	15.166	31.073	+ 104,9 %
Total aggregate	75.655	109.341	+ 44,53 %

Moving beyond the macro-structural overview, it is important to take a closer look at the specific dynamics of each individual category, so the three subsequent charts provide a granular visual breakdown of the lexical trends from 2023 to 2024, isolating the exact keywords that drove the overall volume growth.

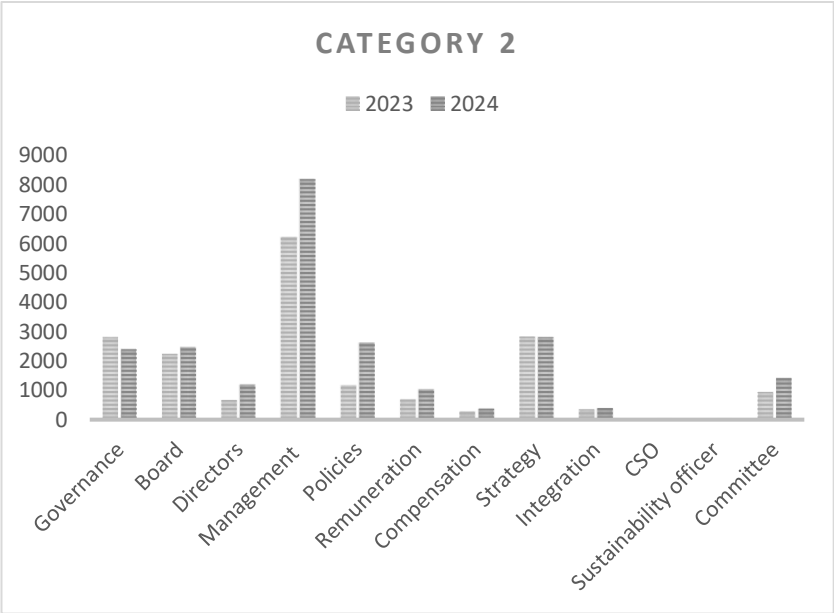
The first one (Figure 26) represents the Climate Change category and highlights a significant contraction of generic corporate words in favor of highly parameterized metrics. Broad environmental terms historically susceptible to greenwashing practices, such as "ESG" and "Environmental", recorded a decline; conversely, highly-specialized and quantitative terms like "Scope-3" and "Financed emissions" observed a substantial explosion. This lexical dynamic demonstrates that European banks have shifted their strategic focus away from merely reporting their direct operational ecological footprint (Scope 1 and 2) to actively disclosing and assuming accountability for the indirect emissions generated by their lending activities and credit portfolios, which represent the true empirical core of banking climate risk management.

Figure 26. Climate Change Category



The second chart (Figure 27), dedicated to corporate governance and organizational structure, highlights a clear upward shift of sustainability supervision within the corporate hierarchy. Climate-related responsibilities are no longer confined to corporate social responsibility (CSR) departments but have become an integral part of board-level decision-making; in fact this institutionalization is verified by the sharp increase in terms like "Directors" and "Management", the explicit formalization of executive roles like the "Sustainability officer" and also, the increase in the terms "Remuneration" and "Compensation" which indicates a stronger integration of ESG considerations into executive incentive schemes, whereby linking variable compensation to the achievement of ESG targets serves as a powerful structural defense against greenwashing.

