



GRINS – Growing Resilient, INclusive and Sustainable

"9. Economic and financial sustainability of systems and territories"

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SPOKE 4

D4.1.1 – Definition of ESG scores for SMEs through dedicated surveys and of augmented credit ratings including ESG factors

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Executive summary

To **achieve** the **European climate neutrality** objectives by **2050**, financial institutions play a **crucial role** in promoting and supporting **transition** by mobilizing sustainable investments and funding for the green transition of the economic system. In **Italy**, the involvement of **SMEs** is central, being the main actors in the national value chain and SMEs must be supported in their transition path towards sustainability objectives.

In this document, the topic relating to the **reporting** and **collection** of **environmental, social** and **governance** (ESG) information is covered through the definition of some **guidelines** for an **efficient ESG questionnaire**.

The second part is dedicated to the analysis of the **relationship between credit risk indicators and ESG factors**, with an in depth analysis on the ESG profile of SMEs belonging to the Veneto region.

The last chapter defines the setup of augmented credit ratings including ESG factors through an indirect approach, which allows the compliance with European sustainability reporting requirements and technical feasibility for the banking system.

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1. The context: the dimensions of ESG risks and the impact on investors and SMEs

Work package 4.1 is dedicated to exploring the dimensions of ESG (Environmental, Social and Governance) risks and the impact on investors and SMEs (Small and Medium Enterprises).

The main actions of the project include the assessment and measurement of ESG risks with a particular focus on SMEs, and the impact of sustainable investments, the integration of sustainability considerations into investor risk management, both at individual, corporate and system levels, and the creation of a database dedicated to the collection of ESG and climate risk.

The work package includes specific activities to analyze and define the factors that influence how companies report environmental, social and governance (ESG) risks. Furthermore, it is planned to develop ESG score using targeted surveys and available information.

The work package plans to conduct impact analyses that will help investors to evaluate and optimize their investment portfolios. This includes defining strategies to optimally combine different financial instruments and hedging techniques to finance sustainable investments. The goal is to provide investors with the information and tools needed to make more informed decisions and focus on sustainability in their investments. Furthermore, it wants to analyze and identify mechanisms for reporting cases of greenwashing.

Finally, the work package 4.1 is dedicated to creating credit ratings that incorporate environmental, social and governance (ESG) factors.

This deliverable is dedicated to the definition of ESG scores for SMEs through dedicated surveys and the setup of augmented credit ratings including ESG factors. It is structured in 4 sessions: an overview of the current challenges faced by EU and Italian SMEs; the definition of ESG scores for SMEs; the relationship between credit risk and ESG; the definition of a credit rating that incorporate ESG factors. The appendix includes the regulatory framework (European sources of regulation on ESG disclosure for firms).

2. Overview of the current challenges faced by EU and Italian SMEs

2.1 EU SMEs at glance

According to the last SME FACT SHEET¹:

- SMEs represent 99.8% of all EU companies (0.2% large enterprises)
- SMEs employ 64.4% of the total employed workforce in the EU
- SMEs contribute up to 51.8% of the value added in the EU
- SMEs are exposed mainly to risks related to: late payments, inflation, skill shortages
- The economic sectors concentrating the largest shares of created value added and employed persons are wholesale and retail, manufacturing and construction.

It is then important to properly understand the different sources of risk and their interaction with SMEs capability to make green investments.

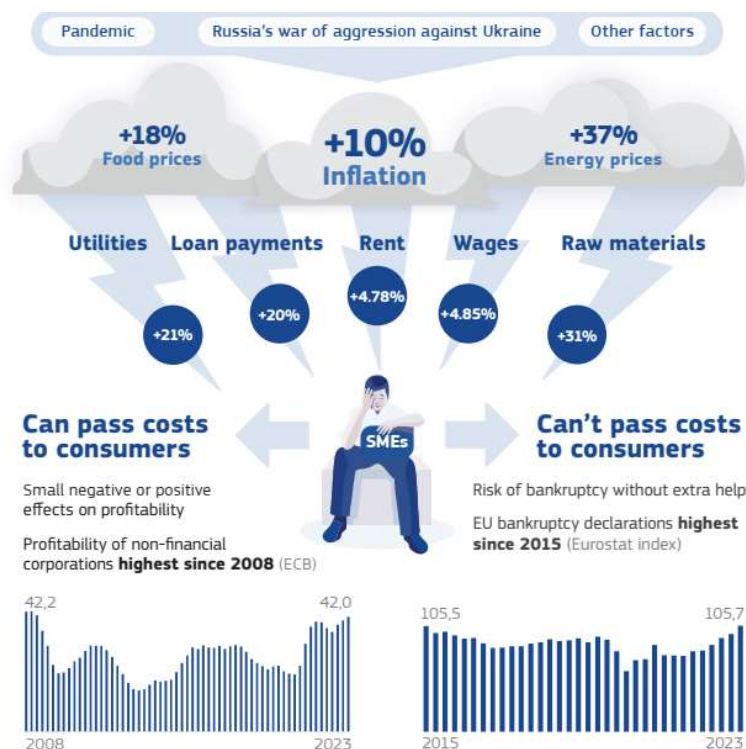
With a focus on the potential impact of Inflation on SMEs², it is important to consider:

- In result of the Pandemic and the Ukrainian war, SMEs are facing significant costs increases:

¹ Source: EC (2023), 2023 SME FACT SHEET.

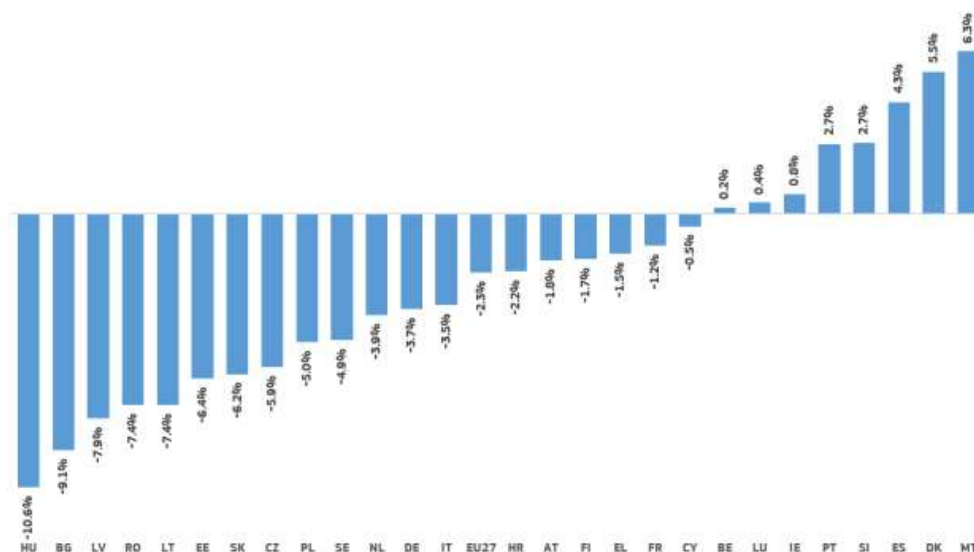
² Source: EC (2023), SMEs and high inflation- infographics.

- Energy prices: + 37%
- Raw material: +31%
- Loan payments: +20% and etc.
- Some of these costs cannot be transferred to customers which increases the risk of bankruptcy without extra help: the EU bankruptcy declarations reach their highest levels in 2023 since 2015.



- Their annual growth rate is significantly impacted by inflation³.
- Several short-term policy measures, targeting the most vulnerable households and businesses have been implemented in 2022:
 - loan extensions and loan holidays (SMEs with short-term liquidity challenges), and
 - indexation of public procurement contracts to avoid contract cancellation,
 but they are expected to be gradually phased out.

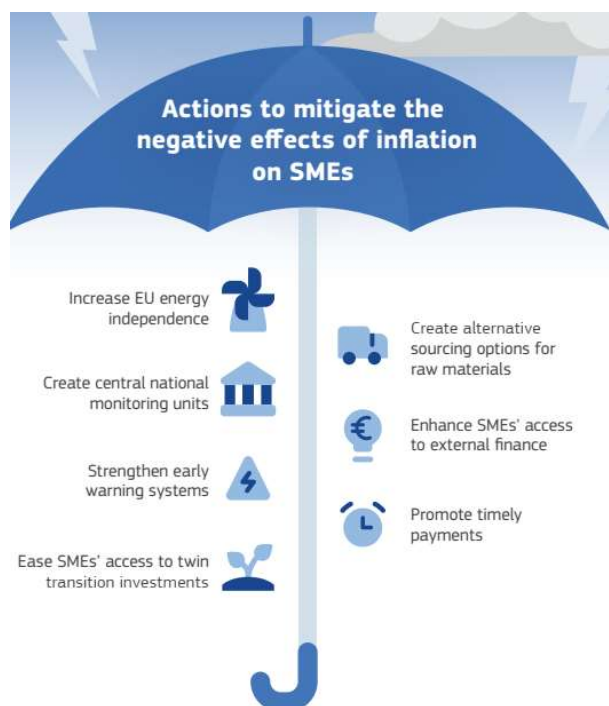
³ Di Bella et al. (2023), *Annual Report on European SMEs: SME Performance review 2022/2023*.



Annual growth rate of SME adjusted for inflation value added in the NFBS in 2022 in the EU-27 and across EU Member States

Among the suggested solutions⁴:

- increase energy independence and sustainable supply of raw materials and production components,
- ease access to twin transition investments (decarbonization and circular economy),
- enhance access to external finance.



⁴ Source: EC (2023), SMEs and high inflation- infographics.

Moving the focus on SMEs development and sustainability, the major barriers to a greater sustainability involvement up to 2020 are⁵:

- lack of customers demand
- the lack of financial resources

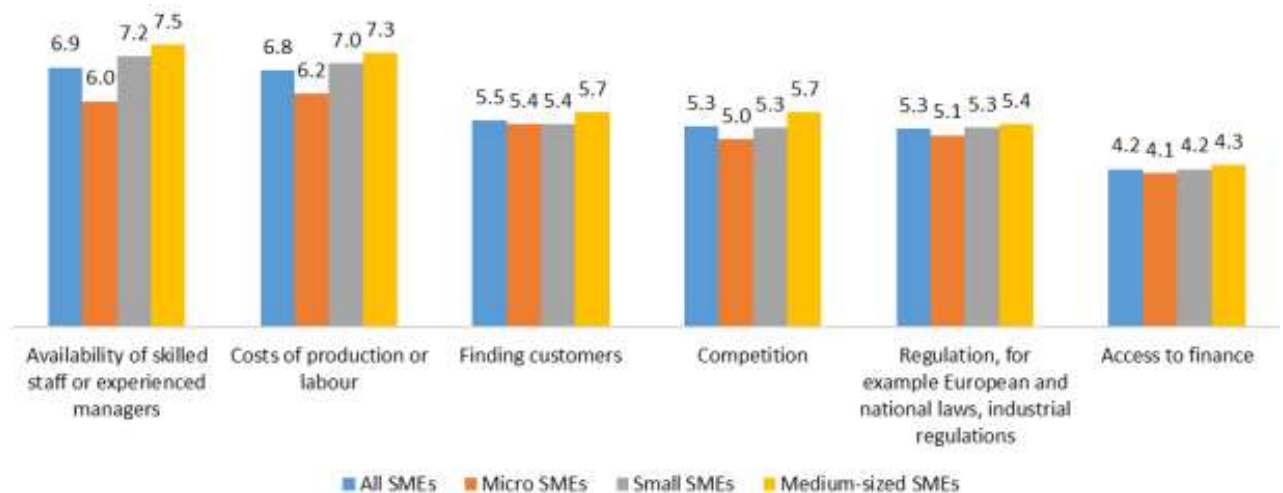
that worsening after the pandemic. Since 2020, there are also changing patterns:

- access to finance remains 6th most relevant challenge
- production costs (including energy costs) being 2nd.

Regulatory obstacles or administrative burden and payment delays come out on top when SMEs report the biggest problems they face:



The most mentioned barriers to sustainability that SMEs face are:



Major issues and challenges faced by SMEs, September - October 2022, (on a scale of 1 to 10)⁶

Focusing now on SMEs' green investments, main difficulties are related to:

- Inflation and interest rates increases affect negatively businesses, with disproportionate effects on SMEs.

⁵ Source: Facts from Flash Eurobarometer 486 (2020).

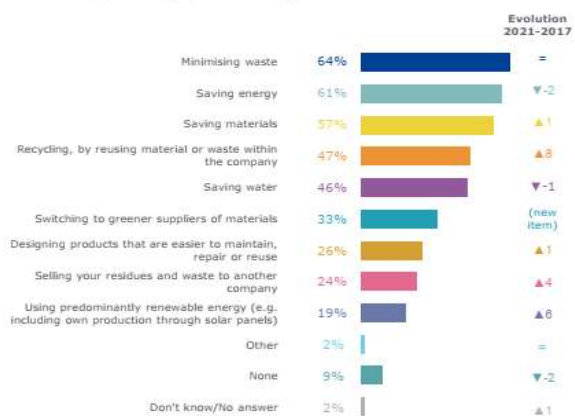
⁶ Source: Di Bella et al. (2023), Annual Report on European SMEs: SME Performance review 2022/2023.

- Increase the risks of late receipt of payments and delayed suppliers' payments.
- Investments, however increased in 2022 (compared to 2021),
- but high inflation effects might be delayed and indirect and
- investment expectations for SMEs are reduced (1% rise in interest rate => decrease of probability of reporting positive investment expectations by 0.83%).
- Mixed effects on green investments: high energy bills motivating energy-efficiency investments.

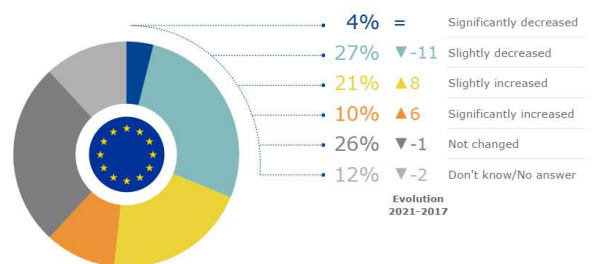
In terms of investments and activities it was detected⁷:

- Up to 2021, focus on: minimizing waste, saving energy and materials.
- In 2021, plans to: prioritize energy savings, maintain waste reduction efforts and material savings (for the upcoming years).
- In 2021, equal proportions of SMEs implementing resource efficiency actions, declare production cost decreases /increases in consequence.
- SMEs implementing resource efficiency actions, rely mainly on own financial and technical expertise (64%, 54% respectively).
- Just 24% rely on external support, including mainly public funding (grants, guarantees or loans), followed by private funding (bank, investment company or venture capital fund) (36% vs 28% respectively).

What actions is your company undertaking to be more resource efficient? (% EU27)



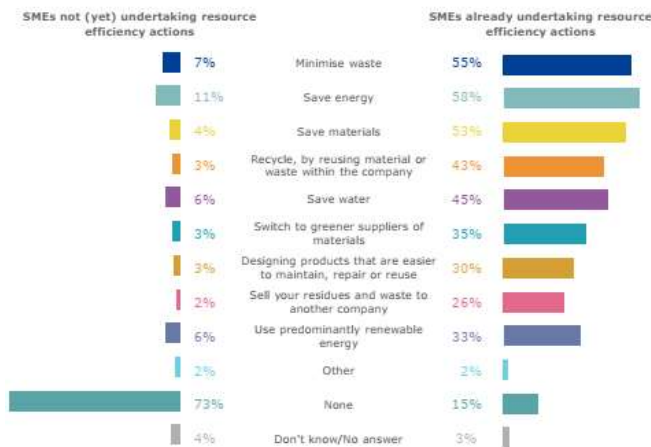
Base: all SMEs, EU27 (n=13 343 in 2021; 11 690 in 2017)
▼▲ Evolution 2021-2017 (comparison with Flash Eurobarometer 456, Sept. 2017)



Base: SMEs undertaking resource efficiency actions, EU27 (n=12 107 in 2021; 10 099 in 2017)
▼▲ Evolution 2021-2017 (comparison with Flash Eurobarometer 456, Sept. 2017)

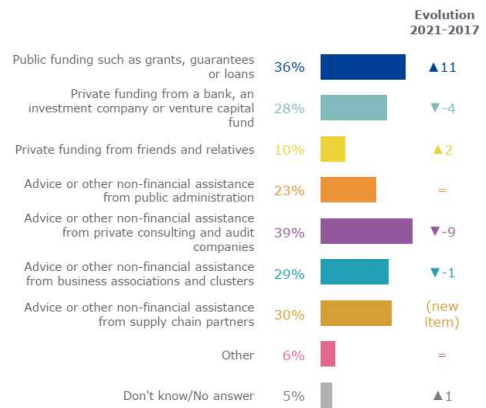
⁷ Source: Flash Eurobarometer 498 SMEs, green markets and resource efficiency (2021).

Over the next two years, what are the additional resource efficiency actions that your company is planning to implement? (% SMEs already taking actions vs SMEs not taking actions, EU27)



Base: SMEs already undertaking resource efficiency actions (n=12 211) and SMEs not undertaking resource efficiency actions (n=1 006), EU27

More precisely, which type of external support is it? (% EU27)



Base: SMEs that rely on external support in their efforts to be more resource efficient, EU27 (n=3 206 in 2021; 2 500 in 2017)

▼▲ Evolution 2021-2017 (comparison with Flash Eurobarometer 456, Sept. 2017)

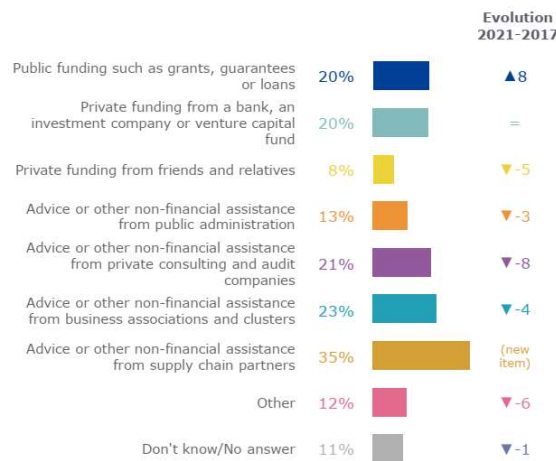
- Almost 1/3 of EU SMEs (32%) propose green products or services with further 11% planning such activities.
- For most SMEs (43%) proposing green products or services, these contribute to not more than 10% of their turnover, just 23% declare a proportion exceeding 50% of their turnover.
- SMEs proposing green products or services, rely mainly on own financial and technical resources (62% and 56% respectively).
- Just 24% rely on external support, including similar shares of public (grants, guarantees or loans), and private funding (bank, investment company or venture capital fund) (20% vs 20% respectively).

Q9 Does your company offer green products or services? (% by country, EU27)



Base: all SMEs, EU27 (n=13 343 in 2021; 11 690 in 2017)

▼▲ Evolution 2021-2017 (comparison with Flash Eurobarometer 456, Sept. 2017)



Base: SMEs that rely on external support for the production of green products or services, EU27
(n=1 150 in 2021; 815 in 2017)

▲ Evolution 2021-2017 (comparison with Flash Eurobarometer 456, Sept. 2017)

The support currently provided to SMEs relates to:

- In response to the 2022 inflation peak, the EU has proposed a set of potential solutions for overcoming SMEs' energy prices exposure⁸:
 - Better understanding of energy use in each company (energy audits, monitoring and control),
 - Further involvement of employees and workforce (better understanding of potential improvements),
 - Priority to highly efficient technologies and equipment,
 - Investment in energy efficiency measures,
 - Good housekeeping and maintenance measures.

However, SME United points out the necessity for SMEs, to ensure an improved access to green finance and to further simplify the framework and reporting requirements⁹.

The GRINS project wants to contribute not only through the discussion of these aspects, but also through some potential practical solutions detailed in this report.

The relevance of the activity is highlighted also in a recent speech by the Deputy Governor of Bank of Italy¹⁰:

- Sustainability information is becoming essential, under the pressure of legislation, supervision and accounting rules;

⁸ Source: EC, 2022, *Coping with the crisis*.

⁹ Willems, V. (2024). *SMEs ask InvestEU to be better tailored to their needs*. SME United.
<https://www.smeunited.eu/news/smes-ask-investeu-to-be-better-tailored-to-their-needs>

¹⁰ Angelini, P. (2024). *SMEs and the climate and environmental transition*, SUERF Policy Brief No. 896.
<https://www.suerf.org/publications/suerf-policy-notes-and-briefs/smes-and-the-climate-and-environmental-transition/>

- Financial intermediaries are preparing to integrate sustainability info in their credit and portfolio management policies;
- Sustainability info allows to systematize and exploit information already in the possession of firms;
- It is difficult to state clearly and univocally on the effects of sustainability on the risk profile of firms, and thus, to justify the modification of prudential parameters for the calculation of capital requirements, but research in the field progresses;
- Nevertheless, intermediaries have expressed their intention to promote financial products favoring sustainable projects with tangible characteristics (“green” loans, mortgages and bonds);
- Furthermore, companies “able to provide reliable information will tend to be perceived as more sustainable, with possible positive effects on access to external financing”;
- “Non-financial companies and intermediaries must intensify mutual collaboration. Sustainability information is certainly an important starting point”.

This deliverable wants to contribute exactly to these directions.

2.1.1 References

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3. Definition of ESG scores for SMEs through dedicated surveys

3.1 CRIF survey: preliminary activities for supporting Italian SMEs in collecting ESG information

3.1.1. The Context

This paragraph defines the preliminary activities involving CRIF within the GRINS project related to the definition of guidelines for Italian SMEs. The aim of the project is to support them in collecting ESG information in a unique and robust standard way to meet current and future regulatory requirements since the sustainability reporting obligation will be introduced gradually and will affect more and more companies¹¹.

