ESG adjusted credit rating: the indirect approach[1]

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Abstract:

The paper introduces an approach to integrating ESG information in credit rating models, denominated "indirect approach". The proposed indirect approach specifies a complete system of assumptions compliant with the regulatory framework and allows the definition of a methodology that is not only fully compliant with the European sustainability reporting but also technical feasible for the banking system. In particular, the feasibility for banks is obtained by limiting the adjustment only to the financial module of the current internal rating models, considering only financial variables homogeneously available for all firms. Moreover, the compliance with European sustainability reporting is obtained by adopting the financial materiality criterion and by focusing the input information of the model on the financial plan considering the adoption of the firm's sustainability plan. Finally, the approach implies a long-run credit risk assessment, 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.

Keywords: credit risk, internal credit rating models, idiosyncratic forward-looking information, ESG information, ESG risk, ESG sustainability disclosure

JEL Classification: G32, G33, D81, K32, Q01, Q51

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1. Introduction

The integration of ESG sustainability information and, in particular, climate change risk, into credit risk assessment of non-financial firms, is required by different regulatory sources and different regulators[4] and all these sources explicitly recall the European regulatory framework on ESG disclosure by non-financial firms[5]. 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 paper we propose an approach to integrate ESG information in credit rating models, denominated "indirect approach", pursuing 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 adjustment only 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 explanatory variables. Moreover, the compliance with European sustainability reporting is obtained by adopting the financial materiality criterion and by focusing the input information of the model on the financial plan considering the adoption of the firm's sustainability plan.

The remainder of the paper is structured as follows. Section 2 deals with the literature review. Section 3 summarises European sources of regulation on ESG disclosure for non financial firms. Section 4 summarises the banking regulation on the integration of ESG information in credit risk. Section 5 describes the main features of the current practice for implementing credit rating models. Section 6 analyses the proposed "indirect approach" to integrate ESG information in credit ratings. Section 7 concludes.

2. Literature review

The literature review having significant banking supervision implications, is divided into two macro-sections. In the first, academic papers are analysed, while in the second regulators' discussion papers are analysed.

2.1 Academic papers

In recent years, the analysis of the impact of firms' ESG performance on their credit quality has become a topic of great interest for scientific research. We present a brief overview of the

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[4] - Guidelines on loan origination and monitoring (EBA, May 2020), also mentioned by "Aspettative di vigilanza sui rischi climatici e ambientali" (Bank of Italy, April 2022)
- Guide on climate-related and environmental risks (ECB, November 2020)
- Principles for the effective management and supervision of climate-related financial risks (BIS, November 2021)
- Final draft implementing technical standards on prudential disclosures on ESG risks in accordance with Article 449a CRR (EBA, January 2022)

[5] In particular, the most relevant ESG disclosure references are:
- EU Taxonomy (European Commission, June 2020)
- Proposed Corporate Sustainability Reporting Directive (European Commission, April 2021) and the connected EFRAG Sustainability Reporting Standards (EFRAG, January 2022)

relevant literature and its major conclusions. The most recent studies on the topic have been selected and ordered by publication date. Overall, a positive correlation between higher ESG risk (low ESG performances) and higher credit risk is documented.

(Aydin, Poppe, & Posch, 2021) examine 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.

(Capasso, Gianfrate, & Spinelli, 2021) 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.

(Chodnicka-Jaworska, 2021) examine 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.

(Carbone, et al., 2021) examine how firm credit risk are 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.

(Bannier, Bofinger, & Rock, 2022) examine 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, Hübel, & Scholz, 2022) examine 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.

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 within credit institutions, authorities in the banking sector have produced reports and discussion papers on the topic, which serve to start the 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 below[6]:

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[6] 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"

- 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.

  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.

3. 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 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.

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

3.1.1 The general architecture of the EU Taxonomy for sustainable activities

The European Taxonomy has been introduced on 18 June 2020 by the European Parliament and Council with the Regulation (EU) 2020/852 ('Taxonomy Regulation')[7]. 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, with the aim of establishing the degree to which an investment is environmentally 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.

To summarise the main features of the European Taxonomy, the following four topics will be discussed:

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
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

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activity must, first of all, pursue one or more of the six environmental objectives set out in the Regulation 2020/852. These environmental objectives are the following six: 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 criteria take the name of technical screening criteria. It should be noted that the content of the technical screening criteria is not reported within the Regulation 2020/852. In fact, the technical screening criteria are defined by the European Commission through specific Delegated Acts[8].

