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Building a Z-ESG Score model for the European Banking and Insurance sector.

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1   Introduction

The increasing interest in the Environmental, Social, and Governance (ESG) framework, from investors and consumers, highlights the rising urgency to scrutinize global industries evaluating their adherence to ESG standards. This greater awareness is driving a transformative change in the way capital is allocated and products are consumed, fostering a commitment to more conscious and ethical investment practices.

The importance of this shift has been emphasized by the growing volume of literature in recent years, aimed at analyzing the complex relationship between ESG standards and their effect on corporate performance and investment outcomes. However, institutions remain in debate over clarifying the definition and far-reaching effects of ESG policies in our interconnected and globalized world.

The increased focus on ESG considerations, forced the financial landscape to undergo a significant transformation of the relevant investment drivers, which were traditionally based solely on financial metrics, that now have been adapted to include ESG standards as a pivotal element. This transformation has been catalyzed by a substantial influx of capital into ESG-compliant companies, underlining the growing recognition of the significance of ESG in the investment arena.

Given this trend, the need to assess the actual level of compliance with ESG standards by individual companies has become critical. Such evaluations enable investors and consumers to make informed choices that are consistent with their beliefs, while also ensuring that their financial decisions are performant and secure.

Before delving into the primary objectives of this study, it is imperative to establish a basic understanding of the ESG framework. This paper provides a concise summary of the crucial aspects of ESG investments and an in-depth analysis of the ESG investment market in order to provide an insight into the critical role of ESG in contributing to more informed and ethical investment practices.

The primary objective of this study is to develop an ESG rating model aligned with the benchmarks established by leading rating agencies. The model aims to evaluate financial institutions' adherence to ESG guidelines by utilizing a comprehensive set of 39 variables, evenly distributed across the three ESG pillars, in order to provide useful and reliable information for investment decisions.

The focus of this study is on the leading financial organizations in Europe, comprising banks and insurance companies. These institutions are headquartered in the 16 most economically advanced countries on the European continent. This approach allows for an in-depth analysis of the 'green transition' in one of the world's most important ESG landscape.

The key to this study lies in the careful selection of variables, combined with the application of two different regression models. The selection of variables was crucial, as it was necessary to capture the multifaceted aspects of each ESG pillar nature, while at the same time ensuring the significance and coherence of the pillar variables with the regression tool.

In order to enhance the reliability of our rating model, we adopted a dual approach in terms of the regression models used: the logistic regression model allowed us to accurately calculate the likelihood of classification,

while the linear regression model was instrumental in assigning a rating grade - the key endpoint of our research.

To collect the required variables data and company ESG scores, we employed the Refinitiv platform. Recognized as one of the most established ESG rating agencies, Refinitiv's extensive range of variables per ESG pillar and coverage of a significant proportion of listed companies around the world are key features.

In conclusion, the research has assigned distinct rating grades to each of the three pillars for every company, culminating with an overall company rating. This rating serves as the ultimate output that the rating model was designed to produce. This comprehensive evaluation not only enables thorough company-to-company comparisons but is also a valuable resource to guide investment decisions.

2   ESG overview

At the beginning of the 21st century, after centuries of exponential industrial growth and unsustainable exploitation of the Earth's resources, for the first-time governments and industrial companies began to consider not only profit, but also the impact of their business model on the social and environmental ecosystem.

Globalization and the essential interdependence between states have brought attention to the frequent occurrence of extreme weather phenomena and pollution-related issues. These events, in addition to posing a threat to life on Earth, cause many problems for companies including supply chain disruptions, issues with business continuity, and reduction in wealth.

Environmental pollution is solely caused by human activity, exemplified by the ozone hole or plastic island. It affects not only a single area, but also biodiversity and human health, while fueling climate change, which poses a much greater threat to all life and business on our planet.

In recent years, companies have invested billions in reshaping their business models as part of the fourth industrial revolution to increase efficiency, mitigate pollution and adopt advanced technologies. Thanks to the development of new alternative energy sources, many firms have transitioned from using oil or carbon-based energy to electrical energy sourced from renewable options such as solar, wind or hydroelectric power[1]. Furthermore, they have implemented more sustainable packaging, reduced the use of plastic and waste, and transformed physical stores into digital ones.[2].

In the early 2000s, as sustainability and corporate responsibility became increasingly important, the relevance of ESG[3] criteria extended beyond governance decisions about sustainability and business continuity. ESG criteria are now among the most influential drivers for long-term value creation for investors[4]. In this context, the ESG rating has been coined to aid conscious decision making amongst companies and consumers regarding investment and consumption, evaluating the commitment of the company to environmental, social and governance issues.

2.1   Introduction to ESG

The acronym ESG, standing for "Environmental, Social and Governance has been employed for several decades without a universally accepted definition. As a result, there is a current debate among corporations and governing authorities regarding its meaning and responsibility.

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[1] Annual investment in clean energy increase to around 4 trillion USD by 2030 "The potential of digital business models in the new energy economy" IEA (2022)

[2] Normative IEA scenario shows the pathway to the global energy sector to achieve net zero CO_2 emission by 2050 (NZE) "The potential of digital business models in the new energy economy" IEA (2022)

[3] "Environmental, Social, Governance"

[4] "ESG importance for Long-Term Shareholder value creation: Literature vs Practice" I. Zumente J. Bistrova (2021)

Although environmental-related movements and policies were already used by companies from the mid-1900[5], to understand how the term was coined, we need to go back to January 2004, at the UN Global Compact's "Who Cares Wins" initiative[6].

During that initiative, were discussed and summarized all the recommendations on how to better integrate environmental, social and corporate governance issues in asset management, referring to those, in the final report, for the first time was used the term "ESG"[7]

The "Who Cares Wins" initiative marked the beginning of a significant movement that exponentially raised awareness around ESG topics in subsequent years. This culminated in 2015 with the adoption of the Sustainable Development Goals (SDGs) and the Paris Agreement at COP21[8], which aimed to align business operations with social and environmental priorities and limit global warming.

To gain a deeper understanding of the impact of ESG policies on the financial world, we first need to delve into each of the environmental, social and governance (ESG) pillars to get an overall picture of the phenomenon.

2.1.1 Environmental pillar

Starting with the Environmental (E) pillar refers to all the environmental aspects of sustainability and responsible production. Its primary focus is the effort and the policy that the company implements to reduce the impact that its activity has on the natural environment including pollution reduction[9], recycling, biodiversity protection but also all the prevention measures that the company should apply to protect business continuity from extreme climate events.

Business continuity[10] it's an important topic, mostly regarding physical risk[11], due to the increasing threats that intense phenomenon as drought, wildfire, cyclone, flood and resource scarcity are bringing to the company's operativity and profitability.

To overcome the physical risk, it's crucial for the company to: first, increase its climate resilience to manage climate change and resource scarcity, second, improve the natural resource management to ensure supply chain resilience and lastly implement risk management to identify, assess and manage the risk that could disrupt business operations.

Every company face also the transition risk[12], which refers to the economic impact of the adoption of the incoming strict regulations that government and institutions are implementing to encourage the development

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[5] In 1997 the Kyoto Protocol was adopted establishing legally binding greenhouses gas emission constraint

[6] The "United Nations Global Compact", launched in July 2000, is the World's largest corporate sustainability initiative and the founder of the Ten Principles for Corporate Sustainability. (unglobalcompact.org)

[7] Elizabeth Pollman (2022) "The Making and Meaning of ESG". At the conference, Kofi Annan invited 55 CEOs of the leading financing institution with 6 trillion US dollars under management.

[8] In the "21st Conference of the Parties" (COP21) there were nearly 200 countries and the result was an important agreement that in the following years has been implemented with new and more strict guidelines.

[9] Not only the carbon emission but it refers to all kinds of waste and pollution that the operating activity produces.

[10] "The connection Between business continuity and ESG" Disaster Recovery Journal (2022)

[11] The physical risk indicates the economic impact that unexpected natural events can cause to the asset or the business of the company. "Aspettative di vigilanza sui rischi climatici e ambientali" Banca d'Italia

[12] "Aspettative di vigilanza sui rischi climatici e ambientali" Banca d'Italia

of renewable energy, reduction of waste and pollution as well as technological development for more sustainable production.

In this scenario business sustainability[13] plays a core role, it combines strategic management and attention to the environment and social impact of the business. This match gives the company a long-term view to anticipate the changing regulation and gain competitivity over the rival firms to reduce the transition risk and the physical risk.

Turning the business into an eco-friendlier production has many advantages[14] for all the stakeholders of the company: first, the better reputation and brand value increase the company's trust of suppliers and customers, improving as well financial performance. Furthermore, reducing the physical and transitional risk along with the regulatory risk makes it easier to obtain licenses to operate and reduce the business disruption risk. Eventually, the company can access capital at a lower cost and encourage investment in the company thanks to the tighter engagement of shareholders and stakeholders.

2.1.2 Social pillar

The social pillar (S)[15] focuses on the social impact of the company's operations and its relationships with its stakeholders. Its focus concerns all the interactions that the company entertains with all the actors, from employees, customers, suppliers, communities to the government.