The main objective is defining guidelines to be considered in the implementation of simple evaluation questionnaires and evolution of existing solutions to facilitate the disclosure

¹¹ Companies with more than 500 employees are already obligated to prepare and publish DNF in 2025 on the 2024 fiscal year. Companies with more than 250 employees and/or €40 million in sales and/or €20 million in total assets are obligated to reporting DNF in 2026 on fiscal year 2025. Listed small and medium-sized enterprises, excluding microenterprises, small and non-complex lending institutions and captive insurance companies must reporting DNF in 2027 on fiscal year 2026 and third-country firms with at least one branch in the European territory and a net turnover of €150 million in the EU must reporting DNF in 2027 publishing it starting from 2028.

activity objectives. Other objective is accelerating the maturity path of SMEs in the collection, management and sharing of ESG information.

Thanks to the participation in the [TranspArEEnS](#) project, UNIVE and CRIF have gained experience in defining ESG assessment questionnaires for SMEs in compliance with the main international standards. Moreover, the questionnaire serves as an essential tool for promoting the ESG culture and increasing market awareness.

CRIF's activities will be based on specific assessments and feedback gathered from key stakeholders such as market experts, and representatives of the banking sector, in order to define the most suitable approach to market needs.

Specifically, the preliminary activities are as follows:

- Analysis of existing tools on the market: the objective is to gather ESG information from Italian companies, also considering the experience gained in the TranspArEEnS project and its related outputs.
- Limitations of the questionnaire: identification of difficulties through the analysis of the Italian market, examining which information has not been shared in order to optimize the required informational scope.
- Proposed solution: suggestion of an initial solution based on empirical evidence derived from market analysis, but still consistent with regulatory requirements and guidelines from public sources (e.g., reflections carried out by ISPRA on Sustainable Finance¹²).

3.1.2. The market responses

To analyze and understand the weaknesses of existing tools, CRIF confronted with several banking industry experts and UNIVE participated to the working group of the Tavolo per la Finanza Sostenibile¹³ in charge of the discussion of the relevant information in the relationship between SMEs and Banks. These discussions deal with considerations on the

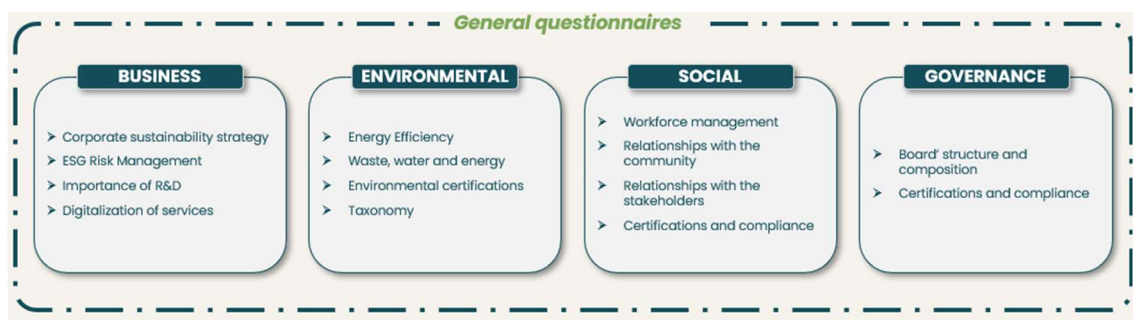
¹² <https://www.isprambiente.gov.it/it/events/la-sfida-ambientale-per-la-finanza-sostenibile>

¹³

https://www.dt.mef.gov.it/it/attivita_istituzionali/sistema_bancario_finanziario/finanza_sostenibile/Tavolo_finanza_sostenibile/

evolution of the regulatory framework, possible synergies with other ongoing initiatives, lessons learned from the market for the evolution of the questionnaire. It is clear that improving the usability of the questionnaire is a common objective of all stakeholders in order to facilitate a more accurate and rapid compilation by SMEs. A relevant objective is to individuate and adopt a single shared template that can become an "industry standard" questionnaire that complies as much as possible with the regulatory requirements to which banks and businesses are subject.

The large volume, granularity and type of information requested, according to the first feedback from the Italian market, led to several difficulties in recovering the high number of data mentioned above in a coherent and uniform way.



Focus on main information needs to be analyzed

3.1.3. Some evidences: limitations and preliminary ideas

In order to define a common language and to support Italian SMEs, the limitations and preliminary ideas emerged could be summarized as follows, also considering the results obtained with the TranspArEEnS project:

- **Uniformity:** the absence of a single standard questionnaire in the market (for example: the absence of a specific unit of measurement to be used in indicating annual electricity consumption resulted in some responses in thousands, and others in percentage value), the idea is sharing a standard defined by industry and market research;
- **Relevance:** the user experience is too articulate (for example: average age of Governing Body: 24% missing responses although all counterparts indicated the

form of their corporate governing body). The proposal is suggesting differentiated questionnaire based on complexity level and company size;

- **Simplicity:** the questions are complex; in fact, the analysis shows a high presence of missing responses (for example: total waste produced in a year: 51% missing responses or water consumed in a year: 13% missing responses). The solution could be using a “simple” language and prevalence of closed-ended or multiple-choice questions;
- **Quickness:** the presence of a high number of questions could be facilitate through request for information not retrievable automatically;
- **Focus:** the goals and benefits are unclear for companies; in fact the suggestion is to introduce questions about minimum regulatory requirements.

3.2 EFRAG Guidelines

3.2.1. The Context¹⁴

The European Corporate Sustainability Reporting Directive aims to create a single reporting standard at European level; the sustainability reporting standard must guarantee the quality of the information reported, requiring that it be understandable, relevant, faithfully represented and finally comparable with each other. Every three years, EFRAG¹⁵ will collaborate with the European institutions for the drafting and updating of the reporting standard.

Companies in the same sector are often exposed to similar sustainability risks and often have similar impacts on society and the environment. The sector-specific sustainability reporting standard is particularly significant in the case of sectors associated with high risks or impacts for environmental sustainability, human rights and governance.

The Commission has to ensure that the information specified by this reporting standard is proportionate to the extent of risks and impacts relating to sustainability issues specific to each sector. The sectors covered by the standard are: agriculture, mining and

¹⁴ See also the Regulatory Appendix.

¹⁵ European Financial Reporting Advisory Group

manufacturing, energy and water supply, construction, motor vehicle trade, transport, warehousing and real estate activities.

3.2.2. ESRS: The sustainability standards developed by EFRAG

The European initiative is part of a quite articulate context, where European and international (IFRS) initiatives overlap. There has been a clear political will from the main international coordination bodies in favor of G20 and IOSCO¹⁶ convergence.

ESRS standards are designed to support the European Green Deal and to be aligned with current European sustainability frameworks (for example: SFDR and EU Taxonomy).

EFRAG will continue to work with the ISSB¹⁷ to achieve interoperability and maximize convergence between the ESRS and the IFRS Sustainability Disclosure Standards. In addition, EFRAG has aligned the reporting areas to those used by the TCFD¹⁸ recommendations. Many reporting requirements are similar or based on these recommendations and standards developed by the GRI¹⁹.

3.2.3. EFRAG structure – ESRS and the application timing

With the issuing of the CSRD²⁰ by the European Union, the adoption of European standards for reporting becomes mandatory.

EFRAG is assigned the task of creating a draft standard for the sustainability report in the EU, the structure of the standard is composed of 4 reporting area (governance, strategy, management of impacts, risks and opportunities and metric and objectives), 3 reporting levels and 3 topics, which could be summarized as follow:

¹⁶ International Organization of Securities Commissions

¹⁷ International Sustainability Standards Board

¹⁸ Task Force on Climate-related Financial Disclosures

¹⁹ Global Reporting Initiative

²⁰ Corporate Sustainability Reporting Directive

- 4 Reporting Area
 - Governance – Information relating to governance on sustainability issues that must be provided by all companies
 - Strategy – Information relating to the strategy on all sustainability issues that must be provided by all companies
 - Management of impacts, risks and opportunities – For topics assessed as material, information on impacts, risks and opportunities should be provided
 - Metrics and Objectives – Metrics and objectives for all material topics; they must be provided by companies regardless of their sector
- 3 Reporting Levels
 - Sector-agnostic disclosure – Disclosure requirements applicable to all companies (for maximum comparability)
 - Sector-specific disclosure (standard under development) – disclosure requirements applicable to companies in a specific sector (for maximum relevance)
 - Company-specific disclosure – Additional disclosure requirements on material impacts, risks and opportunities, not covered by the Topical standard
- 3 topics
 - Environmental information (climate change, pollution, water and marine resources, biodiversity, use of resources and circular economy)
 - Social information (workforce, value chain workers, affected communities, consumers/end users)
 - Governance information (business conduct)

On the 22nd of November 2022, after a period of public consultation, EFRAG proposed to the European Commission a first package of twelve points of ESRS divided into two macro-areas:

- 2 cross-cutting standards: standards that do not concern a specific sustainability topic
- 10 topic-specific cross-sector standards: standards that refer to 3 ESG areas, specifically:

- 5 environmental standards (climate change, pollution, water and marine resources, biodiversity and ecosystems, resources use and circular economy)
- 4 social standards (workforce, value chain workers, affected communities, consumers and end-users)
- 1 governance standard (business conduct)

The ESRS standards address three types of companies²¹ and according to the architecture developed by EFRAG, the Sectors will have to be completed by a series of "Sector Specific" standards.

These standards will require information relating to specific ESG risks, impacts and opportunities based on the sectors to which the companies belong in order to guarantee the maximum relevance of sustainability disclosures.

The classification of sectors is based on the European Classification of Economic Activities (NACE) and the classifications made in the EU Taxonomy. Approximately 40 sectors grouped into 14 macro-groups have been identified (Agriculture, Construction, Energy, Entertainment, Financial Institution, Health Care, Manufacturing, Mining, Sales and Trade, Services, Technology, Transportation, Real Estate).

3.3 General guidelines for an efficient ESG questionnaire

The ESG questionnaire represents the most effective tool for the collection of useful data for the implementation of the standardized framework for the collection of EE-ESG data on European SMEs.

Thanks to the study of the EFRAG directive, the analysis conducted by CRIF and all the comparisons carried out with working groups made up of experts and institutions in such a

²¹ Large unlisted companies that have passed at least two of the following criteria: 250 employees, 20 million euros in the balance sheet, 40 million euros in net revenues; Small and medium-sized listed companies; Companies and subsidiaries of branches with non-EU parent companies for which the parent company has generated net revenues in the EU exceeding €150 million for each of the last two consecutive financial years and at least: a subsidiary company meets the size requirements of the CSRD, a branch has generated net revenues exceeding 40 million euros in the previous financial year.

way to also respect their expectations and reflections in merit, it is possible to confirm that the general guidelines reported in paragraph 3.1 are effective for defining an efficient ESG questionnaire. These guidelines can be summarized in the commitment to:

- i) differentiate the questionnaires based on the level of complexity and company size;
- ii) promote ease of understanding and filling out;
- iii) focus on information in compliance with the evolving regulatory framework.

4. The relationship between credit risk and ESG

4.1 The Context

An efficient collection of the ESG information and data is very important for various reasons: one is that the Italian market potential is enormous, 92% of Italian companies are non-listed SMEs, which are the most representative type of enterprises in the Italian and European production system. As already underlined, small medium-sized enterprises (SMEs) in Italy represent the backbone of the country's economic and industrial manufacturing. Furthermore, the financial exposure to credit institutions is relevant: for example, a medium-sized Italian bank has more or less 400.000 active clients with a financial exposure of 24 billion of euros.

In the next paragraphs it is highlighted the correlation between ESG scores and the impacts on credit risks score²², along with an example of the distribution of ESG profiles of SMEs in the Veneto region.

²² Analysis reported in CRIF Market Outlook

4.2 ESG adequacy and credit risk

CRIF has developed an automatic score²³ which is used by almost the entire Italian banking system to measure credit risk of businesses. It serves as the starting point for the ratings credit cards issued by CRIF Ratings, registered with European Security and Markets Authority (ESMA) and accepted by the European Banking Authority (EBA) as the External Credit Assessment Institutions (ECAI) within the standard approach for measuring credit risk.

In this analysis, the credit score is compared to the ESG score in order to understand whether a better ESG profile is also reflected in (or in any case is connected to) credit risk of companies entrusted by the Italian banking system. *Figure 1* reports the default rates, observed in 2023, on a sample of companies present in the CRIF data ecosystem, corresponding to different combinations of credit score²⁴ (on the columns) and ESG scores (on the rows). It is interesting to observe how default rates reduce significantly as the growth of the counterparties ESG adequacy.

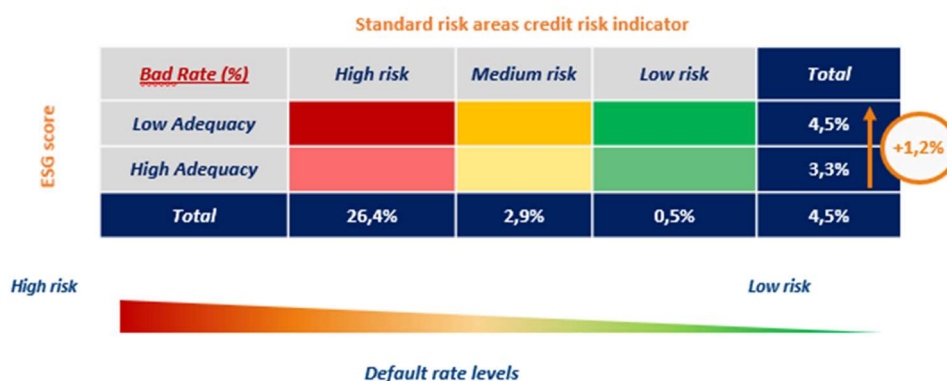


Figure 1. Distribution of bad rate by ESG score class and CRIF credit score (source CRIF)

The interaction between credit scores and ESG, on the one hand, could make the credit scores more precise thanks to the addition of information not yet inside in a traditional risk estimation models probability of default and, on the other hand, it allows Banks to direct their policies of delivery by focusing on the following possible clusters:

²³ Based on personal and performance information deriving from EURISC (the Credit Information system of CRIF) and estimated through proprietary models

²⁴ Particularly low or high credit score values excluded.

- companies with satisfactory credit ratings, but with a level of ESG adequacy still low: these businesses could be supported through loans dedicated to transition towards more sustainable structures;
- companies with high credit risk and modest level of ESG adequacy: these companies appear more vulnerable to risks that are not perfectly appreciated by current internal rating models and could be subject to gradual procedures of disinvestment.

Observing the 2023 CRIF data relating to the disbursement of loans to Banks in the Italian system, it is highlighted that companies with ESG scores with high adequacy (high or very high score) are more advantaged in terms of access to credit.

Figure 2 reports the amount requested is independent of the level of ESG adequacy and the amount paid is highly dependent on the level of ESG adequacy.

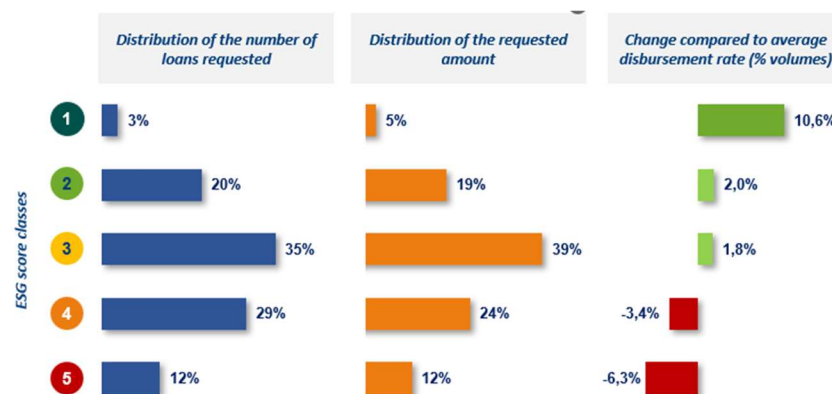


Figure 2. Correlation between credit policies and ESG score (source CRIF)

Analyzing the default rates in the banking system, companies with a high ESG score adequacy (high or very high score - classes 1 and 2) appear less risky than the average of the sample analyzed.

Figure 3 reports that the ESG score efficiently discriminates the risk level of companies requesting credit and the report is confirmed on the post-acceptance portfolio.

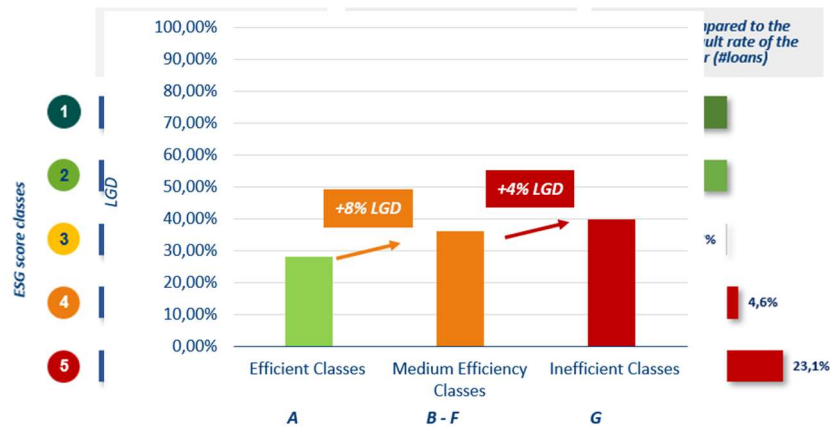


Figure 3. Correlation between credit risk and ESG score (source CRIF)

The following pictures highlight some market insights based on various use cases, experiences, and CRIF benchmarks relating to the integration of ESG factors into credit risk parameters.

Figure 4 reports the discriminatory power of the EPC (Energy Performance Certificate) with respect to the losses observed on the NPL portfolio relating to individuals' mortgage products.

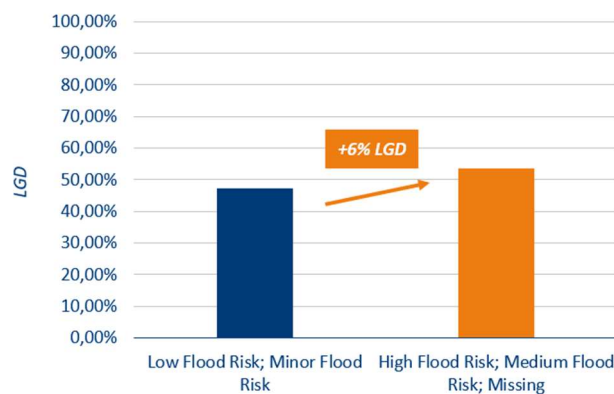


Figure 4. Correlation between energy efficiency classes and LGD (source CRIF)

Figure 5 reports the discriminatory power of the physical flood risk variable with respect to the losses observed on the NPL portfolio relating to the corporate mortgage products.

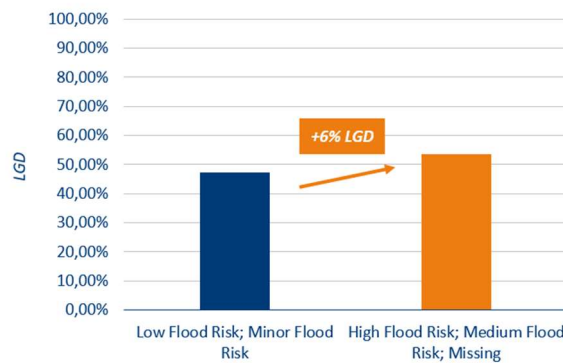


Figure 5. Correlation between flood risk and LGD (source CRIF)

Figure 6 reports the discriminatory power of transition risk variable respect to the probability of default of the specific business portfolio, comparing the impacts of the different stress scenarios on the lifetime PDs.

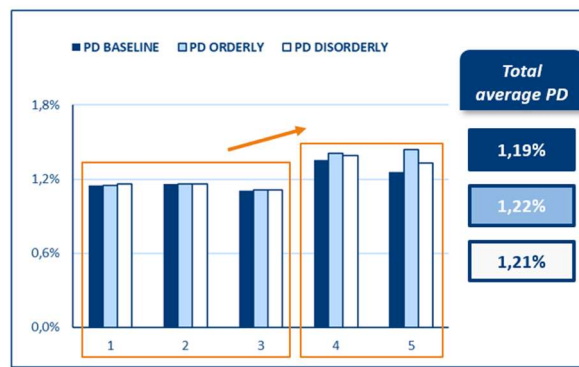


Figure 6. Correlation between transition risk and PD (source CRIF)

4.3 ESG profile analysis of the Veneto region SMEs

Starting from an ESG regulation framework at European level, a focus was carried out on SMEs belonging to the Veneto region to understand the state of the art of Italian SMEs in relation to the topic of sustainability and the different peculiarities that characterized them. From the available sample, appropriately stratified to represent the reality of the Italian territory and in synergy with the GRINS Project, a focus has been conducted on ESG issues relating to 10k companies.

All the companies have been analyzed under the geographical area (*Figure 7*), the sector (*Figure 8*) and the dimension (*Figure 9*); below all the figures with the details.

It should be noticed that the most representative geographical areas (both in terms of numbers and exposure) are Verona, Padua, Venice, Vicenza, Treviso; the wholesale sector has the highest financial exposure (14%) and the 98% of the companies analyzed belong to the SMEs sector, with a financial exposure equal to 70% of the total sample.