The technical screening criteria can be defined as a set of unambiguous criteria that allows to determine:

- 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.

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

To determine if an economic activity can be considered environmentally sustainable, pursuant to the Taxonomy Regulation, 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 synergistically to ensure an effective transition process towards an environmentally sustainable economic system. This synergy between the environmental objectives requires that an economic activity contributing to one of them must not significantly harm the others, to thus undermine 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.

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[8] 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.

- **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:

- <u>Taxonomy-aligned economic activity</u>: 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.
- <u>Taxonomy-eligible economic activity</u>: 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.
- <u>Taxonomy-non-eligible economic activity</u>: any economic activity that is not described in the European Commission Delegated Acts.

3.1.2 A focus on the forward-looking information requests: the Article 8 CapEx Plan

The Article 8 of the Taxonomy Regulation introduces a set of disclosure requirements on the outcomes of the eco-sustainability assessment of economic activities carried out by firms. On 6 July 2021, the European Commission drew up the Delegated Act on Article 8 of the Taxonomy Regulation. By detailing the disclosure requirements pursuant to Article 8 both for non-financial firms and for financial ones, the Delegated Act on Article 8 introduces a set of provisions that apply to all firms subject to the obligation to draw up the Non-Financial Statement (NFS) and which concern additional information content in relation to what is already provided for NFS.

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

In particular, 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 providing idiosyncratic forward-looking information.

After defining what the CapEx Plan is, the methods for computing the numerator and the denominator for each of the three KPIs' ratios, which must be provided by non-financial undertakings, are presented below:

Turnover KPI:
- <u>Numerator</u>: turnover derived from products or services associated with Taxonomy-aligned economic activities.
- <u>Denominator</u>: total turnover.

CapEx KPI:
- <u>Numerator</u>: 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 dimension 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.

3.2 CSDR and EFRAG standards

3.2.1 The general architecture of the new EFRAG European Sustainability Reporting Standard

By amending the Non-Financial Reporting Directive (NFRD), the European Commission Proposal for a Corporate Sustainability Reporting Disclosure (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 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.
- 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 April 2022, EFRAG published 13 ESRS Exposure Drafts covering the full range of sustainability matters: environment, social, governance and cross-cutting standards. From the analysis of these Exposure Drafts it is already possible to define the general architecture and principles that will characterize the ESRS. This general architecture can be described on the basis of the following 4 elements:

Element 1: Double Materiality
First of all, the Draft ESRS require that a firm has to disclose all material information on sustainability matters carrying out a double materiality assessment. Double materiality is the union of impact materiality (connected to actual or potential significant impacts by a firm on people or the environment over the short-, medium- or long-term) and financial materiality (a sustainability matter is material from a financial perspective if it generates significant risks or opportunities that influence or are likely to influence the future cash flows a firm in the short-, medium- or long-term). Impact materiality and financial materiality assessments are intertwined and the interdependencies between the two dimensions must be considered in carrying out the double materiality assessment.

Element 2: Three layers of disclosure
The Draft ESRS aim to promote relevant, faithful and comparable information in a proportional manner. In order to achieve these results, the Draft ESRS adopt a three-layers approach:

a) Sector-agnostic disclosures: first layer of standardised disclosure requirements that are supposed material for all firms across sectors.

b) Sector-specific disclosures: second layer of standardised disclosure requirements that are supposed 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 included 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 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 sub-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: governance topical standards are composed of two standards each of which addresses a specific governance sub-topic.

Element 4: Three 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 three reporting areas (element 4):

a) Strategy, governance and materiality assessment: with regard to this first reporting area the firm is required to disclose, for each material sustainability matter, how the material sustainability matter is related to, interact with, and inform its strategy and business model. Moreover, the Draft ESRS require firms to disclose the resilience of the firm's strategy and business model regarding its capacity to address its material risks and its capacity to leverage its opportunities in the defined time horizon.

b) Implementation measures: the second reporting area covers the general provisions applying to policies, targets, action plans and the resources adopted by a firm on a given sustainability topic. With regard to this second reporting area the firm is required to disclose, for each material sustainability matter:

- The policy to manage the material sustainability impacts, risks and opportunities.
- The measurable outcome-oriented targets set to meet the policy's objectives and the overall progress towards the adopted targets over time.
- The action plans and allocation of resources to meet a firm's policy objectives and targets.