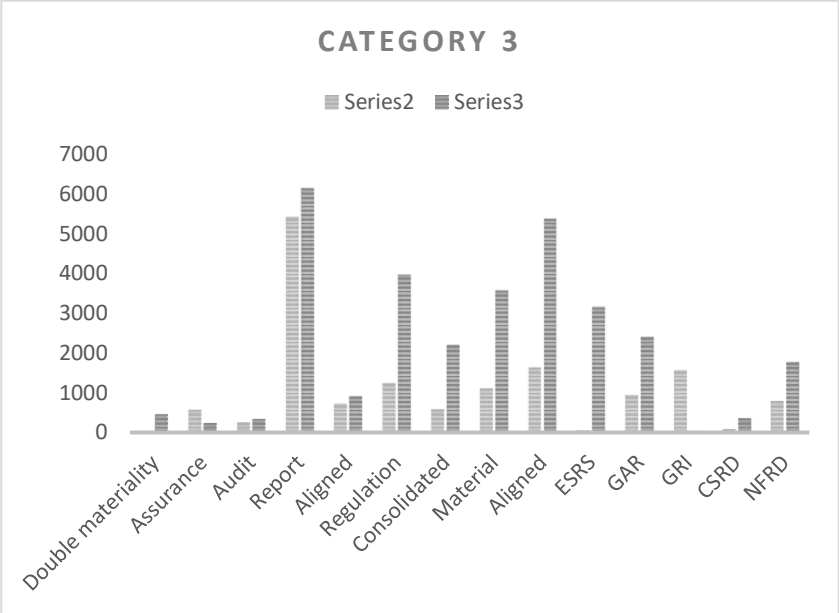
Figure 27. Governance Category



The third chart (Figure 28) illustrates the Compliance macro-category and offers the most visually representation of the European regulatory intervention. The empirical data provides strong evidence of what economic literature defines as a "Substitution Effect", for example the historical gold standard of voluntary non-financial reporting frameworks, the Global Reporting Initiative ("GRI"), was reduced by 97.7% and it has been entirely crowded out by the mandatory European Sustainability Reporting Standards ("ESRS"). Furthermore, the vertical trajectory of "Double materiality" (+1030.0%) certifies the definitive adoption of a two-way reporting paradigm: European credit institutions are now legally mandated to quantify both how their operational activities impact the ecosystem (impact materiality) and, crucially, how climate-

related physical and transition risks financially affect their own balance sheets (financial materiality).

Figure 28. Compliance Category



To fully capture the qualitative essence of the regulatory transition we have to look at Table 3, which present the "Top Movers", isolating the five keywords that recorded the highest positive percentage variations, on the left, and the five that experienced the most drastic contractions, on the right, between 2023 and 2024. The keywords dominating the positive spectrum are the direct semantic manifestation of the new European legislative mandate and the explosion of terms like "ESRS", "Double materiality" and "CSRD" strictly reflects the inaugural application of the new framework in the 2024 fiscal year. Rather, they are not the result of organic linguistic evolutions but of compulsory technical alignments. Simultaneously, the increase in references to a "Sustainability officer" provides crucial evidence of an internal organizational metamorphosis, and in fact the institutionalization of this specific role demonstrates that banks are bridging the historical gap between environmental initiatives and corporate governance, elevating climate risk to the highest levels of executive management. Finally, the significant rise in the term "Financed emissions" confirms that the sector's reporting focus has definitively shifted away from direct operational footprints toward the rigorous measurement of indirect portfolio emissions, recognizing that a bank's true climate impact lies within its lending activities.

Conversely, the negative movers illustrate an important semantic maturation characterized by the replacement of historical frameworks and popular terms, such as “GRI”, which has been the former voluntary gold standard and has been entirely replaced by the mandatory ESRS taxonomy. Similarly, the contraction of broad and marketing-friendly terms such as "ESG", "Environmental" and "Net-zero" indicates that banks are dropping generic sustainability commitments, historically vulnerable to greenwashing, in favor of highly parameterized and auditable metrics.

Finally, the decline in the term "Assurance" present an apparent paradox that warrants a specific methodological clarification because it does not imply a diminished relevance of external auditing, precisely because of the fact that the CSRD introduces the strict legal obligation of mandatory third-party assurance for sustainability data. The rationale behind this decline lies in the fact that, under the voluntary NFRD regime, banks frequently utilized the term "assurance" throughout their reports to artificially boost credibility and constantly reminding stakeholders of their voluntary auditing efforts, but with the advent of the CSRD, external review is no longer a discretionary reputational tool to be boasted but it became a statutory baseline assumption. The drop in frequency, therefore, does not reflect a loss of importance, but rather the definitive transition of sustainability auditing from a marketing exercise to standard legal compliance.