Geographical Area	Companies	Financial Exposure
Verona	25%	27%
Padua	20%	17%
Venezia	18%	12%
Vicenza	16%	21%
Treviso	15%	17%
Rovigo	5%	4%
Belluno	1%	2%

Figure 7. Geographical area (in terms of numbers and financial exposure) of the companies analyzed

Sector	Companies	Financial Exposure
Wholesale	13%	14%
Other services	10%	4%
Real Estate	10%	9%
Retail	9%	5%
Manufacture	9%	5%

Figure 8. Sector (in terms of numbers and financial exposure) of the companies analyzed

Turnover size class	Companies	Financial Exposure
Micro < 2 mln	72%	23%
Small <10 mln	17%	20%
Medium <50 mln	9%	27%
Large >50 mln	2%	30%

Figure 9. Dimension (in terms of numbers and financial exposure) of the companies analyzed

4.3.1 Distribution of ESG scores

In the graph below (*Figure 10*), it is reported the distribution of the ESG score on the number of SMEs companies and the financial exposure value. Smaller companies are on average less adequate from an ESG perspective. The overall distribution is more influenced by the behavior of SMEs than large companies, in fact as reported in the previous paragraphs, SMEs in Italy represent the backbone of the country's economic and industrial manufacturing.

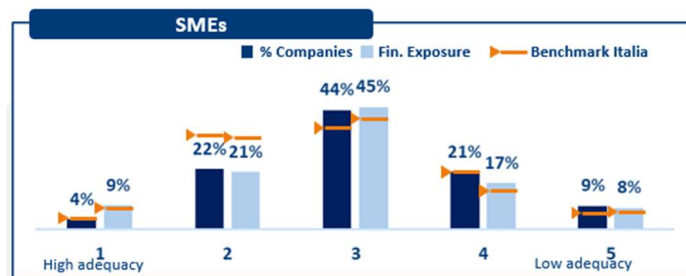


Figure 10. SMEs - distribution of ESG score

4.3.2 ESG Score – Distribution by sector

Figure 11 represents the distribution of the ESG score of the five sectors with a better adequacy profile. The most suitable sectors from an ESG perspective are mainly linked to the world of services, especially due to the Environmental component which presents a high degree of adequacy within the sectors mentioned (mainly due to the low transition risk score). Among the sectors represented, there is a lower degree of adequacy of companies in the "Leisure" sector led by the Governance component.

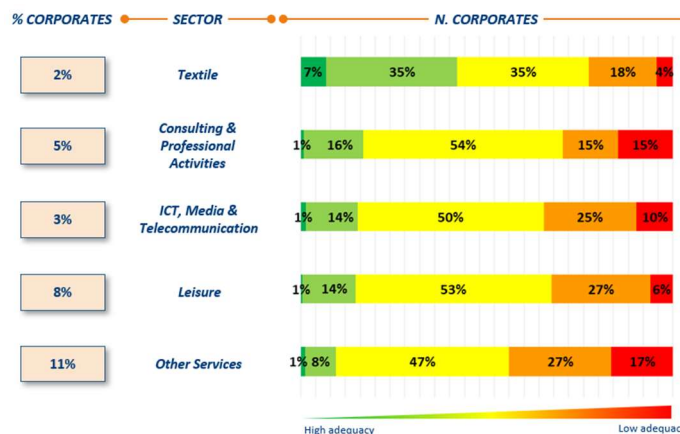


Figure 11. ESG score - distribution by sector

4.3.3 ESG Score – Geographical area distribution

Figure 12 shows the distribution of the ESG score of the Veneto provinces sorted by values of greatest adequacy. The provinces with the best ESG profile (classes 1 and 2) are Vicenza, Treviso and Padua. The high degree of adequacy depends above all on a low Environmental component score (physical risk score in particular). The provinces of Belluno and Rovigo appear to have a worse ESG profile (class 4 and 5). The latter provinces are negatively impacted by the Environmental component, in particular by physical risk.

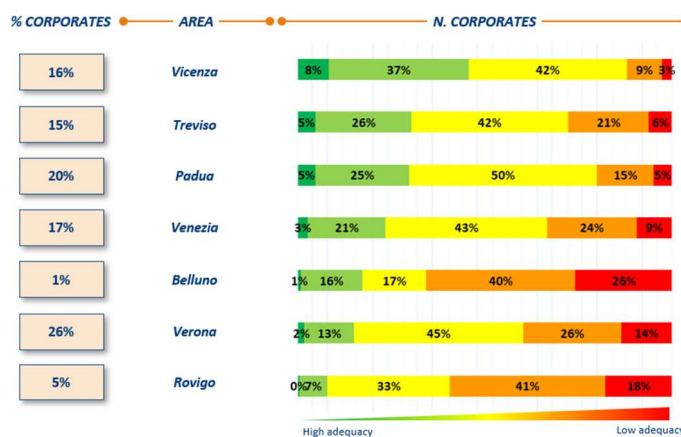


Figure 12. ESG score – geographical area distribution

4.3.4 Physical Risk

In the Figure 13, the 28% of the counterparties appear to be affected by a high physical risk (classes 4 and 5). Compared to the Italian market, companies in the Veneto region are less impacted by high physical risk, with a greater concentration in the central class. For companies most exposed to physical risk, a path of awareness of these components must be undertaken through adaptation activities, thus making the expected impacts at a structural level less serious.

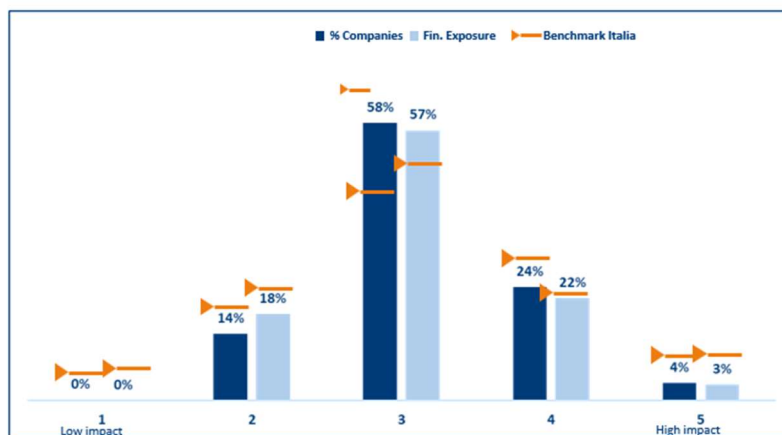


Figure 13. Distribution of physical risk over the number of companies and financial exposure values

4.3.5 Physical Risk – Geographical area distribution

The provinces most exposed to physical risk are the provinces of Belluno and Rovigo, where the percentage of companies with physical risk scores in the worst classes (4 and 5) exceeds 70% (Figure 14). In general, Veneto territory appears to be exposed to risk factors characteristic of the geographical area, such as earthquakes (Belluno is in a highly seismic area), floods, heavy rainfall and rising sea levels (especially in the province of Venice and in coastal areas).

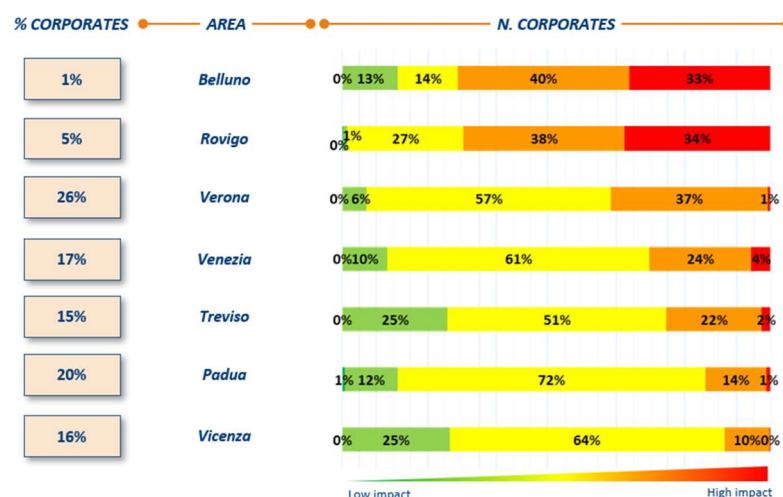


Figure 14. Distribution of Physical Risk score by province sorted by values of greatest risk

4.3.6 Transition risk

The transition score presents most counterparties and exposure in the least impact classes (1, 2, 3). Compared to the market, Veneto has fewer companies in the classes with the greatest impact (4, 5). As expected, companies most exposed to transition risk need greater investments to address the sustainable transition process. From the graph (*Figure 15*) it is possible to see that the use of financial debt is one of the paths taken to cope with this type of investment.

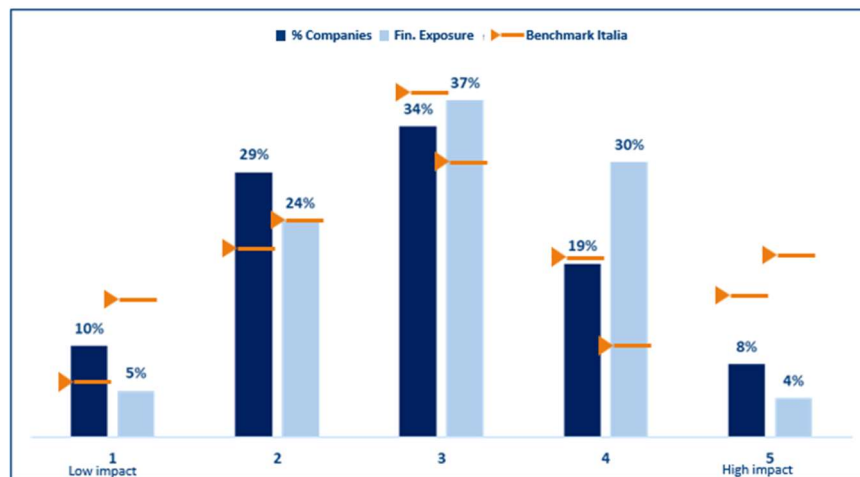


Figure 15. Distribution of transition risk over the number of companies and the exposure value

4.3.7 Transition risk – Distribution by sector

The sectors most exposed to transition risk are "car sales", "food industry" and "agriculture" (*Figure 16*). The high impact on these sectors is identified under various analysis drivers: for the agricultural sector in the higher costs related to the transition from the use of chemical substances to less polluting products, for the car sale sector, in the adaptation of automotive assets powered by fossil fuels, for food sector, the change in available raw materials will lead to the creation of new eating habits.

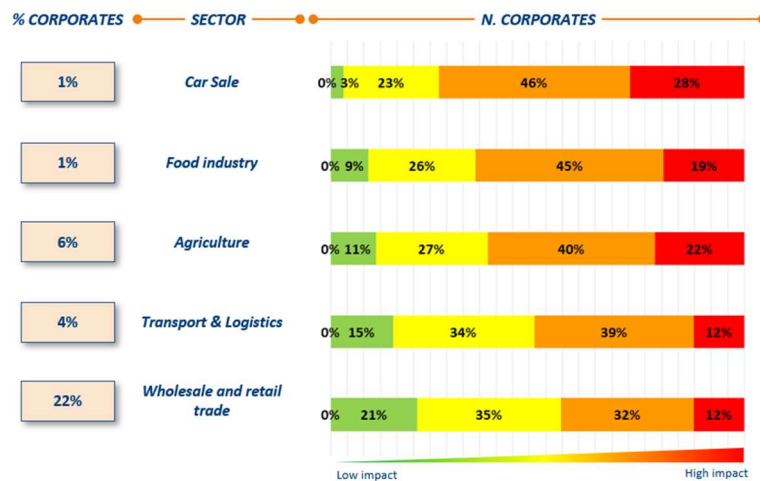


Figure 16. Distribution of transition risk over the sectors

5. ESG adjusted credit ratings: the indirect approach²⁵

5.1 The Context

This session introduces a new approach to integrate ESG information in credit rating models, denominated “indirect approach”. The proposed indirect approach is defined by a complete system of assumptions compliant with the regulatory framework and allowing the definition of a methodology that is technically feasible for the banking system and fully compliant with the European sustainability reporting. In particular, the feasibility for banks is obtained by limiting the adjustment only to the financial module of the current internal rating models and considering only financial variables homogeneously available for all firms. Moreover, the compliance with European regulation is obtained by adopting the financial materiality criterion and by focusing the input information on the financial plan integrating the implementation of the firm’s sustainability plan. Finally, the approach implies

²⁵ Authors: Monica Billio, Andrea Giacomelli, Department of Economics, Ca' Foscari University of Venice

a long-run credit risk assessment, which is necessary to make the creditworthiness assessment consistent with the time horizons of the transition processes and defined in the sustainability plan and the duration of the exposures to finance them.

The integration of ESG sustainability information, also related to climate change risk, into credit risk assessment of non-financial firms, is required by different regulatory sources and different regulators and all these sources explicitly recall the European regulatory framework on ESG disclosure by non-financial firms. This integration is a relevant topic that presents many open issues, on which there is currently very limited literature. Moreover, the analysis of existing literature highlights very different approaches, based on assumptions that are often opposed to each other and consequently imply significant divergences in terms of interpretation and applications.

In this session it is proposed a new approach to integrate ESG information in credit rating models, denominated “indirect approach”. The approach pursues the following two main objectives: compliance with European sustainability reporting and technical feasibility for the banking system. In particular, the feasibility for banks is obtained by limiting the indirect adjustment to the financial module of the current internal rating models, considering only financial variables homogeneously available for all firms, without extending the model specification to ESG variables.

Moreover, the compliance with European sustainability reporting is obtained by adopting the financial materiality criterion and by focusing the input information on the financial plan integrating the implementation of the firm’s sustainability plan.

5.2 Literature review

The literature having significant banking supervision implications includes both academic papers and regulators’ discussion papers.

In recent years, the analysis of the impact of firms’ ESG performance on their credit quality has become a topic of great interest also for academia. We present a brief overview of the relevant literature and its major conclusions. Overall, a positive correlation between higher ESG risk (low ESG performances) and higher credit risk is documented.

5.2.1 Accademic papers

Altavilla, C., Pagano, M., Boucinha, M., & Polo, A. (2023). Climate Risk, Bank Lending and Monetary Policy. CSEF Working Papers(687). Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy.

Combining euro-area credit register and carbon emission data, we provide evidence of a climate risk-taking channel in banks' lending policies. Banks charge higher interest rates to firms featuring greater carbon emissions, and lower rates to firms committing to lower emissions, controlling for their probability of default. Both effects are larger for banks committed to decarbonization. Consistently with the risk-taking channel of monetary policy, tighter policy induces banks to increase both credit risk premia and carbon emission premia, and reduce lending to high emission firms more than to low emission ones. While restrictive monetary policy increases the cost of credit and reduces lending to all firms, its contractionary effect is milder for firms with low emissions and those that commit to decarbonization.

Aslan, A., Poppe, L., & Posch, P. (2021). Are Sustainable Companies More Likely to Default? Evidence from the Dynamics between Credit and ESG Ratings. *Sustainability*, Vol. 13(No. 5), 8568.

Investigate the relationship between environmental, social and governance (ESG) performance and the probability of corporate credit default. The sample used for the analysis included 902 publicly listed firms in the US from 2002 to 2017. The probability of corporate credit default is computed converting Standard & Poor's credit ratings into default probabilities using rating transition matrices. A regression analysis is conducted for investigate the relationship between ESG performance and the probability of corporate credit default. The results reveal that the probability of corporate credit default is significantly lower for firms with high ESG performance. Furthermore, by expanding the time window in the analysis, the results show that the influence of ESG performance strongly varies over time, probably due to financial and regulatory shocks.

Bannier, C. E., Bofinger, Y., & Rock, B. (2022). Corporate Social Responsibility and Credit Risk. *Finance Research Letters*(No 44 (C)). Elsevier.

Assess the effects of corporate social responsibility on credit risk for all publicly listed firms in the U.S. and in the EU that received CSR ratings from Thomson Reuters over the time period 2003 to 2018. The results reveal that, differentiating between the various facets of corporate social responsibility, for U.S. firms only the environmental aspects are connected to a reduction of credit risk, whereas both environmental and social aspects do so only for European firms. The paper also shows that credit ratings do not reflect these credit-risk reducing effects of corporate social responsibility.

Barth, F., Hübel, B., & Scholz, H. (2022). ESG and corporate credit spreads. *Journal of Risk Finance*, Vol. 23(No. 2), pp. 169-190.

Investigate how credit spreads of European firms are related to their environmental, social, and governance (ESG) performance. European and U.S. firms are compared considering nonlinear and indirect effects. The analysis is conducted applying fixed effects regressions on a comprehensive panel data set of U.S. and European firms from 2007 to 2019. Further, nonlinear and indirect effects are investigated utilizing quantile regressions and a path analysis. The results reveal that higher ESG ratings mitigate credit risks of U.S. and European firms. The risk mitigation effect is U-shaped across ESG quantiles, which is consistent with opposing effects of growing stakeholder influence capacity and diminishing marginal returns on ESG investments.

Battiston, S., Mandel, A., Monasterolo, I., & Roncoroni, A. (2023). Climate credit risk and corporate valuation. Available at SSRN: <https://ssrn.com/abstract=4124002> or <http://dx.doi.org/10.2139/ssrn.4124002>.

Shed light on what could be the level of potential carbon risk implied by alternative future climate policy scenarios. A novel climate credit risk model for climate scenario-contingent valuation links the firm's default probability to the climate scenarios developed by financial authorities. Changes in markets' expectations about the materialization of climate transition scenarios lead to adjustments in the firms' default probability and a closed-form expressions is derived for adjustments in bond and equity valuation. Results show that valuation adjustments vary greatly with the severity of decarbonization scenarios and the energy technology composition of the firms' revenues. Losses in equity values can range up

to 80% for firms focusing on fossil fuel activities but can be much lower for firms with diversified energy technology profiles.

Bonacorsi, L., Cerasi, V., Galfrascoli, P., & Manera, M. (2024). ESG Factors and Firm's Credit Risk. Journal of Climate Risk Finance (6).

Aims to build an augmented model for credit risk where ESG factors help predicting the company's credit risk. This study explores the relationship between credit risk and ESG dimensions using Supervised Machine Learning (SML) techniques on a cross-section of 1.000 European listed companies. The proxy for credit risk is the Altman's z-score. An extensive number of raw ESG factors sourced from the rating provider MSCI are considered as potential explanatory variables. In the first stage, by using different SML methods, it is demonstrated that a selection of ESG factors, in addition to the usual accounting ratios, helps explaining a firm's probability of default. In the second stage, the impact of the selected variables on the risk of default is measured. The study shows that firms with a significant portion of revenues tied to carbon emissions or green building face a higher credit risk, whereas hiring more skilled workers reduces credit risk. Moreover, companies located in regions with stricter carbon emission regulations or in regions with better data protection exhibit lower credit risk. More importantly, the results provide evidence of the benefits of stricter regulation and greater disclosure on the ESG dimensions as they indirectly improve the merit of credit of companies.

Capasso, G., Gianfrate, G., & Spinelli, M. (2020). Climate Change and Credit Risk. Journal of Cleaner Production (No 266). Elsevier.

Examine the relationship between exposure to climate change and the credit risk of European firms. The results reveal that the distance-to-default, a measure of corporate default risk, is negatively associated with the amount of firm's carbon emissions and with carbon intensity. Therefore, *ceteris paribus*, firms with high carbon footprint are perceived by the market as more likely to default. The carbon footprint decreases the distance-to-default following shocks – such as the Paris Agreement – that reveal policymakers' intention to implement stricter climate policies. Overall, the results indicate that the exposure to climate risks affects the risk profile of loans and bonds issued by firms. Thus, the paper states

that financial regulators and policymakers should carefully consider the impact of climate change risks on the stability of both lending intermediaries and corporate bond markets.

Carbone, S., Giuzio, M., Kapadia, S., Kramer, S., Nyholm, K., & Vozian, K. (2021). The low-carbon transition, climate commitments and firm credit risk. European Central Bank Working Paper Series (No 2631).

Evaluate how firms' credit risk is influenced by the transition process to a low-carbon economy. The sample used for the analysis considers all the non-financial firms of the stock indices S&P 500 and STOXX Europe 600 for which a credit rating issued by S&P or Moody's was available. Thus, the sample considers a set of 558 firms for the period 2010 to 2019. For all the firms included in the sample further data are collected both on financial and environmental performances. The environmental performance is described by data on firms' greenhouse gas emissions over time with information on climate disclosure practices and forward-looking emission reduction targets, thereby providing a rich picture of firms' climate-related transition risk alongside their strategies to manage such risks. Then, the paper assesses how such climate-related metrics influence two key measures of firms' credit risk: credit ratings and the market-implied distance-to-default. The results reveal that high emissions tend to be associated with higher credit risk. But disclosing emissions and setting a forward-looking target to cut emissions are both associated with lower credit risk, with the effect of climate commitments tending to be stronger for more ambitious targets. These results have strong policy implications for corporate disclosures and strategies around climate change and the treatment of the climate-related transition risk faced by the financial sector.

Chodnicka-Jaworska, P. (2021). ESG as a Measure of Credit Ratings. Risks(9), 226. Basel, Switzerland: MDPI.

Analyse the impact of environmental, social, and governance (ESG) measures on credit ratings given to non-financial institutions by Fitch and Moody's according to economic sector divisions. The analysis is conducted using ESG information and credit ratings of non-financial firms proposed by Moody and Fitch for a sample of 9521 firms from European countries. The final models presented in the paper rely on the database for 2010 and 2020.