The action plan has a retrospective component, including key actions accomplished during the reporting period, and a forward-looking component, including key actions planned in the short-, medium- and long-term.

c) Performance measurement: the third reporting area covers the general provisions applying to the metrics chosen to measure the firm's performance in addressing each sustainability topic. It must be highlighted that the assessment of the potential financial effects over the short-, medium-, and long-term, deriving from the specific material sustainability topic is often required. See, for example, all the Draft ESRS related to the Environmental Topic.

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

As can be seen from the previous paragraph, the Drafts ESRS require that a firm, in formulating its sustainability report, not only shall takes 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 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.
   – Decline 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 to be allocated to support the action plans' implementation.

3. Finally, the firm must continuously monitor the sustainability performance to evaluate the progress of the plan over time.

As just seen, the planning process requires firms to disclose forward-looking information about possible future events regarding material sustainability matters. For this reason, firms have to make estimates in conditions of uncertainty.

Measurement uncertainty arises when metrics cannot be quantified directly and can only be estimated. However, due to the forward-looking perspective of the planning process, the use of reasonable estimates is necessary and unavoidable when preparing sustainability-related information. For this reason, the Draft ESRS state that, in order not to compromise the

usefulness of sustainability information, disclosure metrics affected by significant uncertainties must be clearly and accurately described and the nature and the factors of this significant uncertainty explained. For this reason, the Draft ESRS 1 requires at paragraph 113, that a firm, when determining estimates regarding such possible future events, shall consider:

- their effect on risks or opportunities that influence or are likely to influence the future cash flows and therefore the firm's enterprise value.
- their effect on actual or potentially significant impacts on people or the environment.
- the full range of possible outcomes considering all relevant facts and circumstances.
- the likelihood of the possible outcomes within that range including low-probability and high-impact outcomes, which when aggregated, could become material.

4. 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.

4.1 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

4.2 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.

4.3 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. [...]* "

4.4 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.

5. Credit rating models: the current practice

This paragraph first describes the main features of the credit rating model estimation process currently adopted by banks for the corporate counterparty segment.

Subsequently, 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.

5.1 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.

5.1.1 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. **<u>Financial</u>**: 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. **<u>Internal behavioural</u>**: 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. **<u>External behavioural</u>**: 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. **<u>Qualitative</u>**: 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. **<u>Financial module</u>:** 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. **<u>Internal behavioural module</u>:** 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. **<u>External behavioural module</u>:** 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. **<u>Qualitative module</u>:** 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 neet 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 1 briefly represents the 4-module model which, as said before, is the most used in international best practices for developing credit rating models:

Figure 1
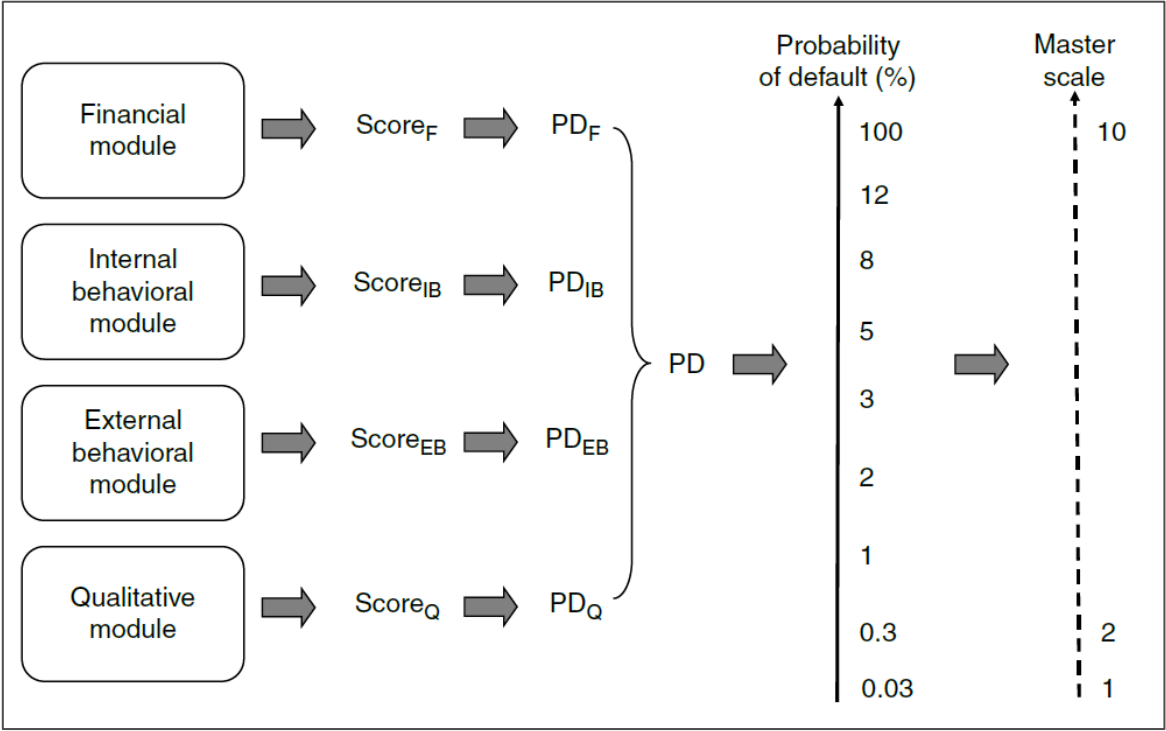
Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