In recent years, mostly after the Covid-19 pandemic, employee-employer relations have changed a lot due to the increasing importance of work-life balance and human rights recognition.

An important role played by the ILO[16] as one of the most important institutions defending labor human rights and social justice worldwide, its work can be circumscribed around the International Labor Standards (ILS) which cover almost the entire range of issues regarding the protection of workers.

This set of standards, which cover right at work, working conditions and social security, has gained global consensus not only from the governments but also employers and workers' organizations. The ILS principle, having the worldwide consensus, are above the regional regulation and have set standards that even developed country has difficulties applying, the ILS aim to guide government regulation and to boost the development of human right. Other important guidelines are set by GRI[17] which delivered the world's most widely used best practice for sustainability reporting standards, reporting covers principally economic, environmental and social standards[18].

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[13] It combines the focus on the business profitability and the attention to the sustainability of the activity. The aim is to maintain the long-term value creation for shareholders meanwhile ensuring to the future generation the same wealth condition "Business sustainability: it is about time" P.Bansal (2014)

[14] "5 ESG benefits for businesses" K.Yasar (2023)

[15] "The "S" in ESG and International Labor Standard" B.Waas (2021)

[16] International Labor Organization (ILO) is a specialized agency of the United Nations born just after WWII in 1945, its main task is to formulate and enforce international labor standards.

[17] The Global Reporting Initiative standard are described in the "Consolidated Set of GRI Sustainability Reporting Standards 2020"

[18] The key social standards are covered between 401st and 414th with an important mention for the 402" Labor-Management relation" and the 407 "freedom of association and collective bargaining". "The "S" in ESG and international labor standards" B.Waas (2021)

The compliance of the company to this set of principles and standards have multiple benefits; better working condition attracts professional workers and increases production, moreover, reduce legal issue and attract investor, capital and partnership due to the reputation of the company.

2.1.3 Governance pillar

The last pillar (G), even if it's crucial in the decision-making of everyday life of the company most of the time is underestimated[19], one reason can be the difficulties on how to estimate and evaluate the governance of a company[20] or the least impact that the governance of a company has over the everyday life of the people.

Governance refers to the system and processes with which companies are directed, controlled and managed. Looking at it through the ESG lens the Governance pillar evaluates the transparency, accountability and effectiveness of the company's corporate governance structure.

In particular, it evaluates the composition and the structure of the board, with a look at the presence of gender and cultural diversity in the board, the executive compensation, the ethics and compliance assessing commitment and effectiveness of internal controls and lastly shareholders' rights and engagement.

Even though Governance it's the only executive pillar, taking decision over the other two, due to the subjectivity of this variable is difficult to assess the real effort of the ESG policy put into action making less clear its pillar score.

It's easy to understand the importance of being Governance compliant, effectively it means that the board embraces the ESG ethic in the board composition and the executive decision.

Similar to the other pillar being compliant have several benefits for the company;

Ensuring regulatory compliance and efficient risk management improve stakeholders' trust alongside the corporate reputation, moreover, provide talent attraction as well as long-term value creation. As a final result, the company has easier and better conditions for raising new capital and higher investor confidence.

2.1.4 Weight approach

Knowing the composition of each pillar, it's time to understand how each pillar is weighted in the ESG score result. There are three different approaches[21]:

1) **Equal Weights:**

    Each pillar is given the same weight, it assumes that all pillars have the same importance in assessing a company's sustainability practice, it's the simplest, most transparent and easiest to compare across industries. Thanks to its ease of calculation and comparison between companies, it is usually the most widely used one, even if it isn't the one with the best performance.

2) **Back-tested Weights:**

    An optimized weighting based on the historical significance of data is employed.

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[19] "Beware the 80/20 Governance Trap: Focus on the "G" in ESG" GS. Hedstrom (2019)
[20] Environmental and Social pillars are almost fully evaluated through quantitative variables meanwhile Governance variables are mostly qualitative.
[21] "ESG Rating: How the weighting scheme affected reprutation" MSCI (2020)

This approach aims to capture the financial resilience of companies to long-term environmental, social and governance risks. The result shows that in order to reflect the overall exposure of the financial variables, the governance pillar must be weighted the most, while the social pillar must be weighted the least. To achieve maximum optimization of weight distribution, the final allocation is 25% for the 'E' pillar, 5% for the 'S' pillar and 70% for the 'G' pillar.

3) **Industry-specific weights**

The approach involves determining weights for each industry to reflect their exposure to E, S, and G risks. Indeed, companies have unique externality and risk exposures that generally align with the most heavily weighted ESG pillar.

The weights vary yearly due to risk rebalancing, and this complexity reduces comparability across industries and over time. The mean weights of the pillars over the period of 2007-2019 were 30% for environmental topics, 39% for social topics and 31% for governance topics; however, this value varied significantly between sectors and over time.

In the short-term, the back-tested approach exhibits the highest significance due to the high weighting of the G-score, while over a longer time horizon, the industry-specific approach shows higher financial significance due to social and environmental improvements[22].

2.2 ESG capital

According to leading global institutions and investment banks, ESG compliance is increasingly becoming a key investment driver.

The PwC report[23] presented at COP27 in Egypt reveals that investors worldwide are extensively adopting Environment, Social, and Governance investments, nearly doubling the invested capital amount in the past five years and the projection for the future indicates that the exponential growth will persist.

Delving into the figures, the overall amount of assets under management (AuM) related to environmental, social, and governance (ESG) factors in 2022 stood at 41 trillion dollars. Taking the projected compound annual growth rate (CAGR) as half of the historical CAGR, the projected ESG capital in 2025 will be 50 trillion dollars, an increase of 18% from the current value, but 30% higher than the 2020 value of 35 trillion dollars.

Strengthening such forecast, according to Bloomberg's projections, in 2025, the assets under management (AuM) for ESG (Environmental, Social and Governance) investments will reach 50 trillion dollars, while the total global AuM will be 140.5 trillion. This indicates that over one-third of funds invested in the next two

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[22] "ESG ratings: how the weighting scheme affects performance" L.E. Lee (2020)

[23] "PwC's Asset and Wealth Management Revolution 2022 Report" it's a global survey of asset managers (250 respondents with a total global AuM of 50 trillion dollars) and institutional investors (250 respondents with a combined global asset of 60 trillion dollars)

years will be directed towards ESG-oriented assets, with a ratio of 1 invested dollar in an ESG-compliant company for every 2.8 dollars invested in the market.[24]
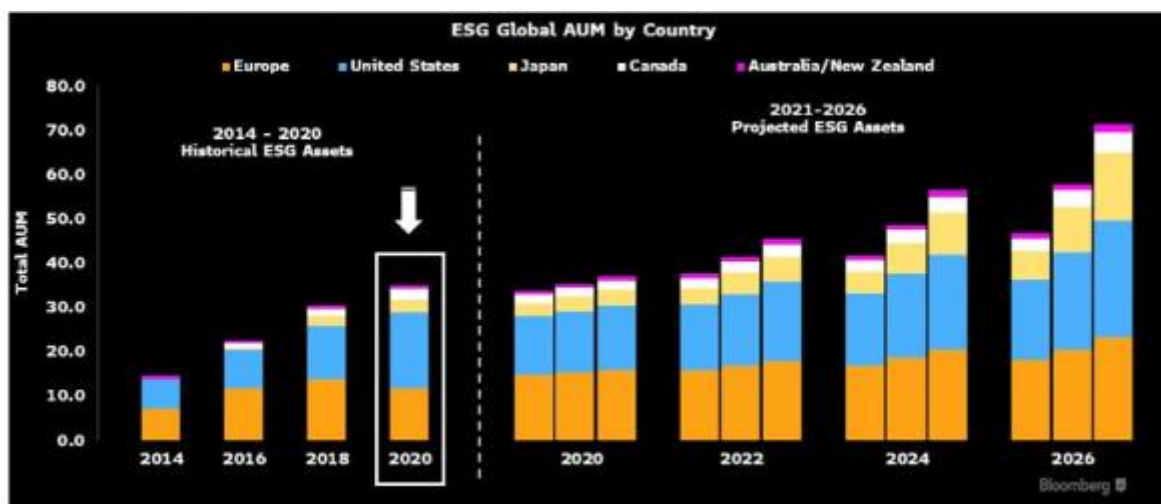
1.   Bloomberg intelligence (2022)

According to the chart, Europe led the investment in ESG assets until 2020, when the US took the leadership thanks to investment growth of more than 40%, with $17 trillion invested in 2020, out of a total of $35 trillion[25].

Although US growth is currently slowing down due to rising interest rates and recession concerns, it is still expected to reach 20 trillion assets under management in 2022, consolidating its leadership position in ESG investments[26].

Europe is also experiencing a slowdown in ESG investment due to the conflict between Ukraine and Russia at the border, rising raw material[27] prices and interest rate hikes.

It is worth noting that Japan and Canada are among the top five ESG investors, with Japan increasing its investment by four times in just two years to a total of $2.2 trillion between 2016 and 2018, and it's set to grow at double-digit rates in the future[28], consolidating its position as the third global player.