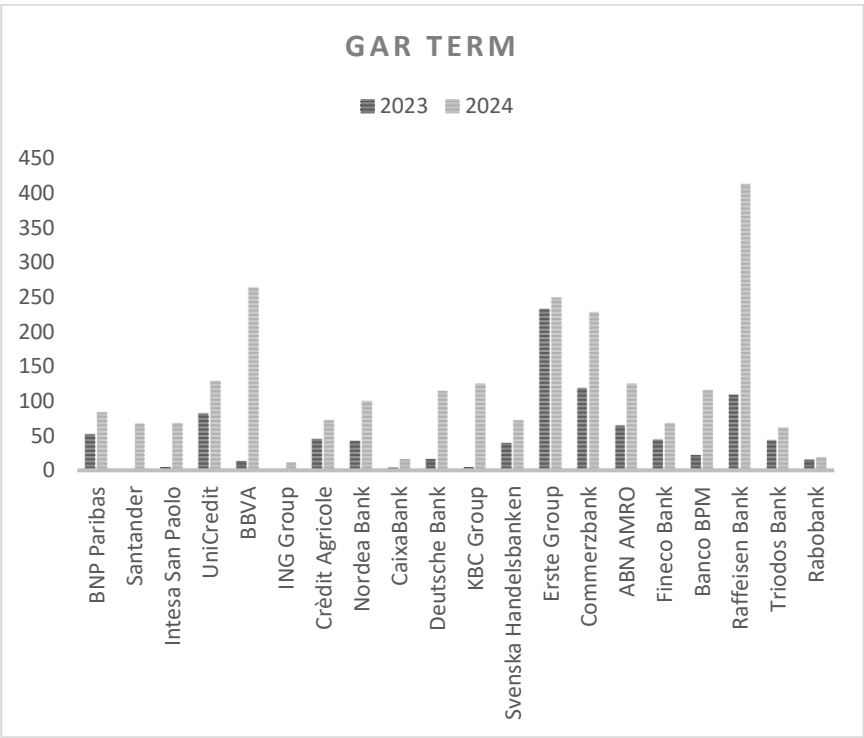
Table 3. Top Movers

WORD SEARCHED	VAR Δ %	WORD SEARCHED	VAR Δ %
Double materiality	1030 %	GRI	- 98 %
ESRS	4998 %	Assurance	- 58%
CSRD	274 %	ESG	- 24 %
Sustainability officer	240 %	Environmental	- 17 %
Financed emissions	71 %	Net-zero	- 17 %

To conclude the text mining analysis and transition toward the final quantitative evaluation of this study, it is useful to isolate the specific semantic trajectory of the sector most critical new metric, the Green Asset Ratio (GAR). As illustrated in Figure 29, which compares the terms frequency across the 2023 and 2024 reporting cycles, the new CSRD framework legally required credit institutions to move beyond abstract sustainability references and explicitly publish their definitive Green Asset Ratio; as a result, while the 2023 NFRD reports primarily treated the GAR as an anticipatory concept, by 2024 the metric had completely saturated

corporate narratives, with the light grey bars demonstrating exponential growth in usage among institutions. Consequently, banks had to dedicate extensive sections of their reports to detail the complex calculation methodologies, justifying the persistent challenges regarding client data availability and explaining the rigorous parameters defining taxonomic alignment. Finally, since semantic frequency alone cannot measure actual environmental performance, despite the text mining analysis prove the sector heightened linguistic focus and structural preparation for this metric, the following section of the chapter will build upon this mapped terminological evolution by transitioning from text to numbers, with the objective of analyze the actual Green Asset Ratio values disclosed by the institutions.

Figure 29. The expansion of the Green Asset Ratio



3.3 The Green Asset Ratio implementation

Having examined the semantic and structural evolution of sustainability reports, this section of the chapter transitions from textual narratives to complex quantitative metrics, by focusing on the implementation of the Green Asset Ratio within our selected sample. To provide a clear evaluation, the following analysis is divided in two parts, the first one establishes a systemic benchmark by drawing on insights from a recent Accenture report, which serves to outline the current macroeconomic reality and the methodological challenges faced by the broader

European banking sector. In the second part, the focus shifts to our primary empirical assessment, where the actual GAR values, separated into Turnover-based and CapEx-based metrics, disclosed by the 20 European banks in our sample for the 2023 and 2024 fiscal years are analyzed and compared, with the objective of demonstrating how different business models perform under the new regulatory framework and to highlight how strict structural limitations, such as the exclusion of SMEs from the calculation, can distort the true representation of an institution sustainable capital allocation. Finally, the chapter will close with concluding remarks that synthesize these findings, discussing the gap between written sustainability commitments and actual numerical alignment.

3.3.1 The systemic benchmark: insights from the Accenture report

The empirical implementation of the regulatory frameworks discussed in the previous chapter culminates in the mandatory disclosure of the Green Asset Ratio (GAR) by banks and credit institutions, thereby enhancing the transparency of their environmentally sustainable exposures.