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, roubust 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:

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

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

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

Here $X_t\boldsymbol{\beta}$ is an index function, which maps from the vector 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:

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

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 $X_t\boldsymbol{\beta}$ can take any value on the real line, the value of $F(X_t\boldsymbol{\beta})$ 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 X_t, necessarily affect $E(y_t|\Omega_t)$ in a nonlinear fashion. Specifically, when P_t is given by $F(X_t\beta)$, its derivative with respect to x_{ti} is:

$$\frac{\partial P_t}{\partial x_{ti}} = \frac{\partial F(X_t\beta)}{\partial x_{ti}} = f(X_t\beta)\beta_i$$

where β_i is the ith element of β. Therefore, the magnitude of the derivative is proportional to $f(X_t\beta)$.

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 $F(X_t\beta) = \Phi(X_t\beta)$ 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 $F(X_t\beta) = \Lambda(X_t\beta)$ is called the **logit model**.

5.1.2   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 2 represents an explanatory factor growing monotonically as the default rate increases (significative positive correlation). In this case, the explanatory factor has to be included in the medium list of its module. Figure 3 represents an explanatory factor decreasing monotonically as the default rate increases (significative negative correlation). Also in this case, the explanatory factor has to be included in the medium list of its module.

Figure 4 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.

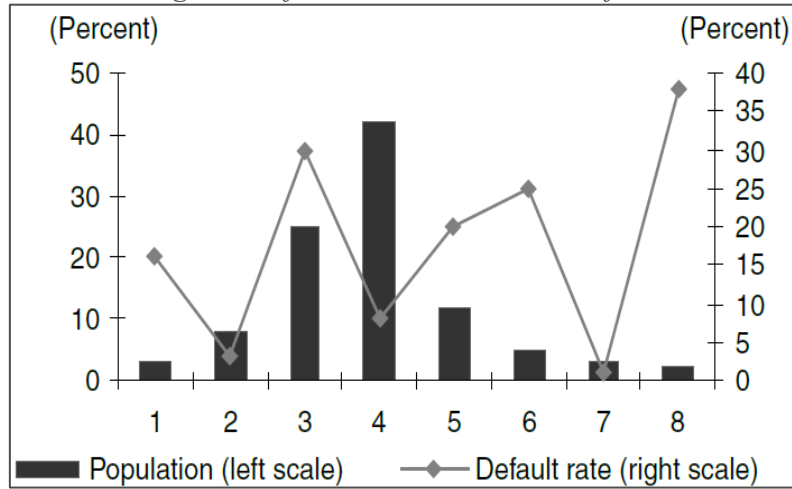*Figure 2 – factor positively correlated to default*
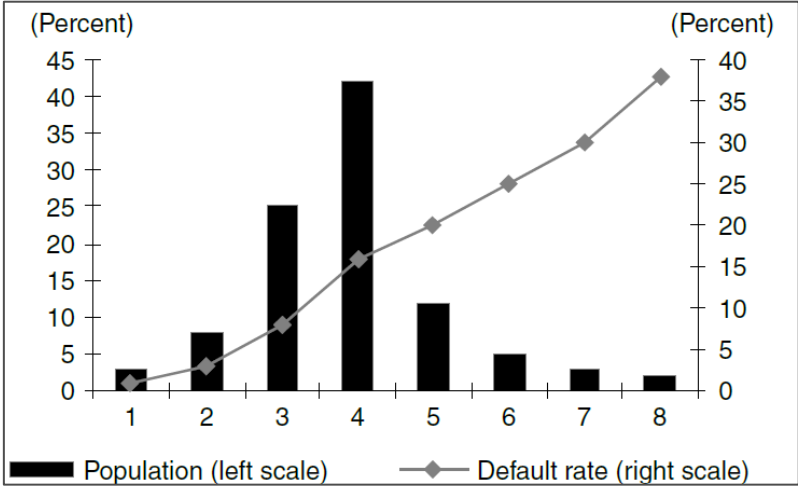
Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