Similar growth has been registered for Canada's ESG capital, indeed, in the period Between 2017 and 2019, Canada's ESG capital saw a significant increase, with AuM growing from 2.1 to 3.2 trillion dollars, collecting 1.1 trillion dollars. This figure accounts for 61.8% of Canada's total capital under management[29].

In contrast, China, the world's second-largest economy and one of the most polluting nations, has a significant absence of relevant investment, contributing only 2.16% of the total ESG AuM[30]. However, in order to meet the commitment to achieving net zero carbon emissions, large-scale environmentally friendly investments have been planned for the coming years.

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[24]Bloomberg Intelligence 2022
[25] "Bloomberg Intelligence" A. Diab (2021)
[26] "Bloomberg Intelligence" A. Diab (2022)
[27]Due to the war, Europe understood the importance of energy independence and started a transition from Russian oil and gas to green energy, fueling the state investment in solar, wind and nuclear energy.
[28] "Charting a path from the Shuchu Kiyaku to ESG for Japanese companies" McKinsey (2021)
[29] "Canadian ESG Assets surge to 3,2 trillion" RIA (2020)
[30] "ESG investment in China: Doing well by doing good" S.Chen (2023)

Examining financial and ESG performance may suggest that the two are in opposition or that ESG asset investors are sacrificing financial returns for ethical ones. However, a survey showed that 90% of asset managers believe that incorporating ESG into investment strategies will enhance overall portfolio returns. Additionally, 60% of institutional investors have reported higher performance yields from ESG investments compared to non-ESG equivalents[31].

2.2.1 ESG Investment Tools

Due to the increasing demand for ESG-focused investment, financial institutions have developed various tools to facilitate ESG investment for clients and foster the raise of new capital.

Some of the most important tools are:

1) <u>ESG Fund</u>: As in the chart below, the global sustainable funds reached $2,5 trillion[32] at the end of 2022. Sustainable funds' growth rate in recent years has reached 12%, which is almost double the growth of the global fund market.

2) As indicated in the chart, Europe accounts for the majority of ESG fund assets, with 83% of global sustainable fund assets, representing 20% of the overall fund assets in Europe[33].

2022 Global sustainable fund assets
Europe accounted for the vast majority of ESG fund assets in 2022.
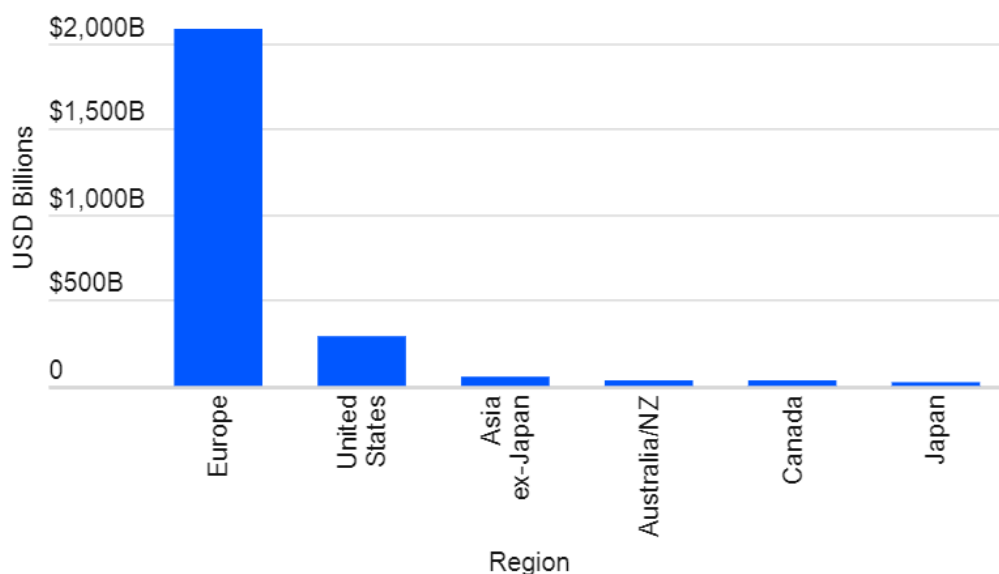
Source: Morningstar Sustainable Fund Flows: Q4 2022 in Review

2.   Morningstar (2022)

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[31] Olwyn Alexander PwC Global Asset & Wealth Management Leader said "*ESG has become perhaps the most powerful driver of growth in asset and wealth management.*"
[32] "ESG investing statistics 2023" Brian Baker (2023)
[33] According to Morningstar. "ESG investing statistics 2023"

3) <u>ESG ETF</u>: This tool is not commonly used. Nonetheless, its importance is underscored by impressive growth rates. Capital raised by ESG ETFs increased from 4.7 billion AuM at the end of 2014 to 169 billion dollars in 2021[34] and 449.5 billion dollars at the beginning of 2023[35].

The forecasts predict even more promising results, with total AuM invested in ESG ETFs expected to surpass 1 trillion dollars by 2026[36].
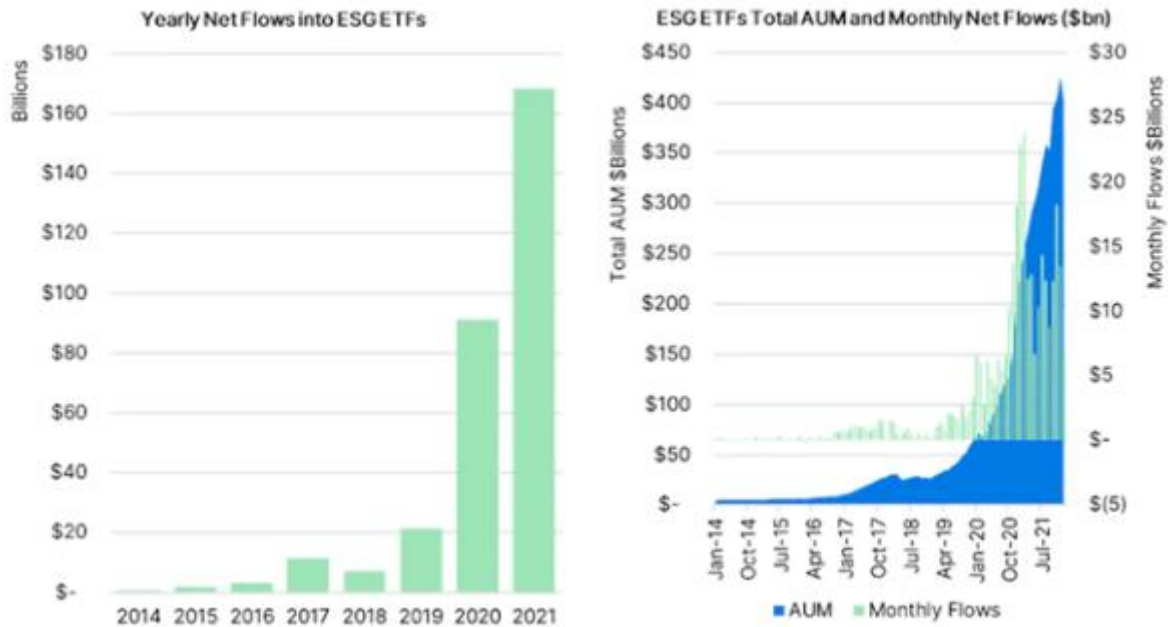
3. Trackinsight, (2022)

The chart above illustrates exponential growth in capital raised, with the annual inflow quadrupling from 2019 to 2020 and more than doubling from 2020 to 2021. This trend is expected to continue at the same pace in the upcoming years[37].
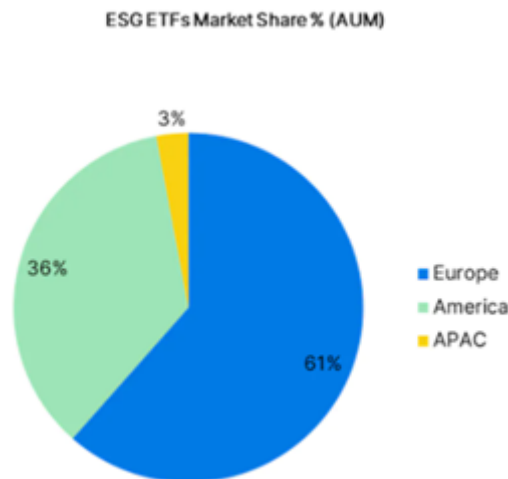
4. Trackinsight, (2022)

As previously observed, the majority of the ETF capital comes from Europe, however, there is a significant influx from the US which seeks to overcome European ESG spending in the ETF.

4) <u>Sustainable bond</u>: Sustainable bonds are financial instruments utilized by governments and corporations to raise funds for particular ESG initiatives or to support the green transition towards environmental sustainability. There are four types of sustainable bonds, which vary depending on the purpose of the raised funds. These include green bonds, social bonds, sustainability bonds, and sustainability linked bonds (SLBs)[38].

ESG bond volumes reached a total of 2.2 trillion debts in 2021[39]. However, the distribution of this amount is uneven across all securities. The green bond remains the favored instrument, despite significant growth in other bond types over the past three years, which now account for almost half of the newly collected capital.