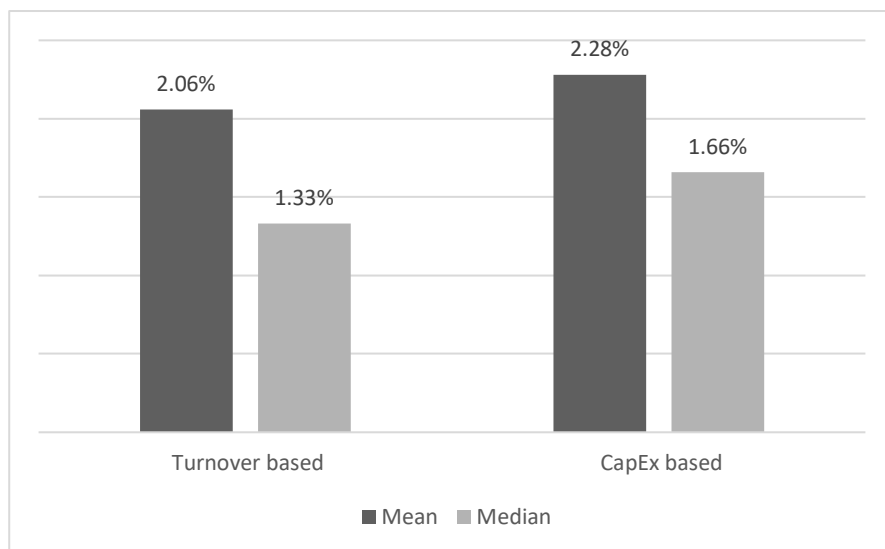
To objectively evaluate the individual performance of the selected banking sample and contextualize the semantic shifts identified during the text mining analysis, it is methodologically important to first establish a systemic benchmark and, the analysis conducted by Accenture⁴⁶ on a sample of 50 European banks across 15 countries during the third EU Taxonomy reporting season, provides this crucial baseline. This analysis reveals a stark reality regarding the sector's current alignment: as we can see from Figure 30 the average GAR based on turnover reached a mere 2.06 %, with a median of 1.33 % and when calculated based on Capital Expenditure, the average slightly increases to 2.28 %, with a median of 1.66 %. A critical statistical insight can be drawn from the significant spread between these mean and median values, because in both the turnover-based and CapEx-based scenarios, the median is noticeably lower than the mean average, indicating that the vast majority of the European banking sector is clustered at the very bottom of the scale, with only a few outliers possessing slightly higher ratios that marginally pull the mathematical average upward.

Then, the slightly higher values recorded in the CapEx-based ratio compared to the turnover-based one provide an important forward-looking indicator, suggesting that the new capital

⁴⁶ A multinational professional services company specializing in consulting, digital transformation and technology, which provides advisory services to businesses, governments and financial institutions worldwide and is widely recognized for its industry research and market analyses

expenditures (CapEx) undertaken by the banks counterparties are marginally more aligned with the EU Taxonomy than their current revenue streams (turnover), reflecting the initial, slow transition investments occurring within the real economy.

Figure 30. Mean and Median Green Asset Ratios across European Banks



The Figure, which might initially suggest a systemic failure in sustainable capital allocation, is largely explained by the severe methodological constraints and data limitations inherent in the current regulatory architecture, as previously discussed in the theoretical analysis of the GAR, where it was highlighted that the metric is affected by rigid structural limitations that risk providing a distorted picture of credit institutions actual commitment to the ecological transition and, consequently, limit its ability to accurately reflect the sustainability profile of their lending activities. The primary driver of this mathematical dilution effect is the so-called "NFRD/CSRD filter", which indicates the exclusion by the calculation perimeter of exposures to entities not subject to the NFRD, in particular the vast majority of Small and Medium Enterprises, from the numerator, while retaining them in the total covered assets of the denominator, with the consequence that banks with traditional commercial business models oriented toward supporting local enterprises face a severe penalty, diluting their overall ratio regardless of the actual environmental value of their lending activities.

Furthermore, significant analytical challenges persist in the retail segment, particularly concerning Residential Real Estate (RRE) portfolios, which constitute a vital component of balance sheets and account for an average of 46.6 % of total disclosed GARs. Demonstrating taxonomy alignment for these specific assets requires stringent and highly granular proof such as an Energy Performance Certificate (EPC) class A or empirical positioning within the top 15%

of the national building stock's primary energy demand, but the strict regulatory prohibition on the use of internal estimates or proxies triggers a profound data availability problem, preventing banks from substituting missing official documentation with internal risk models, and in fact, according to the Accenture report, 30% of banks faced significant operational challenges due to the limited availability of EPCs within their portfolios, forcing them to rely on incomplete external databases or highly costly direct client campaigns.