The *a priori* hypotheses, regarding the relation between ESG risk and credit ratings, are the following: a strong negative impact on non-financial institutions' credit rating changes will result from ESG risk changes, and the reaction of credit rating changes will vary in different sectors. To verify these hypotheses, the paper uses panel event models. The results reveal that all the three factors are characterized by a significant positive correlation with Moody's and Fitch credit ratings: Environmental Pillar Score, Social Pillar Score and Corporate Governance Pillar Score. Environmental Pillar Score has been identified as the most relevant of the three, leading to the conclusion that a firm's environmental policy can reduce its default risk.

Hao, L., Xuan, Z., & Yang, Z. (2022). ESG and Firm's Default Risk. *Finance Research Letters*, 47(PB). Elsevier.

Authors investigate the implications of ESG practices of Chinese listed firms on their default risk. We explore the relationship between default risk and ESG ratings. Applying year-by-season and firm fixed effects, we find that higher ESG ratings mitigate firms' default risk. The mitigation effect increases as the term structure of default risk increases. We find that the magnitude of ESG rating's impact on firms' default risk is smaller for manufacturing firms than non-manufacturing firms. Our findings suggest that credit markets well reflect the ESG practices of firms; investors may improve credit risk management by considering the ESG performances of firms.

Höck, A., Klein, C., Landau, A., & Zwergel, B. (2020). The effect of environmental sustainability on credit risk. *Journal of Asset Management*(21).

The European Commission has proposed establishing a framework that redirects capital to sustainable investments in order to foster sustainable economic growth. A key proposal from this framework is the mandatory consideration of environmental criteria for investment decisions. However, in particular for bond investors, there is not much academic guidance on how to integrate sustainability criteria in the investment process. Hence, this study investigates the impact of environmental sustainability on the pricing of credit risk for European corporations. Furthermore, whether or not the credit worthiness of a corporation has a moderating effect on the relationship between the environmental sustainability and

the credit risk premium is analysed. The findings prove that more sustainable companies have lower credit risk premiums if they also have a high credit worthiness.

Kabir, M., Rahman, S., Rahman, M., & Anwar, M. (2021). Carbon emissions and default risk: International evidence from firm-level data. *Economic Modelling*(103(C)). Elsevier.

Investigate the effect of carbon emissions on firms' default risk. While existing literature exhibits the implications of emissions for firm performance and value, little is known about its impact on the default risk and underlying economic channels of the impact. Using a panel dataset of 2785 unique firms over the period 2004–2018 from 42 economies, we document a significant and negative impact of emissions on firms' distance-to-default, a reverse measure of default risk. We also provide evidence that firms' environmental commitments and green initiatives mitigate the effect of emissions on default risk while environmental controversies exacerbate the effect. Finally, we identify the ROA and cash flow volatility as potential channels through which emissions affect the default risk. Overall results suggest that credit risk implications of firm-level emissions are worth considering in policy decisions by relevant stakeholders.

Michalski, L., & Low Yew Kwong, R. (2024). Determinants of corporate credit ratings: Does ESG matter? *International Review of Financial Analysis*(94).

Investigate if ESG variables are determinants of corporate credit ratings. The study performs an empirical evaluation of fourteen multinomial classifiers in the prediction of credit ratings on a large dataset consisting of macroeconomic, firm-level financial, and ESG variables. The study shows that environmental and social responsibility variables are important determinants for the credit ratings, specifically measures of environmental innovation, resource use, emissions, corporate social responsibility, and workforce determinants. The influence of ESG variables become more pronounced following the financial crisis of 2007–2009, and are important across both investment-grade and speculative-grade classes.

Safiullah, M., Kabir, M., & Miah, M. (2021). Carbon emissions and credit ratings. *Energy Economics*(100(C)). Elsevier.

Examine the impact of firm-level carbon emissions on credit ratings, drawing on a sample of 3116 firm-year observations over the period 2004–2018 in the context of U.S. We find a negative, economically meaningful impact of carbon emissions on credit ratings. This finding remains robust when we employ the instrumental variable approach, difference-in-differences approach, and propensity score matching estimates to address potential endogeneity concerns. Our channel analysis reveals that firms that emit high carbon face higher cash flow uncertainty, which in turn, results in lower credit ratings.

5.2.2 Reports & discussion papers by Regulators

Following the developments in the scientific literature and the increasing need to address the issues of ESG risk management for the banking sector and credit institutions, authorities have produced reports and discussion papers on the topic, which constitute the basis of discussion for subsequent regulatory proposals. Two relevant EBA papers on how to include Environmental, Social and Governance (ESG) risks into the first and second pillars of the banking prudential framework are discussed below²⁶:

European Banking Authority. (2021, June 23). *Report on management and supervision of ESG risks for credit institutions and investment firms*. EBA/REP/2021/18.

The EBA has received several mandates to assess how to include Environmental, Social and Governance (ESG) risks into the three pillars of the banking prudential framework. This report assesses their potential inclusion in **Pillar 2** by providing common definitions of ESG risks, elaborating on the arrangements, processes, mechanisms and strategies to be implemented by credit institutions and investment firms (institutions) to identify, assess and manage ESG risks, and recommending how ESG risks should be included in the supervisory review and evaluation performed by competent authorities. The report focuses on the resilience of institutions to the potential financial impact of ESG risks across different time horizons, which needs to be carefully assessed and ensured by institutions and supervisors by taking a comprehensive and forward-looking view, as well as early, proactive actions.

²⁶ With regard to the inclusion of ESG risks into the third Pillar EBA has published the “Final draft implementing technical standards on prudential disclosures on ESG risks in accordance with Article 449a CRR”. Since these ITS drafts already represent a regulatory outline, they are discussed in the specific section “Sources of regulation on ESG and Credit Risk”

In this report, EBA defines ESG risks as risks that stem from the current or prospective impacts of ESG factors on the institutions' counterparties or invested assets. Thus, ESG risks materialise through the traditional categories of financial risks (credit risk, market risk, operational and reputational risks, liquidity and funding risks).

EBA identifies different approaches for the assessment of ESG risks. An interesting one is called "*The Exposure Method*". This approach is a tool that institutions can apply directly to the assessment of individual counterparties and individual exposures, even in isolation. The basic principle of this approach is to directly evaluate the performance of an exposure in terms of its ESG attributes. This can then be used to complement the standard assessment of financial risk categories. Indicators used for this assessment are typically calibrated at company level, taking into account granular sector level characteristics to capture the specific sensitivities to ESG factors of different segments and sub-segments of economic activity. Notably, this method covers all three aspects of ESGs, whilst many of the other approaches and tools tend to focus predominantly on climate risk to date.

European Banking Authority. (2022, May 02). Discussion Paper – The role of environmental risk in the prudential framework. EBA/DP/2022/02.

This report assesses the potential inclusion of ESG risks in Pillar 1, raising the question whether the actual prudential framework can sufficiently account for these new risk drivers.

EBA provides an initial assessment on how the actual prudential framework interacts with environmental risks and poses questions on whether adaptations are required to effectively address such risks. The analysis is focused on exposures related to assets and activities associated with environmental objectives/impacts. Those related to social objectives/impacts will be considered in the next steps.

In the conclusions, EBA demonstrates that the Pillar 1 framework already includes mechanisms that allow the inclusion of new types of risk drivers such as those related to environmental risks. These include internal models, external credit ratings and valuations of collateral and financial instruments. In addition, the paper considers the forward-looking nature of environmental risks and puts up for discussion the use of forward-looking methodologies.

As an alternative to recognising environmental risks within the existing framework, the potential introduction of specific risk-weighted adjustment factors is considered. The initial analysis indicates that targeted amendments to the existing prudential requirements would address these risks more accurately than such adjustment factors, given the various challenges associated with their design and implementation. Finally, while there is potential for the existing framework to capture environmental risks, the way in which such risks translate into financial risks over time remains an area of significant uncertainty.

5.3 Credit rating models: the current practice

This paragraph describes the main features of the credit rating model estimation process currently adopted by banks for the corporate counterparty segment. Some examples of models developed by main European banks are provided to highlight the homogeneity of some characteristics.

This description allows in the following Section 6 to indicate which features of the current models must be modified, according to the approach presented in this paper, to integrate the ESG information.

5.3.1 Main steps in developing a credit rating model

Credit rating models are pivotal tools for supporting banks in their processes of loan origination and monitoring. The main objective of credit rating models is the estimation of a counterparty's probability of default within a determined time horizon (typically one year), in order to classify the counterparties included in a bank's portfolio according to their degree of credit risk.

Commonly, the process for developing internal credit rating models is articulated in four main steps, the first of which includes 3 sub-steps:

STEP 1: Data collection, definition of model structure and methodological approach

STEP 1.1 Data collection and sampling

STEP 1.2 Model structure

STEP 1.3 Methodological approach (statistical methodology)

STEP 2: Univariate analysis

STEP 3: Multivariate analysis

STEP 4: PD calibration and mapping to the master scale

It must be highlighted that credit rating models are differentiated according to the type of the analysed counterparty (e.g., corporates, retails, sovereigns or banks). Therefore, being the ones on which this paper focuses, credit rating models for corporate counterparties we will discuss it in the following paragraphs, where each of the abovementioned four steps for developing a credit rating model for corporates will be analysed.

STEP 1: Data collection, definition of model structure and methodological approach

STEP 1.1: Data collection and sampling

As said above in this paragraph, the main objective of a credit rating model is the estimation of a counterparty's probability of default within a determined time horizon. Therefore, the Step 1.1 requires that, after identifying a corporate sample on which to conduct the analysis, a "long list" of explanatory factors, which are supposed to be predictors of a counterparty's default, must be defined.

The factors supposed to be potential predictors of default must be identified with regard to different information areas, in order to analyse a counterparty's creditworthiness from different points of view. As regards corporate counterparties, the following four information areas are usually identified:

1. Financial: the factors belonging to this area rely on accounting data on the financial performance of the counterparty; therefore, these data are mainly derived from the financial statements of the counterparties. A non-exhaustive example of financial factors that can be considered in a credit rating model are listed below:

- Cash
- Equity
- Fixed assets

- Gross margin / Capital employed
- Net margin / Equity

2. Internal behavioural: the factors belonging to this area rely on data about the counterparty behaviour with the lending bank; therefore, these data are derived from internal information of the lending bank. A non-exhaustive example of internal behavioural factors that can be considered in a credit rating model are listed below:

- Average balance / Withdrawn facilities limit
- Withdrawn facilities outstanding / Withdrawn facilities limit

3. External behavioural: the factors belonging to this area rely on data about the counterparty behaviour with the banking system; therefore, these data are usually derived from credit bureaus. Credit bureaus are data collection agencies that provide the financial system with information on the credit standing of counterparties. A non-exhaustive example of external behavioural factors that can be considered in a credit rating model are listed below:

- Withdrawn facilities outstanding toward the banking system (evaluating bank excluded) / Withdrawn facilities limit toward the banking system (evaluating bank excluded)
- Unauthorized drawn toward the banking system (evaluating bank excluded)

4. Qualitative: the factors belonging to this area rely on qualitative judgment expressed by relationship managers; therefore, these data are directly derived from the knowledge of relationship managers. A non-exhaustive example of qualitative factors that can be considered in a credit rating model are listed below:

- What percentage of assets is not linked strategically to the company's business?
- If a business plan has been developed, has the proposed strategy been implemented?
- Does the company's official financial forecast appear realistic?

Therefore, four long list of explanatory factors are defined, one for each information area. After their definition, it is necessary, for each of the identified factors, to conduct a preliminary sample analysis verifying the data quality and having sufficient observation depth to conduct robust statistical analysis.

It is then possible to move on to the following sub-steps for the definition of the model structure and the methodological approaches to be used.

STEP 1.2: Model structure

After defining the long lists of explanatory factors for the four information areas (Step 1.1) it is necessary to define the structure of the credit rating model to be implemented.

International best practices for the development of credit rating models relies on **modular models**, where the number of modules required for the credit rating model is equal to the number of the identified information areas.

The reason for using modular models lies in the fact that, as seen for the previous Step 1.1, the factors belonging to the four information areas can be of different types and with different observation frequencies. Therefore, it is necessary to process such data using specific methodologies and expertise. Thus, a credit rating model for corporate counterparties has to rely on four different modules:

1. **Financial module:** the input of the financial module are the financial factors identified in the Step 1.1. This module is thus fed with accounting data on the economic and financial performance of a counterparty which are derived mainly from its financial statement. The main output of the financial module is a **financial credit score** ($Score_F$), an ordinal value that sorts the creditworthiness of the bank's counterparties depending on their accounting data.

It is important to note that the financial credit score is not the probability of default of a counterparty, but it is just an ordinal value sorting the creditworthiness of firms only relying on their accounting data. Therefore, the financial credit score is then mapped to a **financial probability of default** (PD_F).

2. **Internal behavioural module:** the input of the internal behavioural module are the internal behavioural factors identified in the Step 1.1. This module is thus fed with data about a counterparty behaviour with the lending bank which are derived from internal information of the lending bank. The main output of the internal behavioural module is an **internal behavioural credit score** ($Score_{IB}$), an ordinal value that sorts the

creditworthiness of the bank's counterparties depending on their internal behavioural data.

Also in this case, the internal behavioural credit score is not the probability of default of a counterparty, but it is just an ordinal value sorting the creditworthiness of firms only relying on their internal behavioural data. It is then mapped to an **internal behavioural probability of default** (PD_{IB}).

3. External behavioural module: the input of the external behavioural module are the external behavioural factors identified in the Step 1.1. This module is thus fed with data about a counterparty behaviour with the banking system which are derived from credit bureaus. The main output of the external behavioural module is an **external behavioural credit score** ($Score_{EB}$), an ordinal value that sorts the creditworthiness of the bank's counterparties depending on their external behavioural data.

Again, the external behavioural credit score is not the probability of default of a counterparty, but it is just an ordinal value sorting the creditworthiness of firms only relying on their external behavioural data. It is accordingly mapped to an **external behavioural probability of default** (PD_{EB}).

4. Qualitative module: the input of the qualitative module are the qualitative factors identified in the Step 1.1. This module is thus fed with data about qualitative judgment expressed by relationship managers which are directly derived from the knowledge of relationship managers. The main output of the qualitative module is a **qualitative credit score** ($Score_Q$), an ordinal value that sorts the creditworthiness of the bank's counterparties depending on their qualitative data.

The qualitative credit score is not the probability of default of a counterparty, but it is just an ordinal value sorting the creditworthiness of firms only relying on their qualitative data. It is then mapped to a **qualitative probability of default** (PD_{IB}).

Each type of probability of default (in the four areas) is computed only relying on a counterparty's specific data and it expresses the probability that, in a 12 months horizon, a past due event (that is, the regulatory definition of default) will occur. For further information about the mapping of the credit score to the probability of default, see the following step 4.

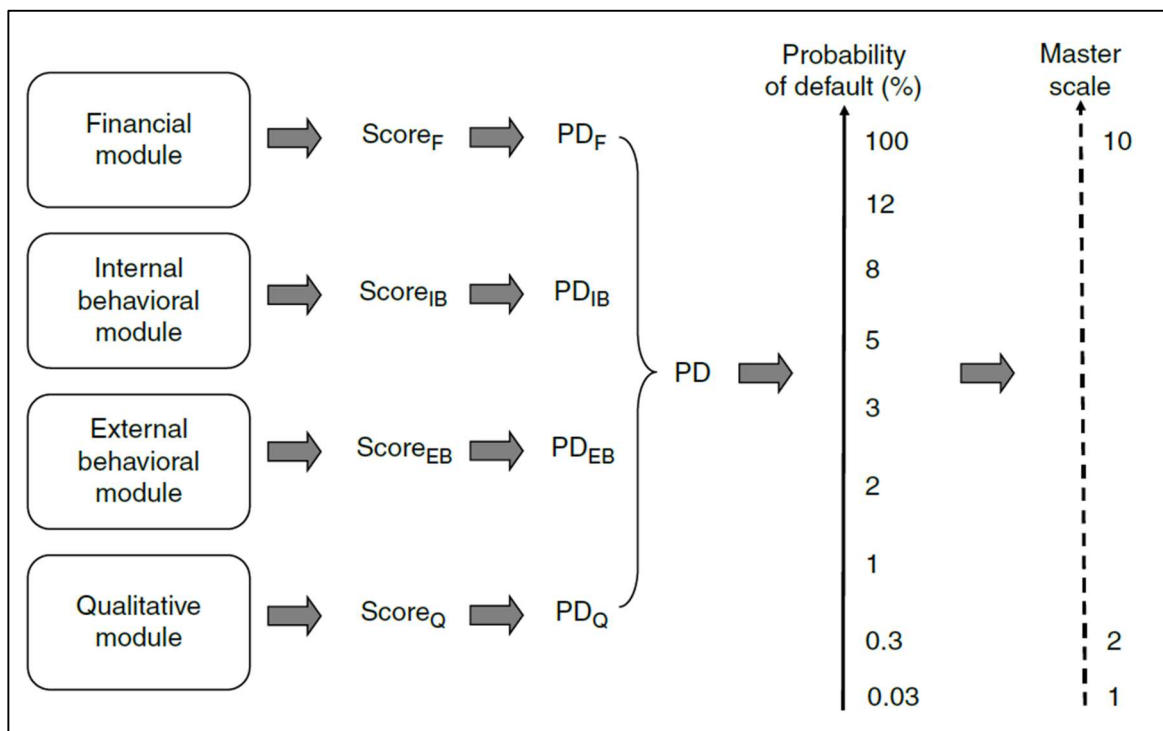
Summarising what previously said, for each module the main output is a **modular credit score**, an ordinal value that sorts the creditworthiness of the counterparties, depending on the type of data used (accounting data, counterparty behaviour with the lending bank, counterparty behaviour with the banking system and qualitative data).

Each of the four modular credit scores is then mapped to a **modular probability of default**. The modular PDs express the probabilities that, in a 12 months horizon, a past due event (that is, the regulatory definition of default) will occur.

It is important to highlight that the modular PDs represent the probabilities of default calculated based only on the factors belonging to each module. Therefore, the four modular PDs need to be integrated to obtain a **unique probability of default** that will be subsequently associated with a rating class contained in the bank's "master scale" that defines the rating classes as subsets of the PD domain.

The following *Figure 17* briefly represents the 4-module model which, as said before, is the most used in international best practices for developing credit rating models:

Figure 17 – Four module credit rating model



Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

STEP 1.3 Methodological approach (statistical methodology)

After defining the long lists of explanatory factors for the four information areas (Step 1.1) and the structure of the credit rating model to be implemented (Step 1.2), it is necessary to define which methodological approach to apply for computing the credit ratings.

There are two main methodological approaches that can be used for computing credit ratings: the statistical methodology and the expert-based methodology. The choice of which methodology to use is made on the basis of the following considerations:

- if the factors' samples included in the four modules are sufficiently wide, robust and with a sufficient observation depth, it is possible to use a statistical approach.
- otherwise, if it is not possible to conduct robust statistical analysis, it is necessary to rely on expert-based methodologies.

In international best practices both approaches are commonly used synergistically. First of all, statistical-based modular credit scores are mapped into statistical-based modular probabilities of default. By contrast, expert-based modular credit scores are generally not transformed into default probabilities, but they are used to upgrade or downgrade the rating class assigned by the statistical component of the model.

For the sake of synthesis, in this paragraph we will focus only on the discussion of the statistical methodology, being the most relevant for the purpose of this paper.

The most frequently adopted statistical technique in the development of credit rating models for corporates counterparties are **binary response models**. In a binary response model, the value of the dependent variable y_t (Bernoulli distributed) can take on only two values, 0 and 1. Let P_t denote the probability that $y_t = 1$ conditional on the information set Ω_t , which consists of exogenous and predetermined variables denoted by a row vector X_t of dimension k . A binary response model serves to model this conditional probability. Since the values are 0 or 1, by definition P_t is also the expectation of y_t conditional on Ω_t :

$$P_t \equiv \Pr(y_t|\Omega_t) = E(y_t|\Omega_t)$$

Thus, a binary response model can also be thought of as modelling a conditional expectation, imposing the condition that $0 \leq E(y_t|\Omega_t) \leq 1$, which must hold because $E(y_t|\Omega_t)$ is a probability.

In principle, there are many ways to do this. In practice, however, two very similar models are widely used, and both ensure that $0 \leq P_t \leq 1$ by specifying that:

$$P_t \equiv \Pr(y_t | \Omega_t) = F(\mathbf{X}_t \boldsymbol{\beta})$$

Here $\mathbf{X}_t \boldsymbol{\beta}$ is an index function, which maps from the vector \mathbf{X}_t of explanatory variables and the vector $\boldsymbol{\beta}$ of parameters to a scalar index, and $F(x)$ is a transformation function, which has the properties that:

$$F(-\infty) = 0, \quad F(\infty) = 1, \quad \text{and} \quad f(x) \equiv \frac{dF(x)}{dx} > 0$$

These properties are, in fact, just the defining properties of the cumulative distribution function (CDF), of a probability distribution. They ensure that, although the index function $\mathbf{X}_t \boldsymbol{\beta}$ can take any value on the real line, the value of $F(\mathbf{X}_t \boldsymbol{\beta})$ must lie between 0 and 1.