Annual issuance of GSSS bonds, US$ billions
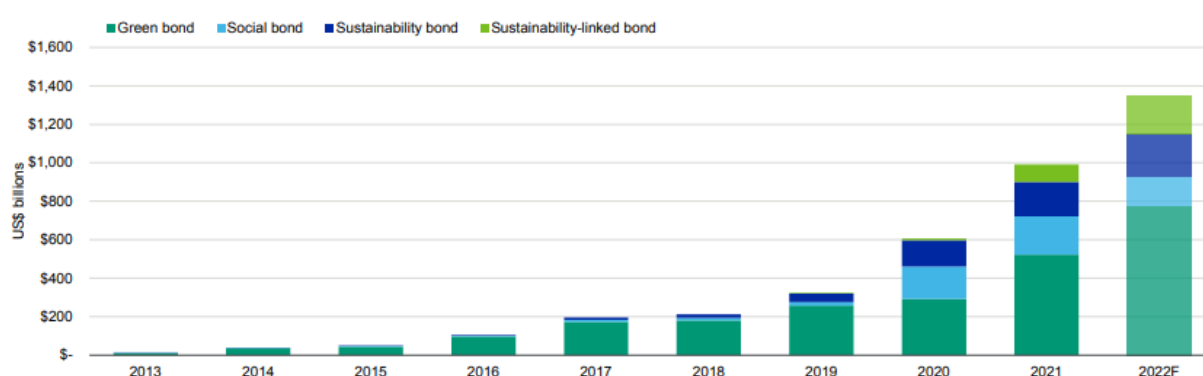
2022F represents Moody's 2022 issuance forecast.

Sources: Moody's ESG Solutions and Environmental Finance Bond Database

5. Moody's ESG Solutions Database

Whilst we expect a slower growth rate for social bonds due to the end of the pandemic situation, the growth rate of green and sustainable bonds is expected to be double-digit, driving overall ESG bond capital to grow by approximately 36% per year[40].

Focusing on green and sustainable bonds, this impressive growth is due to the issuing of many company bonds aimed at starting new ESG-friendly projects but also funds to reshape the business in an eco-friendlier way.

Recently, several countries have launched new sovereign green bond initiatives to enhance the efficiency of their national infrastructures. Europe's NextGenerationEU and US President Joe Biden's rescue plan, for example, aim to invest €800 billion and $1.9 trillion respectively in digitalization, sustainability and green transition to support their economies and environmental initiatives after the pandemic.

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[38] "ESG Solutions" MOODY'S (2022)
[39] "GSIA, Bloomberg Intelligence"
[40] Represents around half of the 64% growth rate achieved in 2021 taking into consideration also the gradually declining growth as the mature market.

Regarding the sustainable-linked bond, it increased from 9 billion in 2020 to 90 billion in 2021, and it is expected to grow to 200 billion dollars in 2022.

The chart 5. illustrates that this ESG debt expansion will lead to nearly 1.4 trillion dollars of growth in 2022, making up 63% of the previous ESG debt capital issued since 2021. Moreover, according to Bloomberg forecasts, ESG bond market will reach 11 trillion worth by 2025.

Most of the ESG capital is currently invested in investors' stock portfolios or managed by institutions through portfolio management. However, the rising availability of newer and more efficient tools is driving the capital market towards these forms of investment.

2.3   ESG performance

ESG has emerged as one of the key drivers of investment in our century; it is hence imperative to understand the real returns of ESG investment, and the associated benefits of holding ESG-compliant assets.

As previously discussed, the ESG theme is controversial, starting from the intrinsic definition, the unclear level of investment and projected inflows, to the actual benefits for the company applying the ESG policy.

Before delving into the investment performance perspective, it is worth examining the correlation between a company's performance and its adherence to ESG regulations, and determining whether the company's performance is truly improving as a result. In order to accomplish this, we will employ widely used ratios, such as profitability, ROA, and EV/EBITDA.

2.3.1   Company financial performance

To gain an understanding of whether the company creates value through ESG, it is crucial to investigate how the company generates value. There are two main approaches to running a company[41]:

1) <u>Stakeholders theory (Freeman,1984)</u>: which suggests that a successful company can align the interests of the company with those of its stakeholders, taking into account not only the shareholder's goal of profit maximization, but also the welfare of the community, the environment and the interests of all customers, employees and suppliers. From this perspective, the ESG metric can assess the performance of managing issues for the entire stakeholder community. In this context, the company's value creation doesn't come just from improved financial performance, but also from the value created for stakeholders, which in turn increases the value of the company as a whole.

2) <u>Shareholder theory</u>: in opposition to the stakeholder view, if the company's sole objective is to maximize shareholders' profits, further research is necessary to establish the correlation. As the primary value driver only pertains to the interests and profits of owners, the creation of wealth for other stakeholders should not be taken into account. Furthermore, any ESG policies that do not clearly improve the company's operation and profitability are considered to be expenses, as only financial metrics are usually used to assess a company's value creation.

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[41] "Impact of ESG performance on firm value and profitability" M. Aydogmus (2022)

While the shareholder approach was predominant throughout the 20th century, in the early 21st century, more and more companies shifted towards socially and environmentally responsible management[42] to raise capital and revenue in response to growing ESG concerns among investors and consumers.

Due to the conflicting views on the correlation between ESG and CFP[43], it is more efficient to conduct a statistical analysis of all recent published papers[44]. This will provide a comprehensive understanding of the phenomenon from all angles and produce an overall picture.

Based on the Rockefeller study, where over 1,000 academic papers on ESG performance and climate change have been analyzed, as evident from the chart below. Out of these papers, 92% have found a non-negative result and 58% have found a positive relationship between ESG and financial performance such as ROE, ROA and share price[45].
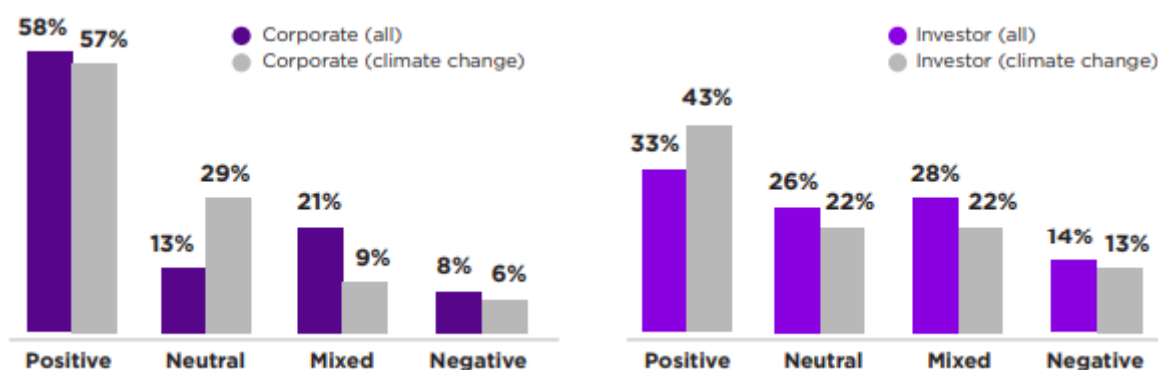
6. Rockefeller (2021)

The neutral result of 13% refers to studies in which the adoption of ESG policies had no impact on profitability and share price compared to non-compliant companies, while the mixed result (21%) comes from academic papers that found both positive, neutral and negative aspects.

The graph on the right outlines investigations on investment parameters adjusted for risk, such as alpha or Sharpe ratio, for a stock portfolio. Despite the continuing positive results, with 59% exhibiting similar or better performance than traditional investment and only 14% showing negative outcomes, the percentage is slightly lower with respect to the financial performance of companies.

The study indicates a positive correlation connecting ESG, financial performance, and stock performance, though it is noteworthy that there is no perfect correlation between financial performance and stock performance.

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[42] "Inside the ESG ratings: (Dis)agreement and performance" m. Costola (2021)
[43] "Corporate Financial Performance" (CFP)
[44] "Uncovering the relationship by aggregating evidence from 1000 plus studies published between 2015-2020" T.Whelan (Rockefeller)
[45] The grey column display similar finding related to climate change article related to financial performance, while the purple one shows the relationship between ESG and financial performance.

Additionally, we can deduce the following six conclusions:

1) **"Improved financial performance due to ESG becomes more marked over a long-time horizon"**

   Corporate investment in environmental sustainability has minimal to no impact on financial performance in the short term but yields positive effects in the long term[46].

   Companies with high ESG ratings have demonstrated returns 3.8% higher per standard deviation of ESG score in the mid to long term. (Dorfleitner et al . (2018))

2) **"ESG Integration as a strategy seems to perform better than negative screening approaches and ESG momentum may cause improvers to outperform leaders"**

   The study discovered that ESG integration outperforms negative screening and divesting. 33% of studied cases yielded positive alpha, whilst 53% of studies showed neutral or mixed outcomes.

3) **"ESG investing appears to provide downside protection, especially during the social or economic crisis"**

   The research establishes a significant association between reduced sustainability-related risks and enhanced financial returns. In the first quarter of 2020 during the COVID-19 pandemic, 20 out of 26 ESG index funds outperformed their conventional counterparts[47].