Therefore, in its inaugural reporting phase, the GAR functions less as a pure indicator of environmental sustainability and more as a measure of a bank's data infrastructure readiness and its structural exposure to large corporations, a limitation that explains why, as accurately summarized by the Accenture researchers, these initial ratios currently lack the maturity required to effectively guide strategic decision-making and instead incentivize the mere "financing of green" rather than the broader and more complex systemic objective of "greening finance".

Having established this essential systemic benchmark and detailed its underlying methodological limitations, the following section will shift the focus to our primary research, proceeding to analyze the actual Green Asset Ratio values directly extracted from the official reports of the 20 European banks comprising our sample.

3.3.2 Empirical Assessment of the Green Asset Ratio within the Selected Sample

Moving from the general macroeconomic overview outlined in the previous paragraph to the conducted analysis, this section aims to examine the actual Green Asset Ratio values published by the twenty European banks that make up our research sample, with the main goal of verifying whether the structural and methodological limits, seen at a general system level, are directly reflected in the data reported by the main European market players, and also understanding how different business models influence the performance of this crucial climate compliance indicator.

From a strictly methodological point of view, the quantitative research was carried out through a careful manual extraction of data from the Annual Reports published by each individual bank on its official website. To allow for a comparison over time and to evaluate the impact of changing regulations, this data extraction examined the reports for the 2023 and 2024 financial years by specifically focusing on the standardized reporting tables required by Article 8 of the European Taxonomy, thus tracking how these parameters evolved during the transition from

the old Non-Financial Reporting Directive to the newer and stricter Corporate Sustainability Reporting Directive.

It is important to note that the transition to the CSRD does not introduce the GAR as a novel metric, but it fundamentally expands its application perimeter, progressively including a significantly larger group of non-listed and medium-sized banks under the mandatory disclosure umbrella.

To ensure a deep analysis and a proper comparison, we did not extract a single overall value for each bank, but rather collected and separated two fundamental metrics required by the regulator: the Turnover-based GAR and the CapEx-based GAR. The first one represents a static picture of the banks current portfolio alignment because it expresses the percentage of green assets weighted according to the present revenues generated by the financed companies, essentially acting as an indicator that measures the existing economic sustainability linked to the current daily operations of the corporate clients. The second one is a dynamic and forward-looking metric that evaluates alignment by weighting the new investments that client companies are making in order to expand, convert or improve their business activities in a sustainable way. The simultaneous comparison of these two calculation bases is of fundamental importance for correctly understanding a banks real commitment, as it allows to distinguish the mere "passive sustainability" of today's balance sheet from the banks true willingness to finance the evolution of the real economy. For example, if the CapEx-based GAR is higher than the Turnover-based one, as in our case, we gain practical evidence of an active transition path, which indicates that even though current economic activities might not yet fully meet the strict criteria of the Taxonomy, future capital flows are already strongly directed toward climate compliance.

The results of this data extraction, which will be presented and analyzed in the following figures, provide a clear practical map of the current state of the European banking sector, revealing significant differences and confirming the deep gap between the written narrative of sustainability and the complex numerical metrics imposed by the regulator.