These properties also ensure that $F(x)$ is a nonlinear function. Consequently, changes in the values of the x_{ti} , which are the elements of \mathbf{X}_t , necessarily affect $E(y_t | \Omega_t)$ in a nonlinear fashion. Specifically, when P_t is given by $F(\mathbf{X}_t \boldsymbol{\beta})$, its derivative with respect to x_{ti} is:

$$\frac{\partial P_t}{\partial x_{ti}} = \frac{\partial F(\mathbf{X}_t \boldsymbol{\beta})}{\partial x_{ti}} = f(\mathbf{X}_t \boldsymbol{\beta}) \beta_i$$

where β_i is the i^{th} element of $\boldsymbol{\beta}$. Therefore, the magnitude of the derivative is proportional to $f(\mathbf{X}_t \boldsymbol{\beta})$.

The first of the two widely used choices for $F(x)$ is the cumulative standard normal distribution function:

$$\Phi(x) \equiv \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x \exp\left(-\frac{1}{2}X^2\right) dX$$

When $F(\mathbf{X}_t \boldsymbol{\beta}) = \Phi(\mathbf{X}_t \boldsymbol{\beta})$ it is called the **probit model**.

The second of the two widely used choices for $F(x)$ is the logistic function:

$$\Lambda(x) \equiv \frac{1}{1 + e^{-x}} = \frac{e^x}{1 + e^x}$$

When $F(\mathbf{X}_t \boldsymbol{\beta}) = \Lambda(\mathbf{X}_t \boldsymbol{\beta})$ it is called the **logit model**.

STEP 2: Univariate analysis

After defining the long lists of explanatory factors for the four information areas (Step 1.1), the structure of the credit rating model to be implemented (Step 1.2) and the methodological approach to apply (Step 1.3), a preliminary univariate analysis has to be conducted for each of the four modules.

The main objective of the univariate analysis is to determine which of the explanatory factors contained in the long lists are significant for the prediction of counterparty default events and have a sounded economic interpretation. Thus, the aims of the univariate analyses are:

1. analysing the distribution of the explanatory factors in their fields of existence.
2. verifying the economic soundness of the factors.
3. verifying the proper relationship of the factors with the default and the statistical significancy.

At the end of the univariate analyses, it is possible to select for the four lists of factors belonging to the four modules a sub-set of factors that are:

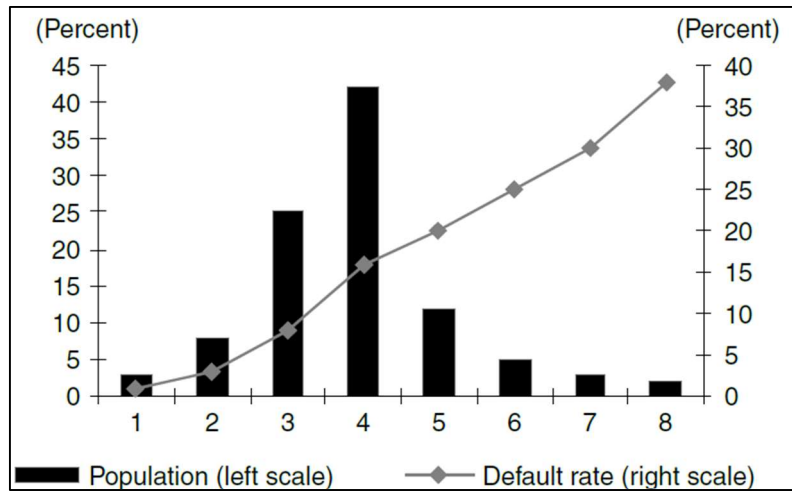
1. statistically predictive of the default event of the counterparty, at univariate level.
2. intuitive from the economic interpretation.
3. capable of ensuring coverage of the main risk categories.

The sub-sets of chosen factors for the four informative areas are usually called “medium lists”.

Three Figures below represent a possible outcome of a univariate analysis on a certain explanatory factor. *Figure 18* represents an explanatory factor growing monotonically as the default rate increases (significant positive correlation). In this case, the explanatory factor has to be included in the medium list of its module. *Figure 19* represents an explanatory factor decreasing monotonically as the default rate increases (significant negative correlation). Also in this case, the explanatory factor has to be included in the medium list of its module.

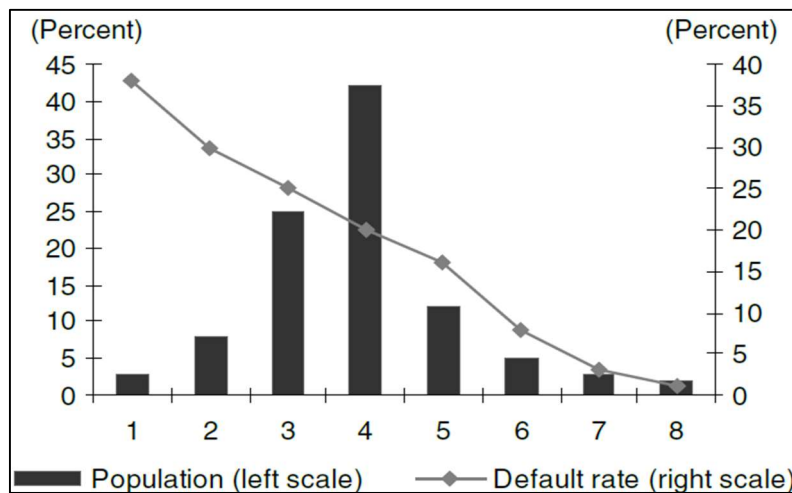
Figure 20 represents an explanatory factor which is not correlated with the default rate. In this case, the explanatory factor must not be included in the medium list of its module.

Figure 18 – Factor positively correlated to default



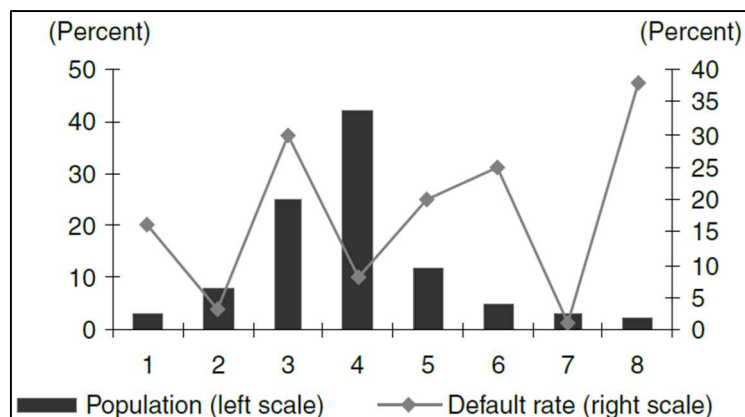
Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

Figure 19 – Factor negatively correlated to default



Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

Figure 20 – Factor uncorrelated to default



Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

STEP 3: Multivariate analysis

After conducting the univariate analysis and having obtained the relative medium lists (Step 2), it is necessary to specify and estimate the logit-probit model introduced in Step 1.3 for each of the four medium lists. This estimate procedure is also called multivariate analysis for each of the four medium lists, necessary to determine the optimal variable selection ("short lists" of explanatory factors) and the weight for each factor.

By far the most common way to estimate logit-probit models is to use the method of maximum likelihood²⁷. Since the dependent variable is discrete, the likelihood function cannot be defined as a joint density function. When the dependent variable can take on discrete values, the likelihood function for those values should be defined as the probability that the value is realized, rather than as the probability density at that value. With this redefinition, the sum of the possible values of the likelihood is equal to 1, just as the integral of the possible values of a likelihood based on a continuous distribution is equal to 1.

If, for observation t , the realized value of the dependent variable is y_t , then the likelihood for that observation if $y_t = 1$ is just the probability that $y_t = 1$, and if $y_t = 0$, it is the probability that $y_t = 0$. The logarithm of the appropriate probability is then the contribution to the loglikelihood made by observation t . Being the probability that $y_t = 1$ is $F(\mathbf{X}_t\boldsymbol{\beta})$, the contribution to the loglikelihood function for observation t when $y_t = 1$ is $\log F(\mathbf{X}_t\boldsymbol{\beta})$. Similarly, the contribution to the loglikelihood function for observation t when $y_t = 0$ is $\log (1 - F(\mathbf{X}_t\boldsymbol{\beta}))$. Therefore, if \mathbf{y} is an n -vector with typical element y_t , the loglikelihood function for \mathbf{y} can be written as:

$$l(\mathbf{y}, \boldsymbol{\beta}) = \sum_{t=1}^n (y_t \log F(\mathbf{X}_t\boldsymbol{\beta}) + (1 - y_t) \log (1 - F(\mathbf{X}_t\boldsymbol{\beta})))$$

For each observation, one of the two terms inside the parentheses is always 0, and the other is always negative, being the logarithm of a probability clearly smaller than 1. The first term is 0 whenever $y_t = 0$, and the second term is 0 whenever $y_t = 1$. For the model to fit perfectly, $F(\mathbf{X}_t\boldsymbol{\beta})$ would have to equal 1 when $y_t = 1$ and 0 when $y_t = 0$, and the entire expression inside the parentheses would then equal 0. This could happen only if $\mathbf{X}_t\boldsymbol{\beta} = \infty$ whenever $y_t = 1$, and

²⁷ For further information see: Davidson, R. & McKinnon, K. (2021)

$X_t\beta = -\infty$ whenever $y_t = 0$. Therefore, we see that the loglikelihood function $l(y, \beta)$ is bounded above by 0.

For the logit-probit models, the loglikelihood function is globally concave with respect to β . This implies that the first-order conditions, or likelihood equations, uniquely define the maximum likelihood (ML) estimator $\hat{\beta}$. These likelihood equations can be written as:

$$\sum_{t=1}^n \frac{(y_t - F(X_t\beta))f(X_t\beta)x_{ti}}{F(X_t\beta)(1 - F(X_t\beta))} = 0, \quad i = 1, \dots, k$$

In this estimate procedure, factors that are highly correlated with other ones are eliminated. This is necessary to mitigate the issues that multicollinearity could cause to the model²⁸.

For each of the four modules, the modular credit score is obtained as the output of the related logit-probit regression:

Financial Module $\rightarrow F(X_F\beta) = Score_F$

Internal Behavioural Module $\rightarrow F(X_{IB}\beta) = Score_{IB}$

External Behavioural Module $\rightarrow F(X_{EB}\beta) = Score_{EB}$

Qualitative Module $\rightarrow F(X_Q\beta) = Score_Q$

STEP 4: PD calibration, integration and mapping to the master scale

As seen in discussing Step 1.3, the modular credit scores (that are the outputs of the logit-probit regressions) are an ordinal index of the counterparty's probability of default. Therefore, it is necessary to calibrate the relationship between the modular credit scores and the modular probabilities of default.

Afterwards, the modular PDs are integrated to obtain a unique probability of default that will subsequently be associated with a rating class contained in the bank's "master scale" that defines the rating classes as subsets of the PD domain.

The calibration process is the process of estimating the relationship between a credit score and its relative PD estimate, where the PD estimate is intended as the long-run average default rate (namely, the *through-the-cycle* PDs).

²⁸ For further information see: Davidson, R. & McKinnon, K. (2021)

The calibration process that European banks need to conduct is regulated by EBA's *"Guidelines on PD estimation, LGD estimation and the treatment of defaulted exposures"*. For this reason, the main calibration process required by EBA is summarized in the following five steps:

1. First, the credit scores sample must be sorted from "best" to "worst" and then subdivided in n ranges (called "rating grades").
2. Second, the one-year default rates associated to each rating grade must be calculated.

To calculate the one-year default rate, the following elements should be ensured:

- (a) that the denominator consists of the number of non-defaulted counterparties with any credit obligation observed at the beginning of the one-year observation period.
- (b) that the numerator includes all those counterparties considered in the denominator that had at least one default event during the one-year observation period.

The one-year default rates are typically calculated monthly, adopting a 12-months timeframe as the one-year observation period.

Where the one-year default rate is calculated by rating grade, the denominator should refer to all counterparties assigned to a rating grade at the beginning of the observation period.

3. Third, the observed average one-year default rates ('observed average default rate') must be calculated for each rating grade. The observed average default rate is calculated as the arithmetic average of all one-year default rates.

To calculate the observed average default rate, credit institutions are required to choose the most appropriate between an approach based on overlapping and an approach based on non-overlapping one-year time windows.

4. Fourth, the long-run average default rate (*through-the-cycle* PD estimate) must be calculated for each rating grade. The long-run average default rate must be calculated as the observed average of the one-year default rates in the historical observation period.

To determine the historical observation period, additional observations to the most recent 5 years, at the time of model calibration, must be considered relevant when these

observations are required in order for the historical observation period to reflect the likely range of variability of default rates of that type of exposures.

And to assess the representativeness of the historical observation period, credit institutions are required to assess whether the historical observation period contains a representative mix of “good” and “bad” years, and they must consider all of the following:

- (a) the variability of all observed one-year-default rates.
- (b) the existence, lack or prevalence of one-year default rates relating to bad years as reflected by economic indicators that are relevant for the considered type of exposures within the historical observation period.
- (c) significant changes in the economic, legal or business environment within the historical observation period.

5. Finally, a quantitative calibration test by rating grade must be conducted.

Where scoring methods are used, institutions should ensure that the PD estimates which were derived as a simple average of individual PD estimates are adequate for relevant grades, by applying calibration tests to these estimates at a grade level, on the basis of one-year default rates representative of the likely range of variability of default rates.

After performing the calibration process, four modular probabilities of default are obtained, one for each module:

Financial Module $\rightarrow F(X_F\beta) = Score_F \rightarrow \text{calibration} \rightarrow PD_F$

Internal Behavioural Module $\rightarrow F(X_{IB}\beta) = Score_{IB} \rightarrow \text{calibration} \rightarrow PD_{IB}$

External Behavioural Module $\rightarrow F(X_{EB}\beta) = Score_{EB} \rightarrow \text{calibration} \rightarrow PD_{EB}$

Qualitative Module $\rightarrow F(X_Q\beta) = Score_Q \rightarrow \text{calibration} \rightarrow PD_Q$

To complete, the four modular PDs are integrated to obtain a single PD. To obtain a single PD is necessary to assign to each modular PD an integration weight. The integration weights can be assigned using statistical methodologies and/or relying on the internal bank experience. After assigning the integration weights to the four modular PDs, it is possible to derive the integrated PD according to a simple weighted average:

$$PD = (PD_F \cdot W_F) + (PD_{IB} \cdot W_{IB}) + (PD_{EB} \cdot W_{EB}) + (PD_Q \cdot W_Q)$$

The integrated PD is then associated with a **credit rating class** belonging to the “master scale” of the bank’s rating system that associate a default probability with a corresponding rating class.

5.4 The indirect approach

In this section we introduce and detail an approach for integrating ESG information into credit rating models that is based on four sequential sets of assumptions. The adoption of each assumption is motivated with respect to the regulatory constraints and the various alternatives available in the literature.

5.4.1 First set of assumptions: causal relationships among ESG information, financial information and creditworthiness

The first set of assumptions defines the causal relationships between ESG information, financial information, and creditworthiness.

With regard to the direction of the causal relationships, it is assumed that the ESG performance of a firm impacts its financial performance, which then affects its creditworthiness. In fact, the ESG performance, due to the impacts it generates on the behaviour of stakeholders (including customers and suppliers) influences the financial performance over time.

Moreover, it is assumed that a firm’s transition path (its starting point, the speed of its implementation and its scope) affects the firm’s ability to remain on the market and thus its credit rating. In particular, the ESG sustainability plan adopted by a firm has effects on the firm’s products, costs, investments, and market positioning. These aspects are all reflected on the financial indicators of the firm and therefore on its ability to repay contractual obligations.

It must be highlighted that these assumptions permit to meet the regulatory requirement to assess financial materiality, required by both the EFRAG and ISSB standards.

In particular, EFRAG adopts the following definition of financial materiality: *“A sustainability matter is material from a financial perspective if it triggers or may trigger material financial effects on the undertaking. This is the case when it generates or may generate risks or opportunities that have a material influence (or are likely to have a material influence) on the undertaking’s cash flows, development, performance, position, cost of capital or access to finance in the short-, medium- and long-term time horizons.”*²⁹. Moreover, EFRAG states that *“Impact materiality and financial materiality assessments are inter-related and the interdependencies between these two dimensions shall be considered. In general, the starting point is the assessment of impacts. A sustainability impact may be financially material from inception or become financially material when it becomes investor relevant, including due to its present or likely effects on cash-flows, development, performance and position in the short-, medium- and long-term time horizons. Irrespective of their being financially material, impacts are captured by the impact materiality perspective.”*³⁰

On the other hand, ISSB adopts the following definition of financial materiality: first of all, an entity is required *“to disclose information about its significant sustainability-related risks and opportunities that is useful to the primary users of general-purpose financial reporting when they assess enterprise value and decide whether to provide resources to the entity”*³¹.

Therefore *“a reporting entity shall disclose material information about all of the significant sustainability-related risks and opportunities to which it is exposed. The assessment of materiality shall be made in the context of the information necessary for users of general-purpose financial reporting to assess enterprise value”*³².

With regard to an entity’s enterprise value, ISSB states that *“enterprise value reflects expectations of the amount, timing and certainty of future cash flows over the short, medium and long term and the value of those cash flows in the light of the entity’s risk profile, and its access to finance and cost of capital. Information that is essential for*

²⁹ EFRAG (2022) Final Draft ESRS 1 – General Requirements, Paragraph 52

³⁰ EFRAG (2022) Final Draft ESRS 1 – General Requirements, Paragraph 41

³¹ IFRS – ISSB (2022) Draft IFRS S1 – General Requirements for Disclosure of Sustainability-related Financial Information, Paragraph 1

³² IFRS – ISSB (2022) Draft IFRS S1 – General Requirements for Disclosure of Sustainability-related Financial Information, Paragraph 2

assessing the enterprise value of an entity includes information that is provided by the entity in its financial statements and sustainability-related financial information”³³.

For the dynamics of causal relationships, it is assumed that the ESG impacts on the financial Key Performance Indicators (KPIs) are distributed over time, as there is always a time lag between the outcome of the ESG performance and its financial effect which is articulated in short-, medium- and long-term effects. In particular, long-term effects are assumed to be significantly relevant, as it is also highlighted in the EFRAG definition: “A sustainability impact may be financially material from inception or become financially material when it becomes investor relevant, including due to its present or likely effects on cash-flows, development, performance and position in the short-, medium- and long-term time horizons”.

Given that a firm’s credit rating refers to the firm’s prospective ability to repay its debts, it is assumed to be directly explained only by the financial KPIs of the firm. According to this assumption, therefore, the credit rating depends indirectly on the ESG performance, through its impact on the financial KPIs. For this reason, the proposed approach is called “indirect approach”.

5.4.2 Second set of assumptions: the types of information to be used

The indirect approach focuses then on financial KPIs to be used in the credit rating models, as the financial KPIs of a firm are impacted by its ESG performance. The second set of assumptions concerns the types of information and their sources to compute these financial KPIs impacted by ESG performance.

At a general level, the possible information sources are the following three: direct engagement of the firm by bank’s relationship managers, the firm’s regulatory sustainability reporting, external data sources. This second set of assumptions focuses then on the regulatory sustainability reporting source.

³³ IFRS – ISSB (2022) Draft IFRS S1 – General Requirements for Disclosure of Sustainability-related Financial Information, Paragraph 5.

First, it is assumed that the firm's prospective ability to fulfil its obligations, which is the subject of the credit rating, is better assessed on the basis of the financial KPIs contained in the firm's financial plan, related to future time horizons, rather than relying on historical data.

Furthermore, since the ESG transition is only in its initial stages, it is assumed that the firm's historical data are not very informative on the causal relationship between ESG information and financial KPIs.

Therefore, it is proposed to adopt the idiosyncratic forward-looking information related to a firm's financial plan. For an analytical definition of the contents of the idiosyncratic forward-looking information and of the contents and sources of the financial idiosyncratic forward-looking data, impacted by ESG performance, see Giacomelli (2022).

The assumptions relative to the causal relationship between a firm's ESG performance and its financial performance must be considered directly in the formulation of ESG sustainability and financial plans. This because the implementation of the ESG sustainability plan generates direct impacts on the firm's prospective financial KPIs, which must therefore be considered in its financial plan.

In particular, the following components of the financial KPIs, in order to consider and measure the financial impacts of the ESG sustainability plan, must be considered:

- The Turnover component directly related to the ESG sustainability plan: the positive or negative changes in turnover deriving from the activities included in the ESG sustainability plan. The Turnover component can be expressed either in terms of absolute amount or in terms of percentage of the total.
- The OpEx component directly related to the ESG sustainability plan: the operating costs to be incurred to carry out the activities included in the ESG sustainability plan. The OpEx component can be expressed either in terms of absolute amount or in terms of percentage of the total.
- The CapEx component directly related to the ESG sustainability plan: the costs of fixed assets to implement the transition process envisaged by the ESG sustainability plan. The CapEx component can be expressed either in terms of absolute amount or in terms of percentage of the total.

- The component of loans directly related to the ESG sustainability plan: the amounts, maturities and typologies of financial instruments adopted to finance the investments envisaged by the ESG sustainability plan. The loan component can be expressed either in terms of absolute amounts or in terms of percentage of the total.

The idiosyncratic forward-looking information to be adopted shall provide formal evidence that the prospective financial data, contained in the financial plan, are determined in function of the ESG sustainability plans. It is also important to note that the causal relationships must be considered both in terms of target values included in the firm's plans and in terms of risks of the firm's plans that are measured as deviations from the target values.

In fact, to properly assess the prospective creditworthiness of a firm, it is assumed necessary to consider that, in formulating the ESG sustainability plan, the targets of the ESG KPIs influence the quantification of the financial KPIs' targets for defining the financial coverage of the ESG sustainability plan.