4) **"Sustainability initiatives at corporations appear to drive financial performance due to factors such as improved risk management and more innovation"**

   Implementing a sustainability strategy enhances a firm's reputation, mitigates firm risk, increases stakeholder mutuality and boosts innovation capacity. These improvements, in turn, drive financial performance.

5) **"Studies indicate that managing for a low carbon future improves financial performance"**

   A survey conducted on 736 US public companies between 2005 and 2015 discovered that by investing in carbon-efficient businesses and short carbon-inefficient ones, it was possible to achieve an extraordinary annual return of 3.5% to 5.4%.[48]

6) **"ESG disclosure on its own does not drive financial performance"**

   In reality, only 26% of studies have discovered a favorable correlation between disclosure and performance, while the relationship between ESG policy and financial performance increases to 53%.

In regard to the final point, it's important to underline the importance of disclosing the company's ESG performance, because taking environmental actions without effectively communicating the effort and the results will not translate into market value. Nevertheless, the quality of ESG disclosure must exceed a certain level over a period of time to generate a positive ROA from a good CSR performance[49]. This performance results from higher stakeholder trust and greater company transparency.
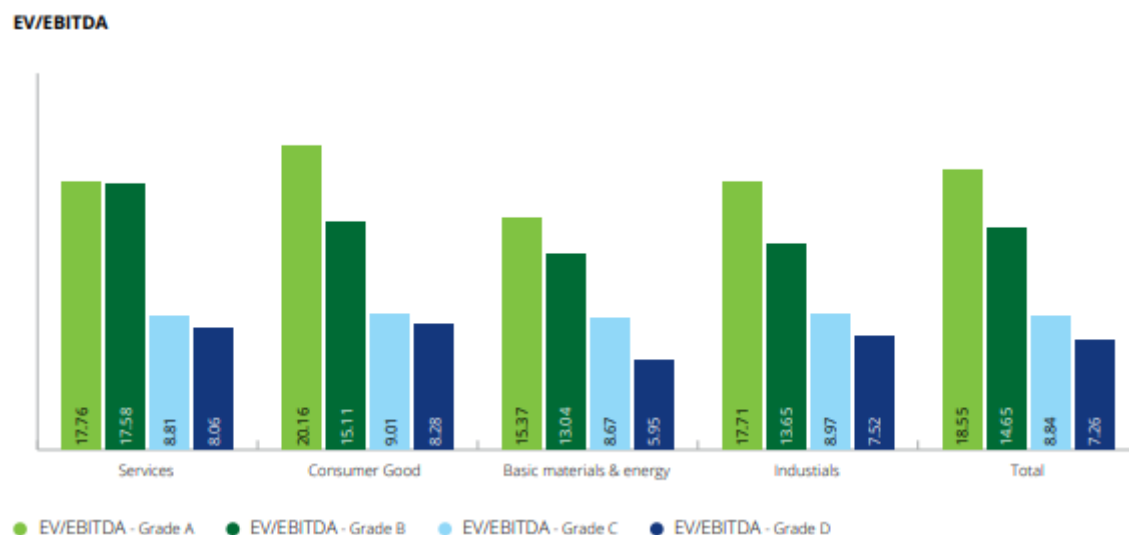
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[46] Hang et al. (2019)
[47] Morningstar (2020)
[48] In, Park and Monk (2019)
[49] "The fundamental effects of ESG disclosure quality in boosting the growth of ESG investing" H. Wen (2022)

Knowing the correlation between ESG investment and financial performance, let's examine whether it affects financial ratios such as EV/EBITDA. Being this ratio one of the most widely used for evaluating companies. Enterprise value over earnings before tax, depreciation and amortization (EBITDA) measures the total value of the company over its capacity to generate income through the operative activity. The chart below shows a clear correlation between the ESG score and EV/EBITDA multiple[50] across all 4 industries considered.

EV/EBITDA

	Services	Consumer Good	Basic materials & energy	Industials	Total
EV/EBITDA - Grade A	17.76	20.16	15.37	17.71	18.55
EV/EBITDA - Grade B	17.58	15.11	13.04	13.65	14.65
EV/EBITDA - Grade C	8.81	9.01	8.67	8.97	8.84
EV/EBITDA - Grade D	8.06	8.28	5.95	7.52	7.26

7. EV/EBITDA Deloitte (2022)

Taking into account grade D as unsatisfactory or insufficient relative ESG performance and grade A as excellent relative ESG performance, there is a clear relationship between higher ESG scores and higher EV/EBITDA multiples, even if the multiples vary from sector to sector, as displayed in chart 7.

The study findings reveal that companies with the highest grade have an enterprise value of approximately 18 times their EBITDA, while those with the lowest grade have a multiple of only 7. Furthermore, the study notes that a 10-point[51] difference in scoring corresponds to a 1.2x improvement in the EV/EBITDA multiple, and a 10-point improvement is associated with a 1.8x higher multiple, rewarding a company's improvement efforts with a proportionately higher increase in the multiple.

To summarize, the majority of recent studies have identified a significant positive correlation between ESG performance, firm value, and profitability, supporting the stakeholder theory and confirming it as the dominant theory. ESG investing has also exhibited downside protection during social or economic crises[52].

2.3.2 Portfolio performance

Knowing the positive impact that being ESG compliant implies on the corporate financial performance, let's see if it has implications on the stock and bond return of the company and if holding an ESG company has a positive effect on the portfolio composition.

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[50] "Does a company's ESG score have a measurable impact on its market value?" Deloitte (2022)
[51] Considering the grading scale is over 100 point and every grade consist of 25 points each.
[52] "Impact of ESG performance on firm value and profitability" M. aydogmus (2022)

Starting with the cost of capital of the company, it's interesting to study the condition of the cost of debt and equity of an ESG compliant company compared to a less ESG compliant company, to analyze and measure if there is an advantage and to quantify it.

- Cost of debt: The improved risk management, downgrade protection and better reputation linked to ESG investing reduce the default risk. As a result, it lowers the interest paid, minimizing the cost of debt on borrowed funds, including bond issuances and loans from lending institutions[53]. Indeed, A study carried out on European and American businesses between 2006 and 2016[54] discovered that ESG-related news is linked negatively with credit default swap (CDS) spreads. This correlation resulted in a significant decrease in CDS spread, around 4%, when positive news was reported.

  Additionally, the default rate is positively linked to business energy consumption and negatively correlated with corporate governance and social responsibilities.

  Lending institutions have increasingly linked their lending tools to incentivize ESG projects and standards in recent years. They are offering lower interest rates[55] to virtuous companies, but also to individual environmentally friendly projects, in order to promote the green transition and increase their ESG exposure[56].

- Cost of equity: ESG performance has emerged as a significant catalyst for increased shareholder value, just as it has on the debt side. In addition to enhanced financial performance, shareholders benefit from a range of other advantages, including long-term value creation, reduced share price volatility[57], reduced uncertainty and risk through better capital policy and management, enhanced reputation and positive stakeholder relations[58].
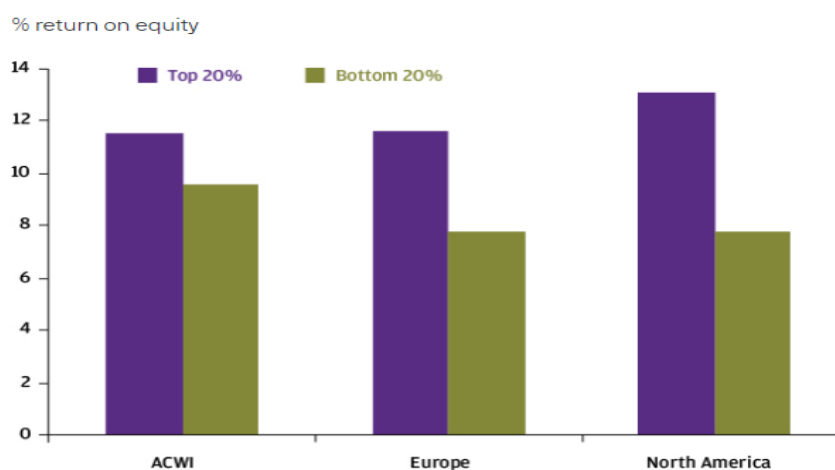
8.J.P. Morgan asset management

[53] "Do environmental social and governance (ESG) performance scores reduce the cost of debt? Evidence from Indian firms" A. Arora and DR D. Sharma (2022)

[54] Naumer and Yurtoglu (2020)

[55] "Greenium" is a new term referring to the green bond premium, representing the willingness of the investor to accept lower monetary return in exchange for supporting environment-benefitting activities.

[56] Sustainability-linked debt instrument are still a niche in comparison to the global lending market but has covered 130 billion a year over 6,8 trillion per year in 2020 and it's growing by double digit every year. "Sustainable lending " Accenture (2021)

[57] "Due to the long-term view and the downside protection, ESG investors are incentivized to have a buy-and-hold strategy making the stock more resilient to volatility issues. "ESG in equity analysis and credit analysis" CFA institute (2018)

[58] "ESG importance for long term shareholder value creation: literature vs practice" I. Zumente (2021)

As demonstrated in Chart 8, there is a notable difference in performance between the best-in-class and worst ESG companies. In Europe, the top 20% have achieved a 4% annualized outperformance over the bottom 20% in the past decade. While, in North America, this performance gap is even wider[59].