Figure 31. GAR (Turnover-based) comparison between 2023 and 2024

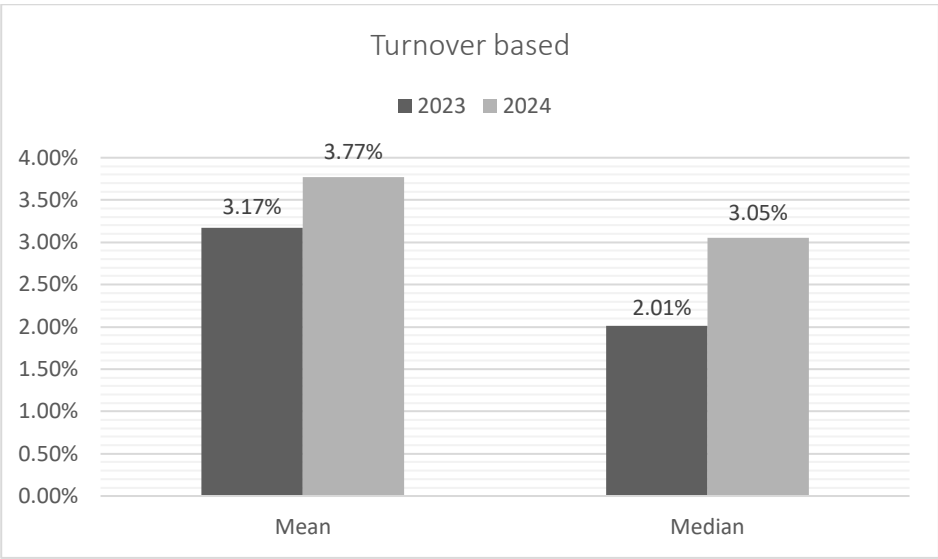
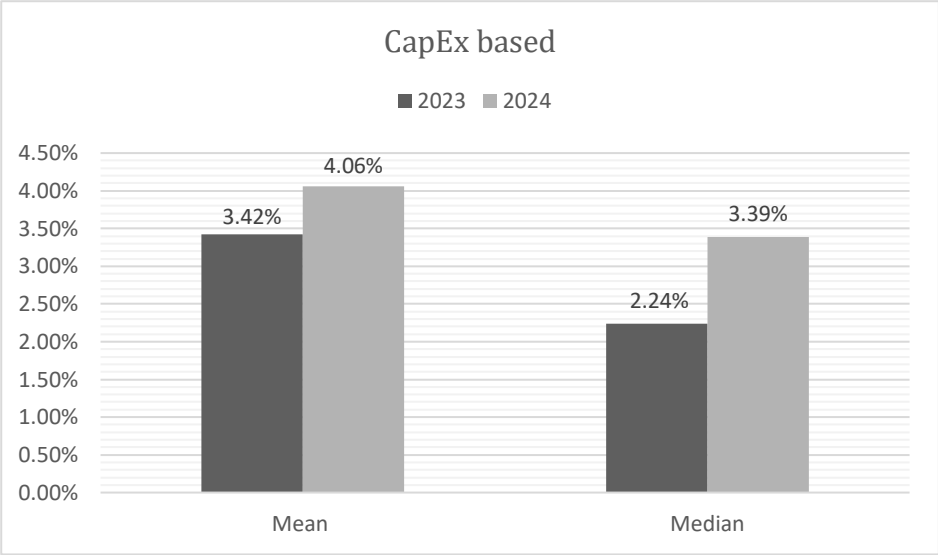


Figure 32. GAR (CapEx-based) comparison between 2023 and 2024



The empirical analysis of the data extracted from our sample of 20 European banks finds its visual representation in Figures 31 and 32, which illustrates the evolution of the Green Asset Ratio over the 2023 and 2024 period, calculated on the basis of Turnover and Capital Expenditure (CapEx), respectively.

A key methodological element characterizing both charts is the inclusion of not only the mathematical mean but also the sample median, aiming to empirically verify the dynamics previously highlighted in the Accenture report. Observing the consolidated results of our sample for 2024, it is apparent that the average GAR based on Turnover, as well as the one based on CapEx, are higher than their respective medians, indicating that the majority of credit

institutions are concentrated at the lower end of the Taxonomy alignment scale, and that a few but significant outliers within the sample pull the average upward, fully confirming the distributional asymmetry of the European banking sector and the systemic findings of Accenture's research.

Comparing, the two figures, it is easily noticeable that the GAR values based on CapEx are higher than those based on Turnover, supporting the hypothesis that the CapEx-based GAR acts as a forward-looking indicator, meaning that the new capital expenditures being undertaken by client companies for the ecological transition are proportionally more aligned with the Taxonomy criteria than the revenues generated by their current and historical operations.

Table 4. Evolution of the Green Asset Ratio (Turnover and CapEx) across the selected European banking sample (2023 vs 2024)

BANK NAME	GAR STOCK 2023		GAR STOCK 2024	
	Turnover KPI	Capex KPI	Turnover KPI	CapEx KPI
BNP Paribas	0,78%	1,66%	1,84%	2,12%
Santander	2,40%	2,60%	3,04%	3,28%
Intesa San Paolo	2,65%	3,32%	3,63%	4,36%
UniCredit	1,16%	1,78%	1,36%	1,91%
BBVA	0,52%	0,80%	0,57%	0,84%
ING Group	7,00%	7,00%	7,00%	7,00%
Crédit Agricole	2,96%	3,20%	3,64%	4,38%
Nordea Bank	2,00%	2,00%	4,00%	4,10%
CaixaBank	1,05%	2,30%	3,05%	3,93%
Deutsche Bank	1,30%	1,50%	1,00%	1,20%
KBC Group	0,20%	0,30%	0,50%	0,40%
Svenska Handelsbanken	2,20%	2,20%	3,40%	3,50%
Erste Group	0,53%	0,76%	0,62%	1,02%
Commerzbank	2,34%	2,43%	3,33%	3,59%
ABN AMRO	10,00%	10,00%	11,00%	12,00%
Fineco Bank	0,00%	0,00%	1,68%	1,71%
Banco BPM	2,02%	2,28%	2,52%	2,84%
Raiffeisen Bank	0,39%	0,42%	0,81%	0,71%
Triodos Bank	19,70%	19,70%	17,70%	17,70%
Rabobank	4,12%	4,16%	4,61%	4,67%
MEAN	3,17%	3,42%	3,77%	4,06%
MEDIAN	2,01%	2,24%	3,05%	3,39%