Figure 3 – factor negatively correlated to default
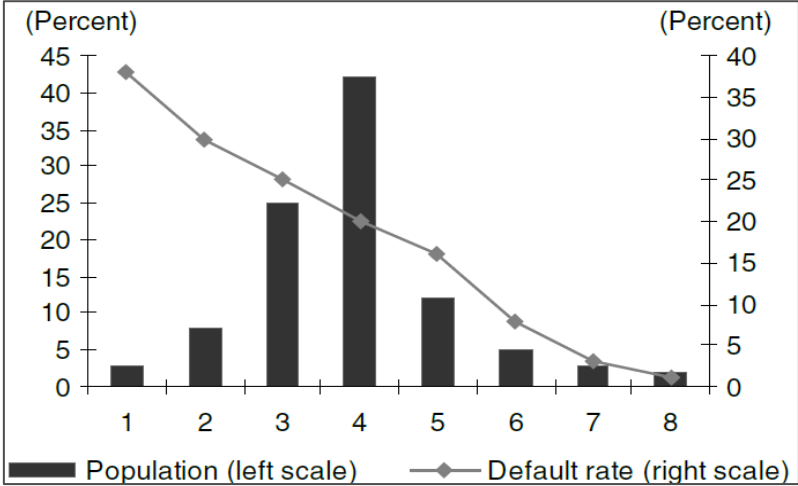
Source: Lizzi, L., Oricchio, G., & Vitale, L. (2012)

Figure 4 – factor uncorrelated to default

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

5.1.3 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 likelihood[9]. 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 $F(X_t\beta)$, the contribution to the loglikelihood function for observation t when $y_t = 1$ is $\log F(X_t\beta)$. Similarly, the contribution to the loglikelihood function for observation t when $y_t = 0$ is $\log(1 - F(X_t\beta))$. Therefore, if y is an n-vector with typical element y_t, the loglikelihood function for y can be written as:

$$l(y,\beta) = \sum_{t=1}^{n} \left(y_t \log F(X_t\beta) + (1 - y_t) \log(1 - F(X_t\beta)) \right)$$

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[9] For further information see: Davidson, R. & McKinnon, K. (2021)

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, $F(X_t\beta)$ 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 $X_t\beta = \infty$ whenever $y_t = 1$, and $X_t\beta = -\infty$ 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 $\widehat{\beta}$. 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 model[10].

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

5.1.4 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).

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[10] 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, <u>the credit scores sample must be sorted from "best" to "worst"</u> and then subdivided in n ranges (called "rating grades").

2. Second, <u>the one-year default rates associated to each rating grade must be calculated</u>.
   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, <u>the observed average one-year default rates ('observed average default rate') must be calculated for each rating grade</u>. 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, <u>the long-run average default rate (*through-the-cycle* PD estimate) must be calculated for each rating grade</u>. 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, <u>a quantitative calibration test by rating grade must be conducted</u>.
   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 $\rightarrow F(X_F\beta) = Score_F \rightarrow$ calibration $\rightarrow PD_F$

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

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

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

5.2 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.

5.2.1   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 EAD[11].