As previously discussed, after establishing the correlation between a higher ESG score and a lower cost of capital, further studies have highlighted the increased significance of this correlation in countries with weaker legal frameworks in which the company operates[60]. The advantages of a lighter regulatory framework are due to the fact that ESG performance guarantees a kind of good behavior practice that substitutes for the regulatory framework and convinces financiers to provide funds at a lower rate.

Despite debt-side cost reduction being more prominent, this still diminishes the overall WACC[61] resulting in positive impacts upon the business's valuations. Furthermore, the improved cost of capital enables investment in further projects, due to the enhanced margin and higher positive NPV[62]. Additionally, a high ESG score reduces systematic risk and therefore, according to the CAPM[63], reduces both the cost of equity and the cost of debt.

9.MSCI (2019)

The above chart shows that the capital cost reduction between the highest and lowest ESG score quintiles on the MSCI World Index is roughly 0.4%[64]. In terms of equity and debt costs, equity is approximately three times more expensive than debt. Despite the significant difference in interest rates, the most notable decline in interest rates came from reduced debt costs which decreased from just below 2.5% to approximately 1.8%. Meanwhile the equity cost fell by a similar percentage, from 8.1% to 7.6%, its higher grade produced a proportionally smaller reduction.

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[59] "The impact of ESG factors on portfolio return" K. Ward (2021)

[60] "The impact of a firm's ESG score on its cost of capital: can a high ESG score serve as a substitute for a weaker legal environment?" R. Priem (2022)

[61] "Weighted average cost of capital "is the average rate that a business pays to finance its assets, it's one of the most used tools to calculate the enterprise value of a company.

[62] "Net present value" is the value of a series of cashflows over the entire life of a project discounted to the present.

[63] "Capital Asset Pricing Model"is a financial model that calculates the expected rate of return for an asset generated by its exposure to risks.

[64] "ESG and the cost of capital" MSCI (2020)

Cost of capital   Cost of equity   Cost of debt

● Low ESG   ● Q2   ● Q3   ● Q4   ● High ESG
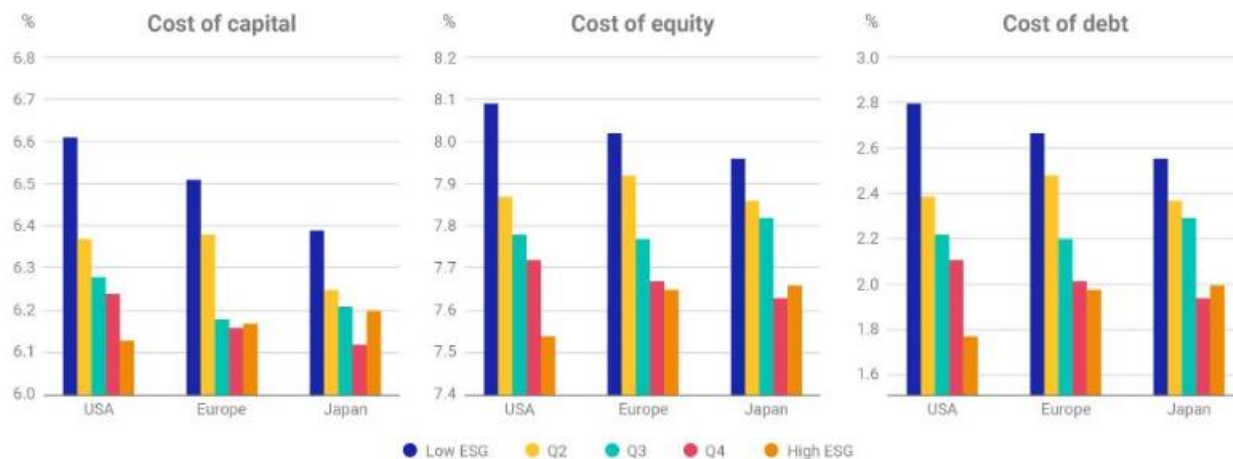
10.MSCI (2019)

In the developed country data, the correlation between cost of capital and ESG score was strongest in the U. S. However, Europe and Japan exhibited some loss of consistency in Q4 and Q5 (higher quintile), while still showing a sharp reduction between the worst and best quintiles.

Supporting the theory, by examining the trend of the mean capital cost for MSCI ESG ratings, businesses that enhance their ESG profile experience advantages due to a decrease in the cost of capital over the medium to long term. These benefits are more noticeable in the developed market portfolio, where sustainability factors favorably influence the risk-adjusted return[65].

In conclusion, as previously stated, ESG compliance has a positive and tangible impact on the financial performance and cost of capital. These improved conditions have several effects on the company, including increased profitability, improved reputation, and reduced cost of raising new capital, which ensure growth, higher market value and greater competitiveness of the company.

2.4 Rating ESG

At the beginning of the 21st century, with the growing focus on socially responsible investing reflected in the ESG market soaring to 30 trillion AuM in nearly two decades, there has been an increase in demand for assets with high ESG performance as well as the demand for a rating agency that could assess and certify compliance with ESG criteria.

The rating agencies, that were evaluating companies' creditworthiness and performance, started to give ESG ratings assessing the company's performance and practices concerning ESG factors. More and more investors, companies and organizations started paying attention to the ESG rating to determine their investment allocation decisions.[66]

As with credit ratings, different agencies use different methodologies to compile their ratings, typically companies are rated using numerical scores from 1 to 100 for each variable and pillar or using letters ranging from AAA (ESG leader) to CCC (ESG laggard)[67], with the final rating depending on the weighting approach.

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[65] "Exploratory review of ESG factor attribution to the portfolio return in Fama-French factor model framework" S. Kumar (2023)
[66] "ESG rating construction: anobjective and transparent approach" C . Corti (2022)
[67]"Environmental, Social and Governance score from Refinitiv" (2022)
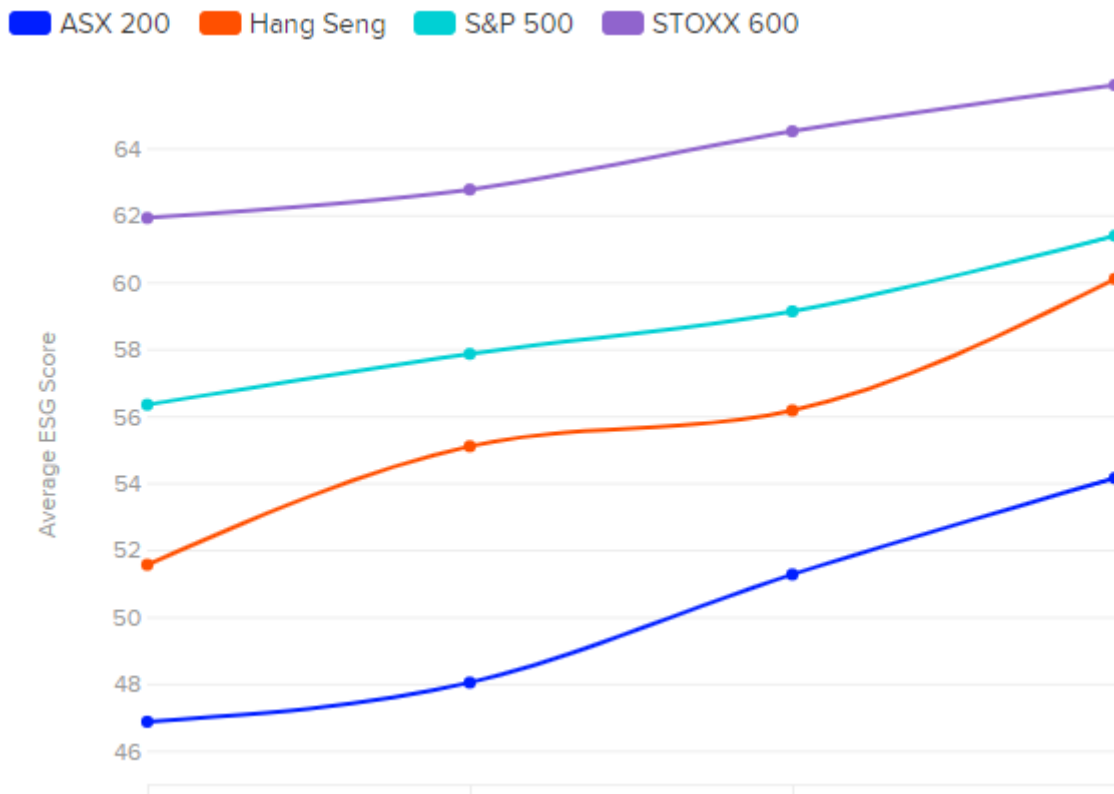
Examining the chart 11 reveals that the most ethical companies are listed in the STOXX 600 in Europe, and are closely followed by the S&P 500 in the US, while The Chinese Hang Seng is quickly moving towards second place.