Turning to a more detailed analysis of single performances, Table 4 reveals a heterogeneous landscape that is heavily influenced by different business models, in fact, traditional commercial banks with portfolios strongly oriented toward SMEs (which fall within the denominator but are excluded from the numerator due to the "NFRD/CSRD filter") inevitably record the lowest values, as demonstrated by data from institutions such as KBC Group or Raiffeisen Bank. Conversely, large groups with a strong orientation toward corporate finance and a robust ESG data framework, such as ABN AMRO and ING Group, are able to perform significantly above the sector average.

The most interesting evidence across the entire sample is certainly represented by Triodos Bank, which records the highest values overall, with a GAR of 19.70% in 2023 and 17.70% in 2024. This leadership is a direct consequence of its peculiar business model, a bank natively founded on the principles of ethical and sustainable finance, whose entire loan portfolio is structurally oriented toward financing projects with a positive environmental and social impact, with the direct consequence that its alignment with Taxonomy criteria is physiologically much higher than that of traditional commercial banks.

Nevertheless, Triodos Bank also represents a statistical anomaly within our sample, recording a decrease in its GAR between 2023 and 2024, in sharp contrast to the general growth trend. This decline should not necessarily be interpreted as a disinvestment from sustainability, but can be explained through two lines of reasoning: on the one hand, the denominator (total covered assets) may have grown at a faster pace than the capacity to originate new eligible "green" loans; on the other hand, the increasingly strict and rigorous application of the complex Technical Screening Criteria imposed by the European Taxonomy may have led to a conservative reclassification of certain assets, demonstrating once again how the GAR, in its current state, is an indicator extremely sensitive to documentary compliance rather than to actual and real-world ecological impact.

The comparison of these extreme cases, highlighting the strong contrast between traditional commercial institutions and positive outliers like ABN AMRO and Triodos Bank, reveals a profound structural division within the European sector: it demonstrates that, under the current regulatory framework, achieving a high Green Asset Ratio is structurally precluded for banks heavily exposed to retail markets and SMEs, while it acts as a mathematical premium for alternative business models. In particular, institutions that operate either with a native ethical mandate dedicated exclusively to sustainable project financing or with a high concentration of large corporate clients capable of bypassing the NFRD/CSRD filter, possess an advantage that fundamentally distorts direct comparability across the broader banking landscape.

3.4 Concluding remarks

The empirical investigation conducted in this chapter provides clear evidence that the European banking sector is undergoing a profound structural transformation, driven by the transition from the NFRD to the CSRD framework and, as demonstrated by the text mining analysis, there has been a definitive semantic shift from voluntary and generic sustainability narratives to rigorous and compliance-driven disclosures, effectively enhancing overall transparency and institutionalizing climate risk governance. However, it is methodologically essential to recognize that the simple counting of keyword frequencies acts primarily as a proxy for the development of corporate sustainability because, while a semantic expansion indicates heightened regulatory focus and structural preparation, it does not inherently guarantee that concrete, real-world actions and corrective measures have been actively implemented by these banking groups to genuinely improve their environmental impact. This limitation explains why the new regulatory landscape, despite raising the barriers against greenwashing practices, does not automatically correspond to an immediate systemic ecological transition.

The quantitative assessment of the Green Asset Ratio across the selected banking sample confirms this duality, exposing a significant contrast between the narrative commitment to sustainability and the actual numerical alignment, with ratios remaining predominantly clustered at the lower end of the scale. Crucially, these low values cannot be primarily attributed to a lack of strategic willingness or a failure in sustainable capital allocation by the credit institutions, but rather, they are the direct mathematical consequence of severe methodological constraints inherent in the current regulatory formula, that is as already said, the so-called "NFRD filter", coupled with the chronic lack of granular data, such as Energy Performance Certificates for real estate portfolios.