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

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

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. <u>the economic-financial module</u>: 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. <u>the behavioural modules</u>: this module is divided into an Internal behavioural sub-module developed on the basis of internal data sources, and an External behavioural sub-module developed on the basis of external data provided by Central Credit Archive ("Centrale Rischi"), allowing customer's monitoring in terms of cash loans, withdrawal, short term maturity, long term maturity, self-liquidating loans, loan guarantees.

3. <u>the qualitative module</u>: 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:

Figure 5 – 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		0.0036%	0.0065%	AA+
B2	02	0.0065%	0.0116%	AA
B3		0.0116%	0.0208%	AA-
C1		0.0208%	0.0371%	A+
C2	03	0.0371%	0.0663%	A
C3		0.0663%	0.1185%	A-
D1		0.1185%	0.2116%	BBB+
D2	04	0.2116%	0.3779%	BBB
D3		0.3779%	0.5824%	BBB-
E1		0.5824%	0.7744%	BB+
E2	05	0.7744%	1.0298%	BB
E3		1.0298%	1.3693%	BB-
F1		1.3693%	1.8209%	B+
F2	06	1.8209%	2.4214%	B+
F3		2.4214%	3.2198%	B+
G1		3.2198%	4.2816%	B
G2	07	4.2816%	5.6935%	B
G3		5.6935%	7.5710%	B
H1		7.5710%	10.0677%	B-
H2	08	10.0677%	13.3876%	B-
H3		13.3876%	17.8023%	B-
I1		17.8023%	23.6729%	CCC
I2	09	23.6729%	31.4793%	CC
I3		31.4793%	99.9999%	C
X1		Past due	100%	D
X2	10	Unlikely to pay	100%	D
X3		Bad loans	100%	D

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

5.2.2 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 EAD[12]. 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.

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

Whit 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.

6. 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.

6.1 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 significant financial effects on undertakings, i.e., it generates or may generate significant risks or opportunities that influence or are likely to influence the future cash flows and therefore the enterprise value of the undertaking in the short-, medium- or long-term, but it is not captured or not yet fully captured by financial reporting at the reporting date"*[13]. Moreover, EFRAG states that *"Impact materiality and financial materiality assessments are intertwined and the interdependencies between the two dimensions should be considered in these assessments. In general, the starting point is assumed to be the assessment of impact materiality, as a sustainability impact may become financially material when it translates or is likely to translate into financial effects in the short-, medium-, or long-term. In addition, beyond considering the actual and potential financial consequences of its material impacts, the undertaking shall consider how it is affected by sustainability matters which are external to its activities".*[14]

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[13] EFRAG (2022) Draft ESRS 1 - General Principles, Paragraph 53
[14] EFRAG (2022) Draft ESRS 1 - General Principles, Paragraph 47

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"*[15].

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"*[16].

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 assessing the enterprise value of an entity includes information that is provided by the entity in its financial statements and sustainability-related financial information"*[17].

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: "*as a sustainability impact may become financially material when it translates or is likely to translate into financial effects in the short-, medium-, or long-term* ".

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".

6.2 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.

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[15] IFRS - ISSB (2022) Draft IFRS S1 - General Requirements for Disclosure of Sustainability-related Financial Information, Paragraph 1
[16] IFRS - ISSB (2022) Draft IFRS S1 - General Requirements for Disclosure of Sustainability-related Financial Information, Paragraph 2
[17] 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 it 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 9[18]. 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.

6.3 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 target[19].

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[18] For details see IFRS Foundation - IASB (2017)

[19] 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.

6.4 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 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.

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.

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.

7. Conclusions

In this paper we propose an approach to integrate ESG information in credit rating models, denominated "indirect approach", pursuing the following two main objectives: compliance with European sustainability reporting and technical feasibility for the banking system.

The proposed indirect approach specifies a complete system of assumptions compliant with the regulatory framework and provides the following contributions:

- A structural explanation of the relationship between ESG performance and the firm's economic-financial performance, both in terms of causal direction and dynamic effects.
- Limit the input information of the model only to indicators that are compliant with the legislation and therefore homogeneously available for all firms.
- Provide reasons for considering only economic-financial variables in the specification of internal rating models, without extending the specification to ESG explanatory variables.
- Introduce an idiosyncratic forward-looking credit rating, overcoming the limits of the models with a systematic forward-looking component such as those adopted for IFRS9.
- Propose a solution for the long run assessment of credit ratings, considering time horizons equal to the duration of exposures and overcoming the limits of one year PD credit rating models.

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