2.4.1 Importance of ESG Rating

As we have seen in the performance paragraph, ESG performance has an important impact on corporate financial performance and valuation, however, the benefits for the company and investors are not just financial. The key reasons why ESG ratings are important for investors can be summarized as follows[68][69]:

- Investment Decision-Making: ESG rating provide valuable information for investors to assess a company's sustainability performance alongside financial metrics, helping the investor to make investment decision wisely both in financially and ethically.

- Risk Assessment and Management: The rating facilitates the evaluation of the company's exposure to ESG risk, their materiality and the opportunities that could arise in this dynamic environment. Moreover, provides insights into a company's risk management practices.

- Transparency and Disclosure: ESG promotes higher information transparency and contributes to improving the availability and quality of data, making it more accessible to stakeholders. ESG rating acts as an indicator to assess the transparency and level of disclosure of the company.

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[68] "5 ESG benefits for businesses" K. Yasar (2023)
[69] "ESG Rating: a compass without direction" D. Larcker (2022)

- Stakeholder Engagement: Sustainability serves as a connection and dialogue between the stakeholder and the company's values. ESG rating helps to quantify and evaluate the sustainability commitments of the company.

- Benchmarking and Comparison: Using the same rating provider, ESG rating enable the comparison between the company's ESG performance within sector or industries, evaluating the differences and assessing the relative strengths and weaknesses.

- Regulatory Compliance and Reporting: ESG align and anticipate the regulatory developments and reporting requirement. The rating provides a benchmark to assess the company's performance and meet evolving reporting expectations.

- Reputation and Brand Value: A high ESG rating influences the company's reputation and brand value improving customer loyalty and attracting socially responsible investors.

In conclusion, ESG rating it's still not strictly regularized and the rating agencies differ in the methodology with which to calculate the rating, anyway, using the same provider for making the investment decision, the benefits coming from implementing ESG rating in portfolio construction remain tangible.

2.4.2 Raters

Nowadays, there is plenty of ESG rating agencies such as MSCI, S&P, CDP, Refinitiv, Susyanalytics or Bloomberg. Most of them are well-known rating companies while others are no profit companies specialized in ESG practice whose purpose is to incentivize the green transition.

Differently from credit ratings, ESG rating is to some extent still nebulous, lacking a common definition, reporting standard and shared characteristics of each pillar component among rating providers. Due to the missing common standards and difficulties in finding data and assessing the rating, each rating agency is proposing its own ESG assessment methodology, making almost inconsistent the comparison between ratings from different raters[70].

The differences between the ESG assessment of the rating agency are multiple:

- Data source: Even if the principal sources of information are public report and websites, every agency has direct contact with the companies and have different methodology and information required to conduct the assessment.

- Number of assessed indicators: The number of variables that compose each ESG pillar is subjective for the raters, who can decide the number of variables, which information is collected and the weight of every variable in the pillar to make consistent the resulting score. For example, MSCI uses 37 ESG criteria while FTSE Russel uses 300 ESG criteria.

- Definition of ESG materiality: Every ESG rating agency has its own definition of materiality, consequently, the weighting mechanism used to assess criteria importance is different. Even using the

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[70] "Inside the ESG rating: (Dis)agreement and performance" M. Billio (2021)

same variable, the discrepancy across ratings can be significant due to the weight of the different components. As already discussed, the pillar weight for the final score can differ, from equally weighted to a more subjective one considering the industries in which the company operates.

- Rating scale: Even the scoring scale changes following the rater philosophy, from numerical (1 to 100) to literal one (AAA to CCC) or a mix of both.

All this heterogeneity, it's an obstacle to univocally calculating the ESG performance and the overall capital invested, moreover reduces the trust in the ESG process delaying a wider application.

2.4.3   Correlation between raters

Even if the variable and the number of criteria differ for every rating company, the important criteria for each pillar are common for almost everyone, studying which standards are used by the raters and how they changed through time[71] it's possible to create a pattern to see which are the most characteristic variable per pillar.
Clearly, from the start of the ESG movement, the criteria have been added and modified in a continuous hunt towards the best criteria composition to pursue the most complete and accurate assessment.
Looking at the correlation between criteria used by different raters;
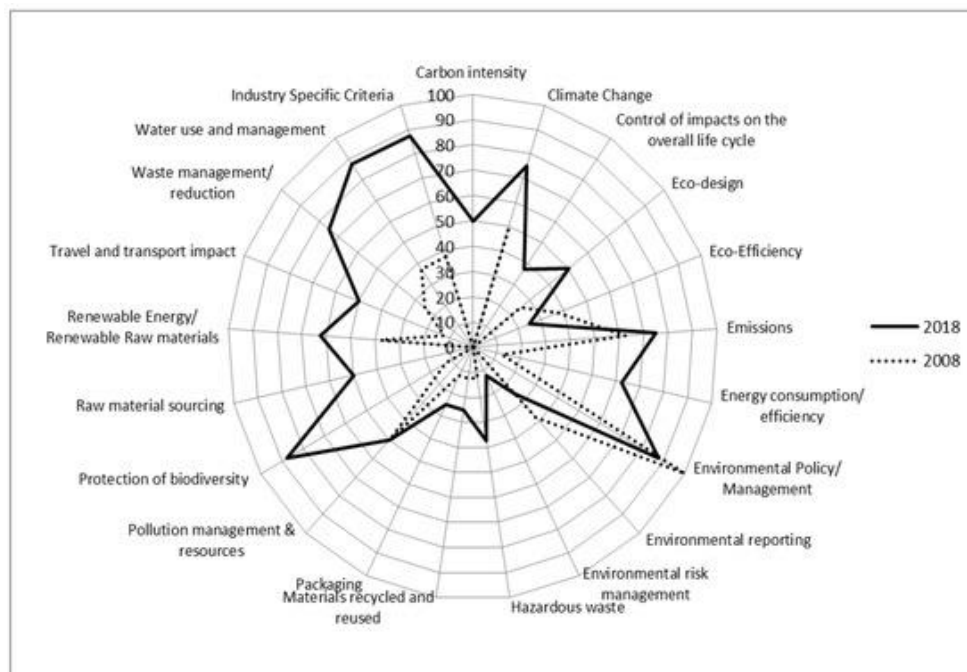
12. Environmental pillar. Rating the raters, E. Escrig-Olmedo (2019)

Regarding the environmental pillar in 2008, the most widely used criteria were environmental policy/management (100%), emission (62,5%) and climate change (50%), while in 2018 increased the interest in externality and the environmental concern so that topic such as water use (87,5%), protection of biodiversity (87,5%) or waste management and reduction (75%) have gained a lot of importance assessing the E pillar[72].

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[71] "Rating the Raters: evaluating how ESG rating agencies integrate sustainability principles" E.Escrig-Olmedo (2019)
[72] After the COP21 in Paris (2015) the attention from assessing the corporate environmental performance on environmental management policies to assess it evaluating the effort in combating climate change reducing the emission consumption and waste.
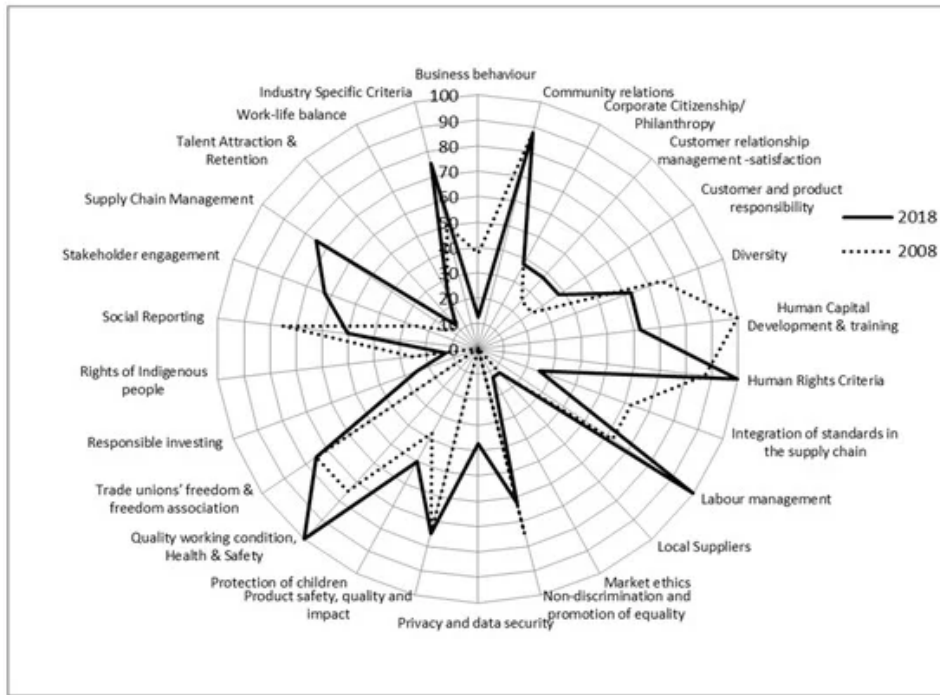
13. Social pillar. Rating the raters, E. Escrig-Olmedo (2019)

The Social pillar was mainly analyzed through human capital development (100%), human rights (87,5%) and community relations (87,5%), after ten years the concern for labor management and quality working condition, health and safety has grown significantly[73] due to the SDGs.