Moreover, to properly assess the prospective creditworthiness of a firm, it is assumed necessary to consider that, in assessing the resilience of ESG sustainability plans, deviations from the ESG KPIs' targets during the implementation of the ESG sustainability plan can raise costs and therefore cause financial KPIs' deviations that can be not consistent with the financial coverage of the ESG sustainability plan. In particular, physical risks have direct impacts on financial KPIs, as they can cause significant unexpected losses. Instead, transition risks require evaluating the financial impacts (e.g. costs increase) due to the deviations of ESG KPIs that may occur during the implementation of ESG sustainability plans.

Therefore, two types of financial impacts are assumed: impacts generated by ESG transition targets and impacts generated by ESG transition risks, measured as deviations from target.

Consequently, two types of input indicators must be considered in credit rating models: financial plan's target and deviation indicators.

It is also relevant satisfying the requirement that all the forward-looking financial KPIs for adjusting credit rating shall be regulatory indicators, compliant with the ESG disclosure regulations: EU Taxonomy, EFRAG Standards and ISSB Standards described in paragraph 3.

Consequently, the source of idiosyncratic forward-looking information proposed in this approach is the Action Plan required by the European Sustainability Reporting Standards of EFRAG, which contains the Capex Plan required by the EU Taxonomy, comprehensive of the ESG sustainability plan and the related financial plan, both formulated over a multi-year horizon.

In fact, EFRAG requires that a firm, in formulating its sustainability strategies, not only shall takes into consideration the backward-looking information but, above all, it must focus on the forward-looking information for assessing how sustainability risks and opportunities could reasonably be expected to affect its business model, strategy and cash flows over the short-, medium- or long-term, its access to finance and its cost of capital.

Furthermore, the CapEx KPI and the OpEx KPI related to the targets defined in the Capex Plan introduced in the Annex I of the Delegated Act of EU Taxonomy are idiosyncratic forward-looking indicators related to the ESG objectives of the undertaking.

For now, the list of ESG KPIs is focused only on Pillar E (Environmental). In fact, the regulatory texts on Pillars S (Social) and G (Governance) are still being defined.

Due to the financial materiality criterion introduced by both EFRAG and ISSB, the financial KPIs' values impacted by ESG sustainability plan – which this paper proposes to use in credit rating models instead of historical data – have legal value and they are mandatory.

In particular, the forward-looking financial KPIs, impacted by ESG sustainability plan, represent possible appropriate inputs for credit rating models for the following reasons:

- They are indicators that meet the mandatory disclosure requirements. This compliance characteristic is necessary to feed credit rating models, which require data that are homogeneous, structured, certified and available for all firms.
- They are forward-looking indicators. This characteristic is necessary to feed the credit rating models as the traditional historical data (backward-looking) do not currently contain significant manifestations of the effects of ESG factors.
- They are idiosyncratic forward-looking indicators, directly linked to firms' ESG sustainability and financial plans. This idiosyncratic characteristic is necessary for credit ratings to be able to support the different phases of the credit process. In fact, it is

essential to consider the specificities of a firm and its ESG plans, when making decisions about creditworthiness aimed at the financing of such plans. By contrast, it should be noted that systematic forward-looking ESG information, sufficient at the level of massive aggregate analyses (e.g., portfolio analysis), does not allow to consider the specificities of the individual firms' sustainability plans. Using it, moreover, would lead to treating individual firms all in the same way as the ESG component within the credit granting processes. By definition, in fact, the systematic ESG forward-looking information only considers the future dynamics of sectoral ESG characteristics or ESG characteristics common to several firms. The use idiosyncratic forward-looking information is required at a regulatory level (e.g., by EBA LOM) as well as in terms of management needs.

- They are data that banks must consider in any case as they are necessary for the calculation of the Green Asset Ratio (GAR), which explicitly requires considering the counterparties' CapEx Plans required by the EU Taxonomy.

Summarising, the regulatory financial KPIs and their related risk indicators can be used as forward-looking inputs of the credit rating models. These financial KPIs and their related risk indicators constitute a subset of the MtTI-based primary ESG indicators defined in Giacomelli (2022). These MtTI-based primary ESG indicators provide information on:

- A firm's current ESG sustainability gap with respect to common and science-based thresholds provided by the international regulations.
- The targets and timing that a firm intends to pursue in the future to bridge the current ESG sustainability gap with respect to the thresholds. This information is contained in the firm's ESG sustainability plan.
- The operative costs, fixed assets and revenues components directly related to the ESG sustainability plan. This information is contained in a firm's financial plan, and it is essential for assessing the financial coverage of the ESG sustainability plan.

It must be highlighted that this second set assumptions allows also to satisfy the specific EBA LOM requests of:

- adopting idiosyncratic forward-looking information in the assessment of creditworthiness.
- identifying ESG factors and integrate them into credit ratings

It is also relevant to point out that the information source this paper proposes to adopt is mandatory at regulatory level for companies over 250 employees. However, by adopting the proportionality principle, the financial materiality assessment can be extended and requested in a simplified form, through direct engagement of firms, even to SMEs with less than 250 employees.

Finally, in order to feed the credit rating models, it is assumed that there is no need to take into consideration systematic forward-looking information.

Systematic forward-looking information does not allow to consider the specific business evolution of a firm. This is due to the fact that while the business evolution of a firm is related to the targets that the firm is pursuing and the riskiness of achieving these targets, the systematic forward-looking information limits itself to considering the component of the business evolution which is described by the future dynamics of the economic system and/or of the firm sector.

A relevant example of the use of systematic forward-looking information in credit risk assessment is the current practice in IFRS 9³⁴. In fact, in the current practice for IFRS 9, the forward-looking analysis of default probability is limited only to its systematic component, which is focused on macroeconomic analysis or, at most, on sector analysis. The systematic forward-looking information adopted in IFRS 9 is only suitable for supporting the management of a credit portfolio, where:

- The common movements due to the systematic components are very significant, as they affect every firm and then portfolio dynamics.
- The specific PD dynamics of the single firms, due to the idiosyncratic component, tend to compensate each other.

³⁴ For details see IFRS Foundation – IASB (2017)

5.4.3 Third set of assumptions: the specification of the functional form of the internal credit rating model

The third set of assumptions concerns the specification of the functional form of internal credit rating models integrating ESG information. The assumed indirect relationship between ESG information and creditworthiness, discussed in paragraph 6.1, has significant implications for the specification of credit rating models.

The first implication is that only the financial KPIs, as in the current versions of internal rating models, described in section 5, should continue to be used as explanatory variables.

However, for such financial KPIs, the idiosyncratic forward-looking values related to the financial plan, considering the impacts of the ESG sustainability plan's implementation, have to be used. The prospective nature of the values of the adopted explanatory variables allows to obtain idiosyncratic forward-looking credit ratings. According to this indirect approach, therefore, ESG explanatory variables should not be considered.

In particular, considering the overall structure of current credit rating models (described in paragraph 5) only the financial module is impacted by the integration of the ESG information.

The second implication is that, compared to the current credit rating models, risk indicators are introduced among the exogenous variables as to consider the possible deviations from the financial plan targets, as highlighted in the second set of assumption (see paragraph 6.2). In fact, compared to a backward-looking perspective, for each explanatory variable in a forward-looking perspective adopting a single point value is not sufficient. For each financial KPI, in addition to the point value referred to the target, a risk indicator must be considered to take into account, *ceteris paribus*, the effect of the magnitude of the possible deviations from the target³⁵.

³⁵ For details on the exhaustiveness of idiosyncratic forward-looking information, see Giacomelli (2022). The forward-looking information's content cannot consist only of a single point value (e.g., the expected outcome, the most probable scenario, the target set in a financial plan).

The assessment of financial risk indicators requires to consider the dependence among the deviations of the KPIs representing a firm's ESG performance and the deviations of the KPIs representing a firm's financial performance. This dependence can be both simultaneous (short-term impacts), or distributed over time, with long-term impacts.

The deviations from the targets of financial KPIs are caused by ESG risk factors directly linked to the ESG sustainability plan, which must include:

- Physical risk factors, both acute and chronic, that cause significant unexpected losses.
- Transition risk factors, including specific ESG risk factors that can materialize over multi-year horizons, such as changes in the regulatory or technological context, that significantly modify the financial impacts of a firm's ESG sustainability plans. The possible deviations from the ESG targets, caused by transition risk factors which may occur during the implementation of the ESG sustainability plan, have significant direct impacts on the firm's financial KPIs such as changes in costs, in the level of fixed assets and in the debt structure to finance their purchase.

The third implication is that the impacts, distributed over time, of the ESG sustainability plan on the financial KPIs are already considered in the values of the financial KPIs specified for the individual time horizons of the financial plan. Therefore, the dynamic specification of credit rating models remains unchanged with respect to current credit rating models as described in section 5.3.

5.4.4 Fourth set of assumptions: the time horizon of the internal credit rating model

The fourth set of assumptions concerns the time horizon of the internal credit rating model.

The reference to the information contained in the ESG sustainability plan and in the related financial one allows to consider systematically a multi-year horizon that covers all the

In fact, if this point value does not occur (which is very likely), the impacts of all possible alternative scenarios remain completely unknown both for the firm and for its stakeholders, severely limiting their decision-making process.

horizon of the ESG sustainability plan formulated by a firm. In this way, a long-run credit risk assessment is adopted, which is necessary to make the creditworthiness assessment consistent with the time horizons of the transition processes and the duration of the exposures financing them.

It has to be highlighted that the horizon of the ESG sustainability plan and the related financial plan constitutes the broadest time horizon that can be taken into consideration to have reliable idiosyncratic forward-looking financial data to feed the credit rating model.

In fact, extending the time horizon beyond the one of the plans entails bias problems for the following reasons. At the end of the firm's plans, a firm will reformulate its objectives and its financial plan, based on the information set available at that future date, which at current time it is obviously not possible to hypothesize. Therefore, considering a time horizon longer than the one of the current plans, assumptions would be projected forward that we know will be significantly biased due to the reformulation of new plans and the consequent financial behaviour of the firm.

The choice of time horizons to be used in credit rating models must therefore be constrained to the multi-year planning cycles adopted by firms, without introducing long-run biased factors.

The behaviour of a firm, in fact, is due to the pursuit of the current plans, while its future behaviour will depend on the new plans that will be formulated.

Other hypotheses to extend the time horizon beyond that of the current plan are biased due to the reasons provided above.

Therefore, compared to current credit rating models, it is necessary to move from a single-period to a multi-period logic for considering the overall time horizon of the plans. From a multi-period point of view, it must be considered that the occurrence of a deviation from a target generates impacts that can cause, over time, new forms of deviation and therefore amplify the possibility of further deviations from targets in subsequent periods. This risk amplification is called the "long-run risk effect".

For the analysis of the prospective financial performance of a firm along the time horizon of a plans, the long-run risk effect is fundamental because it highlights that an initial deviation has significant amplifying effects. On the contrary, by applying a single-period logic, these amplifying effects would not be taken into consideration, thus underestimating the risk of the plans itself and therefore limiting the awareness of its impacts.

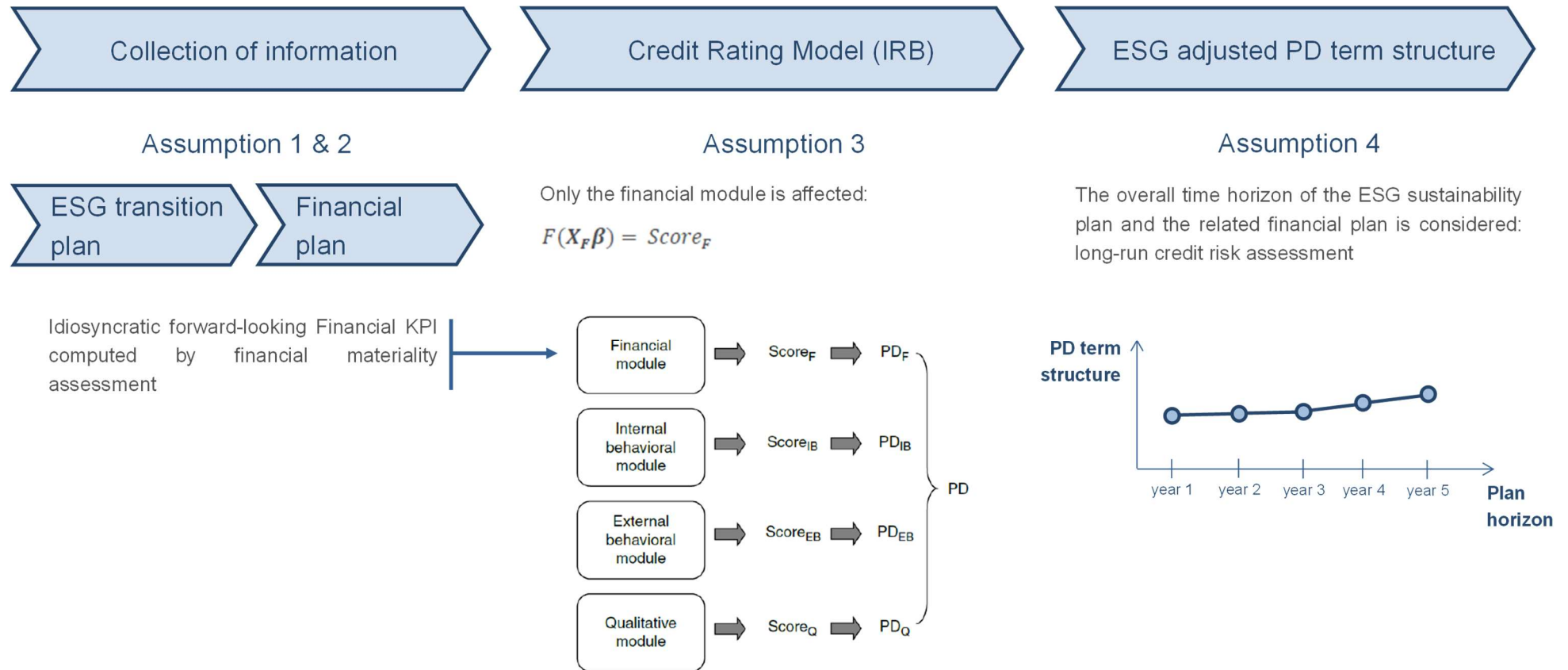
In particular, the unexpected impacts generated by the ESG performance, both on the environment and on stakeholders, can be transformed in the long-run into new risk factors affecting a firm's financial performance.

5.4.5 The process to implement the indirect approach

The four sequential sets of assumptions, that have been analysed in paragraph 6, allow to define the process to implement the indirect approach. A summary of this process is described in the following.

The process is articulated in the three steps represented in *Figure 21*.

Figure 21 – Three steps process to implement the indirect approach



Source: Authors' elaboration.

Step 1) Collection of information

The first step refers to the collection of information to feed the credit rating model, it is based on Assumption 1 and 2 (see paragraph 6.1 and 6.2) and is articulated in two sequential sub steps:

- Sub step 1.1) Collection of the ESG transition plan
- Sub step 1.2) Collection of the financial plan which explicitly requires the implementation of the ESG transition plan

Sub step 1.1) ESG transition plan

The ESG transition plan must be formulated by adopting the Impact Materiality Assessment required by EFRAG standards (as described in paragraph 3.2).

It should be noted that the Impact Materiality Assessment is also conducted through the Taxonomy Alignment process in which the firm:

- measures the KPIs required by the EU Taxonomy technical screening criteria.
- verifies that the KPI measurements respect the required thresholds.

If the thresholds are not respected, the sustainability matter is material, and a CapEx Plan must be formulated. EFRAG standards explicitly recall their linkage with EU Taxonomy³⁶

Sub step 1.2) Financial plan

The financial plan must also be formulated by adopting the Financial Materiality Assessment required by EFRAG standards (see paragraph 3.2). There are two types of idiosyncratic forward-looking financial KPIs computed by adopting the Financial Materiality Assessment:

³⁶ For further information see EFRAG (2022), *Explanatory note of how draft ESRS take account of the initiatives and legislation listed in Article 1 (8) of the CSRD adding article 29 (b)-5 to the Accounting Directive*.

- Financial KPIs target: point value referred to the target describing the financial impacts generated by ESG transition targets.
- Financial KPIs deviations: risk indicator used to take into account the magnitude of the possible deviations from the target, which describes the financial impacts due to physical and transition risks

These idiosyncratic forward-looking financial KPIs are the input of the credit rating model's financial module. In fact, only the correct implementation of the financial plan is relevant for the attribution of the IRB rating.

Plan's reliability (for both ESG transition and financial plans)

In the process of collecting the information contained in the abovementioned plans, their reliability must also be assessed, since the collected information refers to future events and could therefore be distorted in an optimistic sense.

We suggest to evaluate the reliability of plans (and therefore the reliability of the forward-looking inputs of the IRB model) in a systematic and methodologically sound manner through a backtesting activity that directly implements the ESRS standards' requirements described in paragraph 3.2.

The regulation explicitly defines how to deal with uncertain information regarding the future, which constitutes the content of the plans. The regulation requires that:

« [...] about possible future events that have uncertain outcomes, the undertaking shall consider:

(c) the full range of possible outcomes and the likelihood of the possible outcomes within that range. »

Following Giacomelli (2022), for every KPI considered in the plans (both the ESG transition plan and the financial one) the following interpretation of the aforementioned regulatory requirement is adopted:

- "The full range of possible outcomes" is interpreted as the range comprising the target and all the possible deviations from the target.

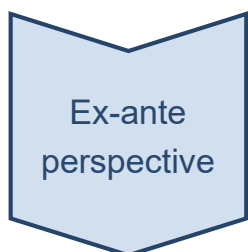
- “The likelihood of the possible outcomes within that range” is interpreted in terms of deviations probability distribution (KPI Risk Profile). The deviations probability distribution allows to define confidence intervals for each KPI to monitor the reliability of the plans based on the results achieved during the implementation of the plans themselves.

Therefore, on the basis of this interpretation, the deviations from targets in the plans (both in the ESG transition plan and in the financial one) have to be:

- Identified ex-ante to describe the plan riskiness (compliant with ESRS) and to compute the related confidence intervals.
- Monitored ex-post to empirically test the plan reliability: any deviations outside these confidence intervals make the plans’ data (both the ESG transition plan’s and the financial one’s) not credible, therefore requiring the updating of both plans.

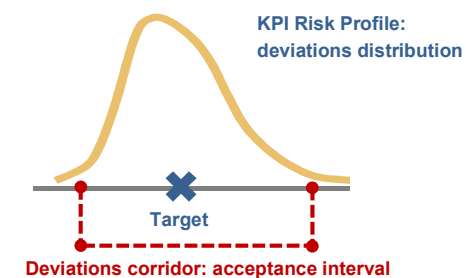
The process of evaluating the plans’ reliability for each individual KPI, by adopting the backtesting methodology described above, is illustrated in the following *Figure 22*.

Figure 22 – Plan's reliability evaluation through backtesting methodology



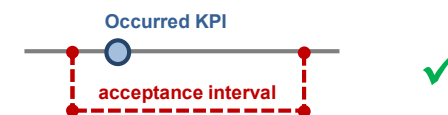
Deviations identified ex-ante through risk assessment:

- ✓ **Deviations causes:** Risk Identification (e.g. physical and transition risk factors)
- ✓ **Deviations order of magnitude:** Risk Quantification
- ✓ Risk assessment articulated on plans with multi-year time horizon



Deviations monitored ex-post through analytical plan reliability testing:

- ✓ **Occurred deviations confirming** the plan reliability and its riskiness
-
- ✓ **Occurred deviations rejecting** the plan reliability:
 - to disclose the management of the unexpected occurred deviations
 - to disclose the revision of the plans and its riskiness



Source: Authors' elaboration.

It should be noted that any occurred deviations that goes beyond the confidence interval does not negatively affect the firm's creditworthiness (PD), but simply makes the financial plan's data not reliable (either negatively or positively). Therefore, in these cases, the financial plan has to be revised before feeding the model to determine the PD.

SMEs engagement

Currently, the ESG transition plans and the related financial plans, connected by the double materiality principle, are mandatory only for firms with more than 250 employees. For smaller firms, i.e., for SMEs, it is necessary to identify the mechanisms that motivate them to prepare such plans on a voluntary basis following the regulatory requirements.

This report aims to motivate SMEs on planning the management of issues judged most relevant for the firm's activity, and which are directly related to the ESG dimensions especially when they require some bank financing. Issues of this nature include the following:

- efficiency of energy sources and stabilization of their cost
- the firm's remaining within large corporates' supply chains
- resilience of production processes to climate change
- compliance with the DNSH criteria of the EU Taxonomy in order to access Public Administration authorizations and to carry out the reporting of projects financed by the Next Generation EU

Formulating the plans to manage such issues and by adopting the compliance requirements offer to SMEs the following advantages:

- An easily identifiable and reliable methodology to measure the ESG gaps to be bridged and the targets to be achieved, as reference is made to the science-based objectives defined by the regulation (EU Taxonomy technical screening criteria).
- Greater ease in disclosing the targets and financing needs, as known and widespread reporting standards are adopted.
- Easier access to credit in order to finance the plans, as formulating a funding request that is compliant with the EU Taxonomy (CapEx plan) allows the bank to enter the credit line in the GAR (Green Asset Ratio) with the related reputational benefits.

It should also be noted that focusing solely on specific business issues allows a «light» and limited implementation of the regulation in the formulation of the plans, which is time- and cost-effective for SMEs.