Looking forward, while the higher values recorded in the CapEx-based GAR provide a positive and forward-looking indication of future capital allocations, they simultaneously reinforce the need for a more comprehensive and realistic representation of banks transition efforts, a requirement that has contributed to the growing relevance of the Banking Book Taxonomy Alignment Ratio (BTAR). This ratio represents a fundamental complementary metric by allowing the inclusion of exposures to non-NFRD obligated entities, such as SMEs, and provide banks with the essential tool to bypass current regulatory limitations, bridging the data gap and finally demonstrating their concrete support for the ecological transition of the real economy.

CONCLUSION

This thesis aimed to investigate the evolution of sustainability in the financial sector, specifically focusing on the key role of banking institutions in driving the ecological transition. As demonstrated throughout the chapters, the global landscape has changed radically, sustainability is no longer a voluntary reputational exercise but a stringent regulatory obligation and, by acting as the primary transmission mechanism of the real economy, banks possess the structural power to reallocate capital toward sustainable objectives, embedding climate risk into traditional financial risk management.

The empirical investigation conducted in this research on a representative sample of 20 European banks provided clear evidence of this paradigm shift, and in fact, on a semantic level, the text mining analysis revealed a profound regulatory shock between the 2023 (under NFRD) and 2024 (under CSRD) reporting cycles. The banking sector narrative evolved radically, completely substituting generic marketing-friendly terminology with highly parameterized vocabulary such as "Double Materiality" and "Financed Emissions". However, the quantitative assessment of the Green Asset Ratio revealed a significant contrast: despite the heightened narrative commitment, the actual taxonomy-aligned ratios remain low, with sector medians fluctuating around 2-3%. Notably, the slightly higher values recorded in the CapEx-based GAR compared to the Turnover-based one provide a forward-looking indication, suggesting that future capital expenditures are beginning to align with sustainability criteria at a faster pace than historical corporate revenues.

This divergence between rigorous semantic compliance and low numerical alignment requires a critical interpretation and highlights the limitations of the current regulatory framework. The low GAR values cannot be automatically interpreted as a systemic failure or a persistent intent to finance polluting industries, rather, they are the mathematical consequence of severe structural constraints, primarily the NFRD/CSRD filter, which penalizes traditional commercial banks that support the local real economy and favors specialized ethical players or large investment banks, by excluding exposures to Small and Medium Enterprises from the numerator while retaining them in the denominator. Consequently, while the text mining analysis effectively measures regulatory focus and structural preparation, it acts as a proxy for attention rather than a guarantee of immediate decarbonization and also the GAR functions more as a stress test for a banks data infrastructure and regulatory exposure than as a perfect mirror of its true ecological footprint.

From a forward-looking perspective, the European regulatory landscape must evolve to bridge this gap between strict compliance and economic reality, and through the recent introduction of the Omnibus Directive it marks a concrete step in this direction, offering a necessary recalibration of timelines and providing market participants with the required time and space to establish a robust data collection ecosystem. Concurrently, the operational maturation of complementary metrics, most notably the Banking Book Taxonomy Alignment Ratio (BTAR), will be crucial because, by permitting the inclusion of SME exposures, the Ratio will allow banks to bypass the current structural limitations of the GAR, finally offering a more comprehensive and realistic representation of their efforts to support the sustainable transition of the broader real economy.

In conclusion, a global ecological transition cannot be achieved without the financial support of the banking sector. European regulations, specifically the CSRD and the EU Taxonomy, act as essential guides, forcing companies to be transparent and effectively helping to stop corporate greenwashing, but, for sustainable finance to succeed, regulation must continue to adapt to the complex and heterogeneous reality of the actual economy. Only by aligning strict bureaucratic compliance with the genuine financing needs of transitioning businesses, the banking sector can fully realize its mandate of transforming the financial system from a mere reflector of climate risk into the primary engine of a sustainable future.

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Dichiarazione del ricorso a strumenti di Intelligenza Artificiale (IA)

Il sottoscritto *Mattia Maksan*, matricola numero 886423, iscritto presso Ca' Foscari al corso di Laurea magistrale in *Economics, Finance and Sustainability*, autore della tesi di laurea *The Sustainable Transition of the Banking Sector – An Empirical Analysis of the European Banking Sector*, relatore *Professore Francesco Scarpa*, consapevole delle sanzioni previste dall'art. 76 del Testo unico, D.P.R. 28/12/2000 n.445, e della decadenza dei benefici prevista dall'art. 75 del medesimo Testo unico in caso di dichiarazioni false o mendaci, sotto la propria personale responsabilità ai sensi degli artt. 46 e 47 del D.P.R. 28/12/2000 n. 445,

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