The collection of these compliant information to feed the credit rating model, consisting of ESG transition plan, financial plan and the plans' reliability assessment, has to be performed using specialised platforms. Recently, the European Commission's science and knowledge service, Joint Research Centre (JRC), has published a Technical Report on platforms to support the EU Taxonomy implementation (Moeslinger, Fazio, & Eulaerts, 2022)³⁷.

Step 2) Credit Rating Model (IRB): specification and parameter estimation

The second step is the Credit Rating Model specification and parameter estimation and it is based on Assumption 3.

Specification

The indirect approach is focused on modifying the financial module of the current IRB models, which have been described in paragraph 5, in particular the logit-probit models, which constitute the financial module, $F(\mathbf{X}_F\boldsymbol{\beta}) = \text{Score}_F$. The inputs of the logit-probit models' current version are historical data (backward-looking) of financial KPIs indicated as \mathbf{X}_F .

The indirect approach requires a specification of these logit-probit models without using ESG variables, but rather using forward-looking financial KPIs. Two versions of model specification can be considered.

³⁷ In this Technical Report the platform developed by KnowShape, a research spin-off of the Ca' Foscari University of Venice, has been selected as "one of the closest aligned solutions with the EU taxonomy". The analysis of this Technical Report is focused on the extension of EU Taxonomy to SMEs. The underlined closeness to the original legislative text ensures that KnowShape platform is suitable for implementing a fully compliant EU Taxonomy assessment in all the firms, both corporates and SMEs.

Version 1 of the indirect approach model specification

In this version, the same financial KPIs used for the current model specification are maintained, but their forward-looking values are considered rather than their historical values, which consist in the financial plan's targets, indicated as X_F^* . This version allows to maintain a significant continuity with the actual IRB models, as historical values are only replaced with the target values of the same financial KPIs.

Analytically the logit-probit model is defined as follows:

$$F(X_F^* \beta) = Score_{F^*}$$

Version 2 of the indirect approach model specification

In the second version, the model specification contains two types of forward-looking financial KPIs: the target values X_F^* , already considered in version 1, and risk indicators for each specific financial KPI, indicated as R_F^* , used to take into account, *ceteris paribus*, the effect of the magnitude of the possible deviations from the target.

Analytically the logit-probit model is defined as follows:

$$F([X_F^* \ R_F^*][\beta \ \gamma]') = Score_{F,R^*}$$

The implications for the parameter estimation of the two model specification versions are analysed in the next paragraph.

Parameter estimation

The two versions of the indirect approach model specification have several implications regarding the parameter estimation.

Version 1 of the indirect approach model specification

By only utilizing the target values for the same financial KPIs used for the current model specification, it is not necessary to re-estimate the related β parameters. The parameter estimates of the current IRB models can be maintained, based on the already available financial KPIs' historical series.

Version 2 of the indirect approach model specification

By using two types of forward-looking variables (target values and risk indicators) the related parameters $[\beta \ \gamma]$ have to be jointly re-estimated.

In this situation it is not possible to use the already available financial KPIs' historical series for the estimation, as there are no historical data on risk indicators, and it is not possible to reconstruct them backwards.

Therefore, the estimation of the parameters $[\beta \ \gamma]$ can only be based on data that are starting to be collected now, taking into account the financial plans' risk indicators that firms must begin to consider on the basis of the new disclosure requirements (CSRD) as well.

Based on the previous considerations, the version 1 of the indirect approach model specification can be adopted immediately (as soon as the first firms' plans have been collected) in order to begin the ESG-adjusted assessments of the counterparties' creditworthiness.

On the contrary, version 2 of the indirect approach model specification, though being more exhaustive from an informative point of view, can only be adopted after having collected the first *cross section* of observations, which include both the risk indicators related to the financial plans and the subsequent observations on the counterparties' solvency or default status, and having estimated the parameters $[\beta \ \gamma]$.

Step 3) ESG adjusted PD term structure: rating attribution

The third step is the indirect approach-based credit rating attribution, consisting in the attribution to the counterparty of a specific ESG-adjusted PD term structure. This third step is based on Assumption 4.

The attributed PD term structure covers the whole multi-year horizon of the ESG transition plan formulated by the firm. In this way, a long-run credit risk assessment is adopted, which is necessary to make the creditworthiness assessment consistent with the time horizons of the transition processes and the duration of the exposures financing them.

In this term structure each PD value (related to a single annual time horizon) is attributed on the basis of the financial targets (which are related to the same annual time horizon of the PD value)

contained in the financial plan that explicitly requires the implementation of the ESG transition plan. It should be noted that these annual PDs can be either positively or negatively affected by the financial plan's forward-looking data.

Therefore, following this approach, the annual PD values to be adopted in the term structure are derived from the traditional PD calibration methods, which are based on the time series of annual default rates.

If a firm does not formulate an ESG transition plan, the information X_F^* , used to feed the aforementioned credit rating model, is not available. This lack of information can be interpreted in different ways in relation to the assessment of the firm's ESG-adjusted creditworthiness. The interpretation differs based on whether the counterparty is:

- a firm with more than 250 employees (corporate), therefore having to apply the CSRD.
- a firm with less than 250 employees (SMEs).

In fact, the CSRD requires corporates to conduct and disclose their materiality assessment for each sustainability matter. This assessment allows to determine whether or not the business model is exposed to significant ESG risk factors (which can influence its creditworthiness) and therefore whether or not it is necessary to formulate a transition plan to manage such risk factors.

Consequently, the lack of an ESG transition plan to present to a bank, and therefore the lack of the input information X_F^* , signifies that, following the materiality assessment, the firm has not identified any material sustainability matter in a forward-looking perspective. This in turn means that there should not be significant variations in the counterparty's PD due to ESG dimension.

On the contrary, if an SME does not present an ESG transition plan to a bank, there are no other mandatory sources of information needed to determine whether the firm is affected or not, in a forward-looking perspective, by any material sustainability matter and therefore whether or not any significant change in the counterparty's PD due to ESG dimensions should be considered.

The lack of an ESG transition plan can occur in two very different situations:

- The firm is not affected by any material sustainability matter in a forward-looking perspective. Therefore, the lack of an ESG transition plan is justified; in this case its PD should not change.

- The firm is not aware that it is exposed to significant ESG risk factors in a forward-looking perspective; in this case, the firm is actually riskier, and its PD should increase. It is reasonable to assume that this second case is the most frequent among SMEs.

Consequently, with the lack of SMEs' ESG transition plans to present to a bank, the lack of additional information allowing to distinguish the two aforementioned situations should lead the regulatory override process to increase the PD as a precautionary measure.

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6. Conclusions

The **path towards sustainability** traced by **the European Green Deal** is **long** and **challenging** as the **objectives** set by **2050**, but there is no doubt it will lead to a radical change in the behavior of European companies.

The guidelines for the **definition** of an **efficient ESG questionnaire** have been identified through the study of the **EFRAG standards**, **market research** and the **active participation** in **working group** composed by **experts** and **institutions** and consist in the creation of a **standard questionnaire** differentiated by **type of company** and **level size**.

A **standard ESG questionnaire**, which therefore provides a set of **minimum information**, allows a **series** of **benefits**, including: an **easier access** to **credit** for **SMEs**, the drafting of a **higher GAR** (Green Asset Ratio) for **Banks** that provide **credit** to **virtuous companies** in terms of sustainability and a **lower credit risk** for Banks (which impacts LGD and PD), since the **correlation between sustainability indicators** and **risk indicators** is **evident**, **returning advantages** and **positive accounting** and **financial aspects**.

To include the relevant information in the credit evaluation process, an **approach to integrate ESG information in credit rating models**, denominated “indirect approach”, is proposed pursuing two main objectives: compliance with European sustainability reporting and technical feasibility for the banking system.

Although the path is long and complex, **Italian SMEs** are **starting** to **approach sustainability issues** and helping companies to **produce ESG information**, **collect** and **analyze them** is the **key to ESG transformation**.

Appendix 1: Regulatory Annex

European sources of regulation on ESG disclosure for firms

The regulations on ESG disclosure play a fundamental role in the integration of ESG information in credit rating models, as they potentially define, for all firms, homogeneous information sources that can be adopted as inputs. As anticipated, at the European level, the two main sources are the EU Taxonomy and the European Sustainability Reporting Standards of EFRAG.

In this paragraph their main features will be summarized, focusing on their forward-looking information requests. In fact, as it will be analysed in paragraph 6, this type of information is essential for integrating ESG information into credit rating models.

EU Taxonomy for sustainable activities (Regulation EU 2020/852)

The general architecture of the EU Taxonomy for sustainable activities

Introduced on 18 June 2020 by the European Parliament and Council with the Regulation (EU) 2020/852 ('Taxonomy Regulation')³⁸, the European Taxonomy has the objective to define a set of unambiguous criteria to determine whether an economic activity can be considered environmentally sustainable and to establish the degree to which an investment is accordingly sustainable. The provisions of the Taxonomy Regulation directly concern all firms subject to the obligation to draw up Non-Financial Statements (NFS) pursuant to articles 19a or 29a of Directive 2013/34/EU.

The main features of the European Taxonomy can be summarized with the following four topics:

Topic 1: Environmental objectives.

Topic 2: Technical screening criteria.

Topic 3: Steps for assessing the eco-sustainability of an economic activity.

Topic 4: Types of economic activities.

Topic 1 – Environmental objectives

³⁸ For further information on the contents of the European Taxonomy and its requests of forward-looking information, see Giacomelli A. (2021), *EU Sustainability Taxonomy for non-financial undertakings: summary reporting criteria and extension to SMEs*, Working Papers Series, Department of Economics, Ca' Foscari University of Venice, No. 29/WP/2021, ISSN 1827-3580.

The environmental objectives are defined at the regulatory level and are common to all firms subjected to the Taxonomy Regulation. In fact, to be considered sustainable, an economic activity must pursue one or more of the six environmental objectives set out in the Regulation 2020/852: climate change mitigation, climate change adaptation, the sustainable use and protection of water and marine resources, the transition to a circular economy, pollution prevention and control, the protection and restoration of biodiversity and ecosystems.

Topic 2 – Technical screening criteria

As previously seen, the objective of the European Taxonomy is to define a set of unambiguous criteria to determine whether an economic activity can be considered environmentally sustainable. These are the technical screening criteria that define:

- Under what specific conditions it can be considered that an economic activity contributes substantially to the achievement of one of the environmental objectives.
- Under what specific conditions it can be considered that an economic activity does not significantly harm to one or more of the other objectives, namely the DNSH principle.

It should be noted that the content of the technical screening criteria is not reported within the Regulation 2020/852 but are defined by the European Commission through specific Delegated Acts³⁹.

Topic 3 – Steps for assessing the eco-sustainability of an economic activity

To determine if an economic activity can be considered environmentally sustainable, it is necessary to follow three sequential steps:

- **Step 1 – Substantial contribution:** assessing that the economic activity substantially contributes to the achievement of one or more environmental objectives based on specific indicators and thresholds detailed in the relative technical screening criteria.
- **Step 2 – Do no significant harm (DNSH):** assessing that the economic activity does not significantly harm any of the remaining environmental objectives, based on specific indicators and thresholds detailed in the relative technical screening criteria. The environmental objectives defined by the Taxonomy Regulation represent a set of objectives that shall be pursued synergically to ensure an effective transition process towards an environmentally sustainable economic system. This synergy among the environmental objectives requires that

³⁹ At the time of writing, the European Commission has published the technical screening criteria relating only to the first two environmental objectives (climate change mitigation and climate change adaptation) through the adoption of the so-called Climate Delegated Act on June 4, 2021.

an economic activity contributing to one of them cannot significantly harm the others, thus undermining the effectiveness of the transition process. In other words, the pursuit of one environmental objective shall not be achieved at the expense of the remaining ones.

- **Step 3 - Minimum safeguards:** assessing that the economic activity is carried out in compliance with minimum social safeguards. The minimum safeguards are a set of procedures that the firm shall implement in order to ensure that an economic activity is carried out in compliance with certain essential social principles laid down in the “OECD Guidelines for Multinational Enterprises” and in the “United Nations Guiding Principles on Business and Human Rights”.

Topic 4 – Types of economic activities

Based on the outcome of the eco-sustainability assessment, economic activities carried out by firms can be divided into three types:

- Taxonomy-aligned economic activity: an economic activity that, on the basis of specific indicators and thresholds detailed in the relative technical screening criteria laid down in the European Commission Delegated Acts, substantially contributes to the achievement of one or more environmental objectives and that does not significantly harm any of the remaining environmental objectives.
- Taxonomy-eligible economic activity: an economic activity that is described in the European Commission Delegated Acts, irrespective of whether that economic activity meets any or all of the technical screening criteria laid down in those delegated acts.
- Taxonomy-non-eligible economic activity: any economic activity that is not described in the European Commission Delegated Acts.

A focus on the forward-looking information requests: the CapEx Plan

The Article 8 of the Taxonomy Regulation introduces a set of disclosure requirements on the outcomes of the eco-sustainability assessment carried out by firms. On 6 July 2021, the European Commission drew up the Delegated Act on Article 8 by detailing the disclosure requirements both for non-financial firms and for financial ones and introducing a set of provisions that apply to all firms subject to the obligation to draw up the Non-Financial Statement (NFS), also requiring some additional information content.

Non-financial firms must disclose within the NFS, in a proper section:

- The proportion of their turnover derived from products or services associated with economic activities that qualify as environmentally sustainable, the so-called Turnover KPI.
- The proportion of their capital expenditure (CapEx KPI) and the proportion of their operating expenditure (OpEx KPI) related to assets or processes associated with economic activities that qualify as environmentally sustainable.

Credit institutions must disclose within the NFS, in a proper section:

- The Green Asset Ratio (GAR). The numerator of the GAR is composed, depending on the specific KPI, of loans and advances, debt securities, equities or repossessed collateral, financing Taxonomy-aligned economic activities carried out by their client undertakings. The denominator is composed of Total Covered Assets, or, depending on the specific KPI, the total of loans and advances, the total of debt securities, the total of equities or repossessed collateral and all other covered assets on the balance sheet.

Each of the three KPIs required for non-financial firms (Turnover, CapEx, OpEx) are calculated as ratios. To illustrate how these ratios are calculated, it is necessary to consider the CapEx Plan. The CapEx Plan is a formal planning document that shall be articulated at the level of individual economic activities carried out by the firm, it shall be approved by the Board of Directors, and it shall specify the objectives that the undertaking has set regarding:

- a) The expansion of Taxonomy-aligned economic activities carried out by the firm. This expansion must be completed within a period of five years.
- b) The development of Taxonomy-eligible economic activities carried out by the firm to become Taxonomy-aligned within a period of five years.

To assess the alignment to the Taxonomy Regulation, the target values set in the CapEx Plan must be referred to the variables and thresholds contained in the technical screening criteria. The formulation of the CapEx Plan, therefore, requires to provide idiosyncratic forward-looking information.

After defining what the CapEx Plan is, let us turn on the methods for computing the numerator and the denominator for each of the three KPIs' ratios.

Turnover KPI

- Numerator: turnover derived from products or services associated with Taxonomy-aligned economic activities.
- Denominator: total turnover.

CapEx KPI

- Numerator: part of the capital expenditure:
 - Related to assets or processes that are associated with Taxonomy-aligned economic activities.
 - Part of a plan (CapEx Plan) to:

- a) expand Taxonomy-aligned economic activities.
- b) allow other Taxonomy-eligible economic activities to become aligned to the Taxonomy Regulation's environmental sustainability criteria within a period of five years.

- Related to the purchase of output from Taxonomy-aligned economic activities

- Denominator: it shall cover additions to tangible and intangible assets during the financial year considered before depreciation, amortisation and any re-measurements and excluding fair value changes. The denominator shall also cover additions to tangible and intangible assets resulting from business combinations.

OpEx KPI

- Numerator: part of the operational expenditure:
 - Related to assets or processes associated with Taxonomy-aligned economic activities, including training and other human resources adaptation needs, and direct non-capitalised costs that represent research and development.
 - Part of a plan (CapEx Plan) to:
 - a) expand Taxonomy-aligned economic activities.
 - b) allow other Taxonomy-eligible economic activities to become aligned to the Taxonomy Regulation's environmental sustainability criteria within a period of five years.
- Denominator: it shall cover direct non-capitalised costs that relate to research and development, building renovation measures, short-term lease, maintenance and repair, and any other direct expenditures relating to the day-to-day servicing of assets of property, plant and equipment by the undertaking or third party to whom activities are outsourced that are necessary to ensure the continued and effective functioning of such assets.

It is relevant to underline that in the Annex I of the Delegated Act on Article 8 the numerators of the ratios have to consider jointly:

- The economic activities that are already aligned; and
- The economic activities for which an alignment plan has been provided on the basis of the Capex Plan.

In conclusion, a portion of the numerator that enters in the calculation formulas of CapEx and OpEx KPI consists of expenses related to the targets defined in the Capex Plan; this requirement introduces the need of planning and the idiosyncratic forward-looking information *ex lege* within the Non-Financial Statements, characterized up to now by a purely backward-looking perspective.

CSDR and EFRAG standards

The general architecture of the new EFRAG European Sustainability Reporting Standard

On 14th December 2022, the European Parliament and the Council have adopted the Corporate Sustainability Reporting Disclosure (CSRD). By amending the Non-Financial Reporting Directive (NFRD), the CSRD defines the regulatory guidelines within which European Sustainability Reporting Standards (ESRS) must be developed. These ESRS will be adopted by the European Commission as delegated acts, based on the technical advice provided by the European Financial Reporting Advisory Group (EFRAG). Compared to the NFRD's sustainability reporting requirements, the principal proposals of the CSRD are:

- to extend the scope of the reporting requirements to additional companies, including all large companies and listed companies (except listed micro-companies).
- to require assurance of sustainability information. Currently, the CSRD requires that all sustainability reports must be subjected to a "limited assurance". However, the CSRD aims to make "reasonable assurance" (i.e., the one to which financial statements are subject) mandatory in a limited period of time.
- to specify in more detail the information that companies should report, and require them to report in line with mandatory European Sustainability Reporting Standards (ESRS).
- to ensure that all information is published as part of companies' management reports, and disclosed in a digital, machine-readable format.

In November 2022, EFRAG published the 12 ESRS Final Drafts covering the full range of sustainability matters: environment, social, governance and cross-cutting standards. From the analysis of these Final Drafts, it is possible to define the general architecture and principles that characterize the ESRS, which can be described with the following 4 elements:

Element 1: Double Materiality

First of all, the Final Draft ESRS require that a firm has to disclose all material information on sustainability matters carrying out a double materiality assessment. Double materiality has two dimensions: impact materiality and financial materiality. A sustainability matter meets the criterion of double materiality if it is material from the impact perspective or the financial perspective or both.

A sustainability matter is material from an impact perspective when it pertains to the undertaking's material actual or potential, positive or negative impacts on people or the environment over the short-, medium- and long-term time horizons.

A sustainability matter is material from a financial perspective if it triggers or may trigger material financial effects on the undertaking. A sustainability matter triggers financial effects on the undertaking when it generates risks or opportunities that have an influence (or are likely to have

an influence) on the undertaking's cash flows, performance, position, development, cost of capital or access to finance in the short, medium- and long-term time horizons.

Impact materiality and financial materiality assessments are inter-related and the interdependencies between these two dimensions shall be considered. In general, the starting point is the assessment of impacts.

Element 2: Three layers of disclosure

The Final Draft ESRS aim to promote relevant, faithful and comparable information in a proportional manner. In order to achieve these results, the Final Draft ESRS adopt a three-layers approach:

- a) Sector-agnostic disclosures: first layer of standardised disclosure requirements that are likely to be material for all firms across sectors.
- b) Sector-specific disclosures: second layer of standardised disclosure requirements that are likely to be material for all firms in each given economic sector.
- c) Entity-specific disclosures: third layer of entity-specific disclosures requirements, that is, a set of disclosures requirements relating to sustainability matters that a firm considers material from a double materiality perspective, but which are not covered or covered with insufficient granularity within the ESRS sector-agnostic or sector-specific disclosures.

Element 3: Three sustainability topics (ESG pillars)

A firm, disclosing the material sustainability matters (element 1) articulated in the three layers of disclosure (element 2), must cover all the three ESG sustainability topics (element 3): environmental matters, social matters, and governance matters. Therefore, the Final Draft ESRS include three set of Topical Standards, one for each of the three ESG sustainability topics, which contain the sector-agnostic disclosure requirements on how to report on impacts, risks and opportunities related to their specific ESG sustainability topic.

- a) Environmental Topical Standards: environmental topical standards are composed of five standards, each of which addresses a specific environmental sub-topic. The five environmental sub-topics are the same as the environmental objectives defined by the Taxonomy Regulation.
- b) Social Topical Standards: social topical standards are composed of four standards each of which addresses a specific social sub-topic.
- c) Governance Topical Standards: there is one governance topical standard, containing disclosure requirements which will enable users of the firm's sustainability statements to understand the firm's strategy and approach, processes and procedures as well as its performance in respect of business conduct.

Element 4: Four reporting areas

In reporting all the material sustainability matters (element 1) articulated in the three layers of disclosure (element 2) for the three sustainability topics (element 3) as previously seen, a firm shall cover four reporting areas (element 4):

- a) Governance: with regard to this first reporting area the firm is required to disclose, for each material sustainability matter, the governance processes, controls and procedures used to monitor and manage impacts, risks and opportunities related to the material sustainability matter.
- b) Strategy: with regard to this second reporting area the firm is required to disclose for each material sustainability matter:
- the elements of its strategy that relate to or affect sustainability matters, its business model and its value chain.
 - how the interests and views of its stakeholders are considered by the firm's strategy and business model.
 - the outcome of its assessment of material impacts, risks and opportunities, including how they inform its strategy and business model.

Moreover, the Final Draft ESRS require firms to disclose information about the resilience of the firm's strategy and business model regarding its capacity to address its material impacts and risks and to take advantage of its material opportunities.

- c) Impact, risk and opportunity management: with regard to this third reporting area the firm is required to disclose for each material sustainability matter:
- the processes to identify and manage material impacts, risks and opportunities; and
 - the information that, as a result of its materiality assessment, the firm has included in the sustainability reporting.

A firm must describe its process to address material impacts, risks and pursue material opportunities through Policies and Action Plans:

- A Policy is a framework for implementing the firm's strategy related to a material sustainability matter. Each Policy includes one or more objectives, linked when applicable to measurable targets. A Policy is implemented through action plans.
 - Action Plans are plans aimed to ensure that the firm delivers against targets set and through which the firm seeks to address material impacts, risks and opportunities. The firm must also disclose decisions to support Action Plans with financial, human or technological resources.
- d) Metrics and targets: with regard to this fourth reporting area the firm is required to disclose, for each material sustainability matter, which metrics it uses to measure its performance, the

target it has set and the progress against those targets in order to track the effectiveness of its Policies and Action Plans.

- Metrics refer to qualitative and quantitative indicators that the firm uses to measure and report on the effectiveness of the delivery of its sustainability-related Policies and against its targets over time.
- Targets are measurable, outcome-oriented goals that the firm aims to achieve in relation to material impacts, risks or opportunities. The firm must track the effectiveness of its Policies and Action Plans through monitoring its targets.

A focus on the forward-looking information requests: the ESRS planning process

As can be seen from the previous paragraph, the Final Drafts ESRS require that a firm, in formulating its sustainability report, not only shall take into consideration the backward-looking information but, above all, it must focus on the forward-looking information describing the future developments of the business model and strategy, in relation to the material sustainability matters.

To provide forward-looking information is not merely a request to disclose qualitative information on management expectations on future business developments. On the contrary, the Final Drafts ESRS explicitly require that a firm implements the following structured planning process:

1. First of all, the double materiality assessment must be conducted for all the sustainability matters using forward-looking information. In this way, sustainability impacts, risks and opportunities are identified.
2. After identifying the material sustainability impacts, risks and opportunities using a forward-looking perspective, the firm must:
 - Define the **Policies** to manage those impacts, risks and opportunities, identifying a set of sustainability objectives.
 - Define **metrics** and related outcome-oriented **targets** to be achieved for pursuing the sustainability objectives defined within the policies.
 - Formulate the **Action Plans** on key actions planned in the short-, medium- and long-term, aimed to reach the firm's policy objectives and targets.
 - Define the resources (financial, human or technological) to be allocated to support the action plans' implementation.
3. Finally, the firm must continuously monitor the progress against the targets it has set in order to measure its sustainability performance and track the effectiveness of its Policies and Action Plans over time.

As just seen, the planning process requires firms to disclose forward-looking information about possible future events regarding material sustainability matters. The disclosure of information such as explanations about possible future events have uncertain outcomes, thus, firms have to make estimates in conditions of uncertainty.

For this reason, the Final Draft ESRS 1, at paragraph 94, requires that, in judging whether information about possible future events is material, a firm shall consider:

- the potential effects of the events on the value, timing and certainty of the firm's future cash flows, development, performance and position including in the long term (the possible outcome).
- the potential effects of the events on the determinants of severity and on the likelihood of material impacts on people or the environment.
- the full range of possible outcomes and the likelihood of the possible outcomes within that range.

Sources of regulation on the integration of ESG information in credit risk

Following the increasing need to address the issues of ESG risk management within credit institutions, authorities in the banking sector have produced regulations regarding the integration of ESG in credit risk management. The most relevant regulatory sources on this topic are presented below.

European Central Bank (ECB)

- European Central Bank. (2020, November 27). *Guide on climate-related and environmental risks*.

The ECB "*Guide on climate-related and environmental risks*" outlines the ECB's understanding of the safe and prudent management of climate-related and environmental risks under the current prudential framework. The ECB Guide describes how the ECB expects credit institutions to consider climate-related and environmental risks – as drivers of existing categories of risk – when formulating and implementing their business strategy and governance and risk management frameworks. It further explains how the ECB expects institutions to become more transparent by enhancing their climate-related and environmental disclosures.

Regarding the integration of climate-related risks performance within the creditworthiness assessment of counterparty firms, the Expectation 8 on Credit Risk Management states that "*In their credit risk management, institutions are expected to consider climate-related and environmental risks at all relevant stages of the credit-granting process and to monitor the risks in their portfolios.*"

Moreover, climate-related and environmental risks are expected to be included in all relevant stages of the credit-granting process. Specifically, credit institutions are expected to form an opinion on how climate-related and environmental risks affect the borrower's default risk.

The climate-related and environmental factors material to the default risk of the loan exposure are expected to be identified and assessed. As part of this assessment, institutions may take into consideration the quality of the clients' own management of climate-related and environmental risks. Institutions are expected to consider changes in the risk profile of sectors and geographies driven by climate-related and environmental risks.

Risk classification procedures are expected to be adjusted in order to identify and evaluate climate-related and environmental risks. In this context, appropriate general risk indicators for their counterparties shall be defined. These risk indicators shall consider climate-related and environmental risks. As part of risk classification procedures, institutions are expected to identify borrowers that may be exposed, directly or indirectly, to increased climate-related and environmental risks. Critical exposures to such risks should be highlighted and, where applicable, considered under various scenarios with the aim of ensuring the ability to assess and introduce in a timely manner any appropriate risk mitigation measures.

Even institutions' loan pricing frameworks are expected to reflect their credit risk appetite and business strategy about climate-related and environmental factors. The ECB expects that an institution's risk committee shall review whether the prices of assets offered to clients take the business model and risk strategy fully into account.

Moreover, institutions' loan pricing is expected to reflect the different costs driven by climate-related and environmental risks. As set out in the EBA Guidelines on loan origination and monitoring, institutions should implement a pricing framework linked to the characteristics of the loan, considering all relevant costs. The impact of climate-related and environmental risks may play out through various cost drivers, such as the cost of capital, funding, or credit risk

European Banking Authority (EBA)

- [European Banking Authority. \(2020, May 29\). Guidelines on loan origination and monitoring. EBA/GL/2020/06.](#)

The EBA Guidelines on loan origination and monitoring require that banks make use of idiosyncratic forward-looking information in the credit granting process to analyse the creditworthiness of firms that are banks' counterparties. The forward-looking information concerns the financial dimension of the counterparty firms.

In paragraph 31 it is said that *"The credit risk appetite should be implemented with the support of appropriate credit risk metrics and limits. These metrics and limits should cover key aspects of the credit risk appetite, as well as client segments, currency, collateral types and credit risk mitigation instruments. When relevant, credit metrics should be a combination of backward-looking and forward-looking indicators and should be tailored to the business model and complexity of the institution."*

The paragraph 31 highlights the need not to limit the creditworthiness analysis to historical data only (backward-looking). Given the limitations of these historical indicators, it is required to

evolve the creditworthiness analysis by integrating historical information with forward-looking information. This integration has the purpose of correcting the historical information with all the aspects concerning the new objectives that characterize the prospective management of firms.

Furthermore, in paragraph 156 it is specified that the required forward-looking information must also be idiosyncratic, in fact, in paragraph 156 it is said that *"Institutions should assess the sustainability and feasibility of the borrower's financial position and the future repayment capacity under potential adverse conditions that may occur in the duration of the loan agreement. To this end, institutions should carry out a single- or multifactor sensitivity analysis, considering market and idiosyncratic events, or a combination of any of them."*

A set of metrics for credit granting and monitoring are identified in Annex 3 of the EBA Guidelines. These metrics, coherently with the requirements discussed above, must be assessed using a forward-looking perspective at the idiosyncratic level of the individual firm. For example, within the metrics for micro, small, medium-sized and large enterprises a firm's future cash flow analysis is required.

The EBA Guidelines on loan origination and monitoring, although they introduce innovative components into banking regulations in relation to the use of idiosyncratic forward-looking information, present the following two open issues which must be addressed:

1. Giving a structured definition of forward-looking information: within the EBA Guidelines, a structured definition of forward-looking information is not given. The regulation lacks structured methodologies for the formulation and representation of idiosyncratic forward-looking information. Furthermore, the EBA Guidelines do not define characteristics of forward-looking information quality which must be guaranteed to have reliable information.
 2. Considering idiosyncratic forward-looking risks: lacking a structured definition of idiosyncratic forward-looking information, the EBA Guidelines do not define how the risks associated with forward-looking information should be considered. This is a relevant issue, given that idiosyncratic forward-looking information must be used:
 - in the overall credit granting processes and
 - in sensitivity analysis to assess the sustainability and feasibility of the counterparty's financial position and the future repayment capacity.
- European Banking Authority. (2022, January 24). Final draft implementing technical standards on prudential disclosures on ESG risks in accordance with Article 449a CRR. EBA/ITS/2022/01.

This report presents the EBA final draft ITS on **Pillar 3** disclosures on ESG risks, which put forward tables, templates and associated instructions that specify the requirement in Article 449a of Regulation (EU) No 575/2013 (the so-called *Capital Requirements Regulation*) to disclose prudential information on environmental, social and governance (ESG) risks, including

transition and physical risk, addressed to large institutions with securities traded on a regulated market of any Member State. The ITS include:

- tables for qualitative disclosures on environmental, social and governance risks.
- templates with quantitative disclosures on climate change transition risk.
- a template with quantitative disclosures on climate change physical risk.
- templates with quantitative information and key performance indicators (KPIs) on climate change mitigating measures, including the Green Asset Ratio (GAR) on Taxonomy-aligned activities according to Regulation (EU) 2020/852 (the so-called *Taxonomy Regulation*), extended information on Taxonomy alignment of exposures in the banking book (BTAR) and other mitigating actions.

In developing these ITS the EBA is following a sequential approach, with an initial focus on climate-change-related risks, given the urgency of the topic, in line with the developments taking place at EU and at international level and considering the data and methodological challenges faced by institutions at this stage. For these reasons, these ITS cover:

- quantitative information on climate-change-related risks (transition and physical risks).
- the disclosure of a Green Asset Ratio (GAR) on EU Taxonomy-aligned activities for exposures towards counterparties subject to disclosure obligations under Directive 2014/95/EU (Non-Financial Reporting Directive – NFRD).
- the disclosure of a Banking Book Taxonomy Alignment Ratio (BTAR) on EU Taxonomy-aligned activities that also includes exposures towards counterparties not subject to disclosure obligations under the NFRD.
- the disclosure of other mitigating actions, together with qualitative disclosures on the broader scope of environmental, social and governance risks. The ITS will be extended at a later stage to broaden the scope of the quantitative disclosures.

In the case of climate change transition risk, the EBA asks institutions to disclose information on exposures towards sectors that highly contribute to climate change, with a breakdown on the one hand of exposures towards fossil fuel and other carbon-related corporates and on the other hand of Taxonomy-aligned exposures. This information is combined with information on financed greenhouse gas (GHG) emissions, that is, scope 1, 2 and 3 emissions of an institution's counterparties financed by the institution, and on the distance to a Paris-aligned scenario. Finally, information on the energy efficiency of the real estate portfolio of the institution is also required.

In the case of climate change physical risk, institutions are asked to identify those exposures towards sectors and geographies that may be negatively impacted by climate change events linked to physical acute and chronic risks, and a disclosure template including this information is included in the ITS.

Finally, institutions are asked to disclose quantitative information on the actions that they are putting in place to mitigate climate-change-related risks, including information on Taxonomy-aligned actions (GAR and BTAR) and on other mitigating actions.

Bank for International Settlement (BIS)

- Bank for International Settlement. (2022, June 15). *Principles for the effective management and supervision of climate-related financial risks.*

This document includes 18 high-level principles. Principles 1 through 12 provide banks with guidance on effective management of climate-related financial risks, while principles 13 through 18 provide guidance for prudential supervisors. The principles seek to achieve a balance in improving practices related to the management of climate-related financial risks and providing a common baseline for internationally active banks and supervisors, while maintaining sufficient flexibility given the degree of heterogeneity and evolving practices in this area.

Regarding the integration of climate-related risks within the creditworthiness assessment, the principle 8 on Comprehensive Management of Credit Risk states that *"Banks should understand the impact of climate-related risk drivers on their credit risk profiles and ensure credit risk management systems and processes consider material climate-related financial risks."*

Moreover, paragraph 35 under principle 8 states that *"Banks should have clearly articulated credit policies and processes to address material climate-related credit risks. This includes prudent policies and processes to identify, measure, evaluate, monitor, report and control or mitigate the impacts of material climate-related risk drivers on their credit risk exposures (including counterparty credit risk) on a timely basis. Banks should incorporate consideration of material climate-related financial risks into the entire credit life cycle, including client due diligence as part of the onboarding process and ongoing monitoring of clients' risk profiles."*

Furthermore, in the context of comprehensive risk management, BIS requires that banks should also identify, measure, evaluate, monitor, report and manage the concentrations within and between risk types associated with climate-related financial risks. For example, banks could use metrics or heatmaps to assess and monitor concentration of exposure to geographies and sectors with higher climate-related risk.

Banks are not only required to identify their climate-risk exposures, by contrast they have to consider a range of risk mitigation options to control or minimise material climate-related credit risks. These options may include adjusting credit underwriting criteria, deploying targeted client engagement, or imposing loan limitations or restrictions such as shorter-tenor lending, lower loan-to-value limits or discounted asset valuations. Banks could also consider setting limits on or applying appropriate alternative risk mitigation techniques to their exposures to companies, economic sectors, geographical regions, or segments of products and services that do not align with their business strategy or risk appetite.

In addition to the integration of climate-risks in the credit risk assessment, within the principles proposed by the BIS there are also references to the use of a forward-looking perspective for

the management of climate-related risks, for example, paragraph 51 under principle 13 on Prudential Regulatory and Supervisory Requirements for Banks states that *"Supervisors should [...] assess the bank's long-term approach to, addressing climate-related financial risks in a forward-looking manner. [...]"*

Bank of Italy

- Bank of Italy. (2022, April 08). *Aspettative di vigilanza sui rischi climatici e ambientali*.

In this document Bank of Italy states that it is aware of the fact that climatic and environmental risks – which can be traced back to traditional financial risks (credit, market, operational and liquidity risk) – also have implications for banks and other financial intermediaries under its direct supervision. Therefore, in line with similar initiatives already adopted by the ECB (for further information see paragraph 4.1), the document contains a first set of supervisory expectations regarding the integration of climate and environmental risks into corporate strategies and governance systems and control, in the risk management framework and in the disclosure of supervised banking and financial intermediaries. Bank of Italy believes that, although focused on environmental aspects, institutions can also consider these expectations with reference to the more general category of ESG risks, where relevant for their operations and considering the regulatory requirements of the sector.

Regarding the integration of climate-related risks performance within the creditworthiness assessment of counterparty firms, the Expectation 8 on Credit Risk Management takes up what was presented by ECB in the *"Guide on climate related risk"* and refers directly to EBA *"Guidelines on loan origination and monitoring"*. In fact, Expectation 8 on Credit Risk Management states that *"Intermediaries integrate climate and environmental risks in all phases of the credit process, adapting the related policies and procedures in line with the GL EBA on the granting and monitoring of loans (EBA/GL/2020/06)"*

Bank of Italy requires that intermediaries must consider climate and environmental risks and their related impacts on credit risk, in particular in:

- granting new loans;
- monitoring the level of sectoral and geographic concentration of the loan portfolio;
- assessing the guarantees supporting the loans.

Moreover, as part of the credit granting process, Bank of Italy requires intermediaries to formalize operational criteria, both qualitative and quantitative, on the basis of which to distinguish sectors of economic activities and individual borrowers according to their exposure to climate and environmental risks. For example, the use of the so-called "heatmaps" indicating vulnerability to climate and environmental risks.

Finally, Bank of Italy requires that intermediaries must map the geographical location and economic sector of borrowers' activities, classifying them according to their degree of vulnerability to physical and transitional risk. In addition, for borrowers associated with higher

environmental and climate risks, an in-depth analysis of the business model will be appropriate, considering the current and/or prospective impacts of regulatory policies.

Appendix 2: Examples of credit rating models in major European banks

After having summarised the current international best practice for developing credit rating models, in this paragraph some brief examples of rating models developed by two of the main European banks will be illustrated.

These examples are aimed at highlighting how internal models adopted by banks can all be considered particular cases of the general approach described in the previous paragraph 5.1.

The credit rating model of UniCredit

Banca d'Italia with act No.365138 dated 28 March 2008 has authorized UniCredit group to use the Internal Rating Based Advanced approach to determine capital requirements for credit and operational risks. Thus, UniCredit has been authorized to use internal estimations of PD, LGD and EAD⁴⁰.

Italian Corporate Rating model

The Integrated Corporate Rating (RIC) model provides a rating for the UniCredit's counterparties included in the Mid-Corporate segment with revenue (or total assets if revenue information is not available) from €5 million to €250 million. In 2019 the model has been reviewed extending the scope to Holdings & Financial Enterprises with total assets above €250 million.

The structure of the credit rating model consists of three basic modules, two of which are quantitative and one qualitative:

1. the economic-financial module: this module considers the financial statements information of the counterparty, that are: cash flows and profitability, financial charges, financial structure and composition of debt, financial stability and liquidity; growth, volatility and operational structure.
2. the behavioural modules: this module is divided into an Internal behavioural sub-module developed on the basis of internal data sources, and an External behavioural sub-module

⁴⁰ All the information reported here is publicly available within the UniCredit Group Disclosure on Pillar III as of 31 December 2021.

developed on the basis of external data provided by Central Credit Archive ("Centrale Rischio"), allowing customer's monitoring in terms of cash loans, withdrawal, short term maturity, long term maturity, self-liquidating loans, loan guarantees.

3. the qualitative module: this module considers the answers to the questions of the qualitative questionnaire filled out during the application phase by relationship managers.

Dedicated versions of the Financial, Behavioural and Qualitative modules have been developed for the three macro-segments covered by the new RIC model: Industrial, Real Estate and Holding & Financial.

UniCredit Group Master Scale

The UniCredit Master Scale is adopted to have a common and shared vision of the customer riskiness at Group level and to increase communication or management reporting. The Master Scale has been developed relying on the following three assumptions:

1. the investment grade/non-investment grade rating classes are clearly separated.
2. the range of PD is sufficiently large, the default classes correspond to those defined by EBA.
3. the Master Scale is based on the Standard & Poor's rating scale: Investment grade classes are closely aligned, while the non-investment rating classes are more granular.

The Master Scale is presented below (Figure 5), showing the correspondence between the rating classes and the linked PDs:

UniCredit Group Master Scale

RATING CLASS (DISAGGREGATED AND AGGREGATED)		PD MIN	PD MAX	S&P PROXY RATING EQUIVALENT
A	01	0.0000%	0.0036%	AAA
B1	02	0.0036%	0.0065%	AA+
B2		0.0065%	0.0116%	AA
B3		0.0116%	0.0208%	AA-
C1	03	0.0208%	0.0371%	A+
C2		0.0371%	0.0663%	A
C3		0.0663%	0.1185%	A-
D1	04	0.1185%	0.2116%	BBB+
D2		0.2116%	0.3779%	BBB
D3		0.3779%	0.5824%	BBB-
E1	05	0.5824%	0.7744%	BB+
E2		0.7744%	1.0298%	BB
E3		1.0298%	1.3693%	BB-
F1	06	1.3693%	1.8209%	B+
F2		1.8209%	2.4214%	B+
F3		2.4214%	3.2198%	B+
G1	07	3.2198%	4.2816%	B
G2		4.2816%	5.6935%	B
G3		5.6935%	7.5710%	B
H1	08	7.5710%	10.0677%	B-
H2		10.0677%	13.3876%	B-
H3		13.3876%	17.8023%	B-
I1	09	17.8023%	23.6729%	CCC
I2		23.6729%	31.4793%	CC
I3		31.4793%	99.9999%	C
X1	10	Past due	100%	D
X2		Unlikely to pay	100%	D
X3		Bad loans	100%	D

Source: UniCredit Group Disclosure on Pillar III as of 31 December 2021

The credit rating model of Deutsche Bank

Based on the approvals of the German Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) and ECB, Deutsche Bank applies the advanced Internal Rating Based approach to the majority of its credit portfolios in order to determine capital requirements for credit and operational risks. Thus, Deutsche Bank has been authorized to use internal estimations of PD, LGD and EAD⁴¹.

Credit ratings are derived on internal rating models which specify consistent and distinct customer-relevant criteria and assign a rating grade based on a specific set of criteria as given for a certain customer. All credit ratings are associated to a probability of default that is assigned as a function of a 21-grade Master Scale.

The set of criteria used for the specific rating model is generated from information relevant for the respective customer segments. The information used are, usually:

1. Financial data
2. Internal and external behaviour
3. Qualitative data

The methods in use to assess the credit ratings range from statistical models to expert-based models considering the relevant available quantitative and qualitative information. Quantitative rating methodologies are developed based on applicable statistical modelling techniques such as logistic regression.

With regard to the corporate rating models, they usually combine quantitative analysis of financial information with qualitative assessments of, inter alia, industry trends, market position and management experience. Financial analysis has a specific focus on cash flow generation and the counterparty's capability to service its debt. The financial analysis is subsequently supplemented by an internal forecast of the counterparty's financial profile.

⁴¹ All the information reported here is publicly available within the Deutsche Bank Pillar III Report as of 31 December 2021.