14. Governance pillar. Rating the raters, E. Escrig-Olmedo (2019)

The last pillar had no major transformations during the period 2008-2018, topic such as corporate governance functions and committees (100%) or board structure (75%) remained unchanged, while transparency and prevention of corruption have increased their importance.

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[73] The adoption of the Sustainable Development Goals (SDGs) became crucial to measure how companies contribute to sustainable development.

As it's possible to see, the environmental pillar is the one that had major development during the period, while for the other pillars, mostly the social one, essentially we had a redistribution of the variable importance.

Looking at the correlation between the scores of different rating agencies[74]:
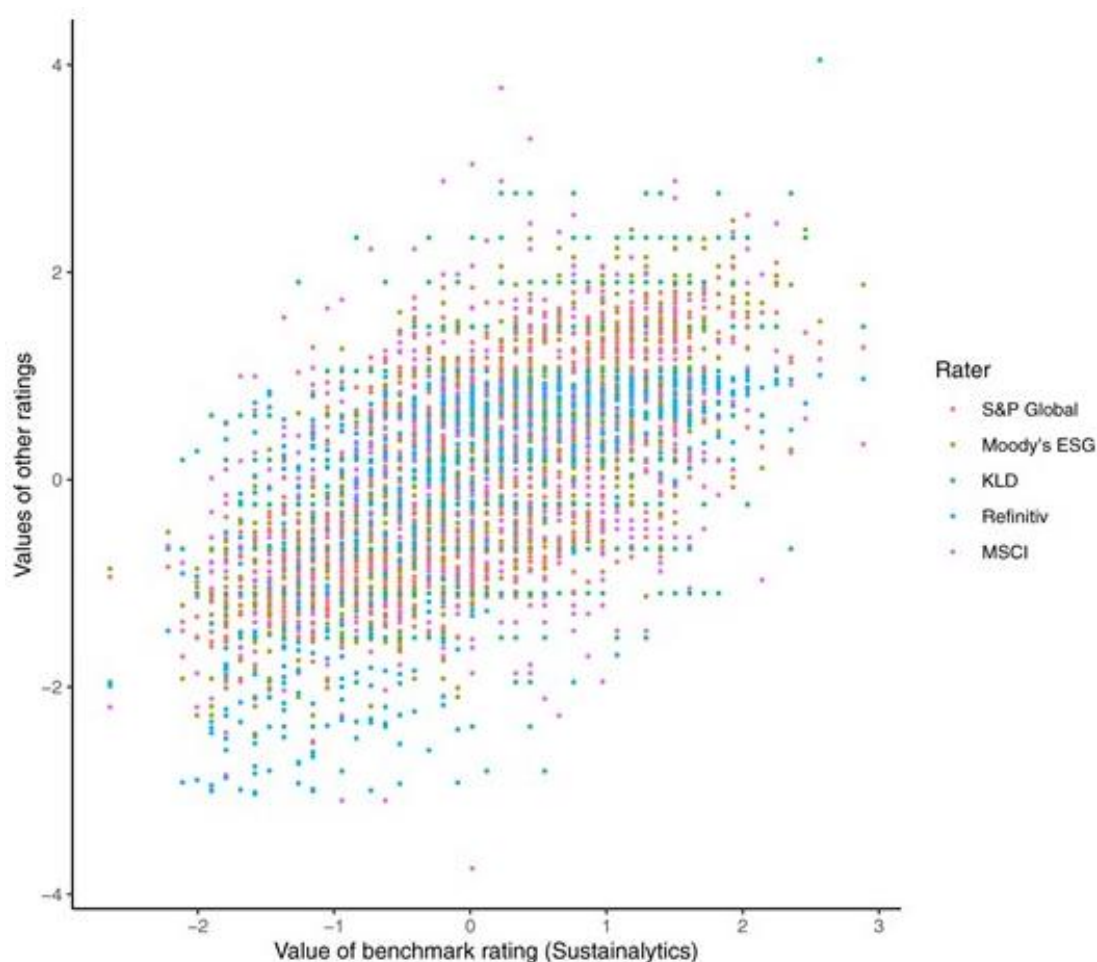
15.Review of finance, volume 26 (2022)

Taking Sustainalytics as a benchmark due to the highest correlation with the other raters, in chart 15., are plotted the value of other raters against the benchmark about a sample of 924 firms.

As it is shown, even if it's weak, there is a positive correlation between the raters. Numerically, there is an average ESG correlation level of 0,54 with the E dimension having the highest average correlation of 0,53 followed by a social pillar with 0,42 and then Governance at 0,30[75].

Although the result shows a positive correlation, the divergence of the result is still significant and not negligible.

2.5   Criticism of ESG

Despite the growing popularity, there are critics and skeptics about the ESG concept and its implementations, that are important to mention and with which we have to deal.

Starting from the issues already discussed in this paper, the non-uniqueness of the definition, without any doubt, it's the main trouble; indeed, without a common agreement about the ESG scope and definition, it

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[74] "Aggregate confusion: The divergence of ESG rating" F. Berg (2022)
[75] G. Brandon, Krueger and Schmidt (2021)

becomes difficult to detect the underlying features such as capital invested, rating or financial performance. All this uncertainty affects the credibility of the ESG movement, the accuracy of the information collected from the market as well as future regulation development.

Connected with the point just argued, ESG rating it's the main tool used by ethical investors to make investment decisions, the divergence of the rating from ESG raters frightens the investors who want to invest their money in assets understandable and secure. In addition, the subjectivity of the standards used and the lack of transparency in the construction of the ESG assessment, make the score even more uncertain, making it harder to assess the correlation with the firm's financial performance.

Additionally, the lack of clarity in ESG ratings from data providers raises concerns about potential conflicts of interest between the raters and the rated index or company. Moreover, a correlation has been observed between companies with high stock returns and higher ratings given by raters with significant index incentives. Lastly, ESG index inclusion decisions appear to be linked to stock returns.[76].

Regarding the companies with a shareholder view, many articles argue that ESG is a distraction, and the only social responsibility of business is to increase the profit for the shareholder, so all the costs to reduce the externalities and to internalize the social and environmental cost of their operation it's just a reduction of profitability for the company. Moreover, investing in ESG projects may have lower returns in comparison to the non-ESG projects focused on profitability[77].

Other considerations come from the struggle for small companies to apply ESG policy due to the high transition cost and meeting the stakeholder request is not feasible without incurring a potential distress situation[78]. Furthermore, the corporate executive may have a short-term performance incentive instead of a long-term one, due to the slowness of the results coming from the ESG policy the managers are not incentivized to undertake ESG projects.

Lastly, there is a growing trend of companies that engage in greenwashing[79] practices to enhance their ESG image without implementing meaningful sustainability practices, to mislead investors and stakeholders.[80]

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[76] "ESG rating agency incentives" S.a. Sridharan (2023)
[77] "ESG and its critics: high-mindedness is easy when it is cost-free." J.B. Quinn (2022)
[78] "Does ESG really matter- and why?" MC Kinsey quarterly (2022)
[79] Is the act of making false or misleading statements about the environmental benefits of the product or practice.
[80] "What is Greenwashing?" C. Lindwall (2023)

3 Scoring methods

As a crucial element of every rating model, the scoring methodology is the fundamental part of each model so it's essential to understand the tools we are going to use and the reliability of the chosen methodologies.

Before delving into the ESG rating model, the focus of this paper, it's important to understand the scoring model used to assess company compliance and relative rating.

To achieve this aim, we shall examine two distinct regression models, which will be utilized subsequently in the paper to evaluate the ESG rating of the companies in the sample. These models are: Discriminant analysis, specifically focusing on the Altman Z-score, and logistic regression, specifically focusing on the Ohlson O-score.

3.1 Discriminant analysis

Multiple discriminant analysis (MDA) is a statistical technique utilized to classify or predict results using various variables. First used during the 1930s[81] MDA has since been implemented in an extensive range of business and academic studies.

MDA, also used by Altman for the Z-score model, it's one of the best and the simplest tools for deriving a linear combination using variables that efficiently discriminate between two or more groups.

Discriminant analysis is a useful and straightforward tool, also used by Altman for the Z-score model, to derive a linear combination of variables that efficiently discriminates between groups.

For instance, using the Altman Z-score as an example, the discriminant analysis requires the presence of the variable being quantifiable for all analyzed companies so that it can determine a set of discriminant coefficients crucial for classifying the firms.

In practice, the coefficients are applied to the independent variable resulting in a score which is used to classify each company into one of several possible groups.

$$Z = v_1x_1 + v_2x_2 + \ldots + v_nx_n$$

The linear discriminant function, as illustrated above, is comprised of the computed discriminant coefficient, v, and the independent variables, x. Consequently, the resulting Z value from the function serves as the dependent variable required for discriminating the companies into groups.

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[81] "Contributions to linear discriminant analysis with applications to growth curves" E. Ngailo (2020)
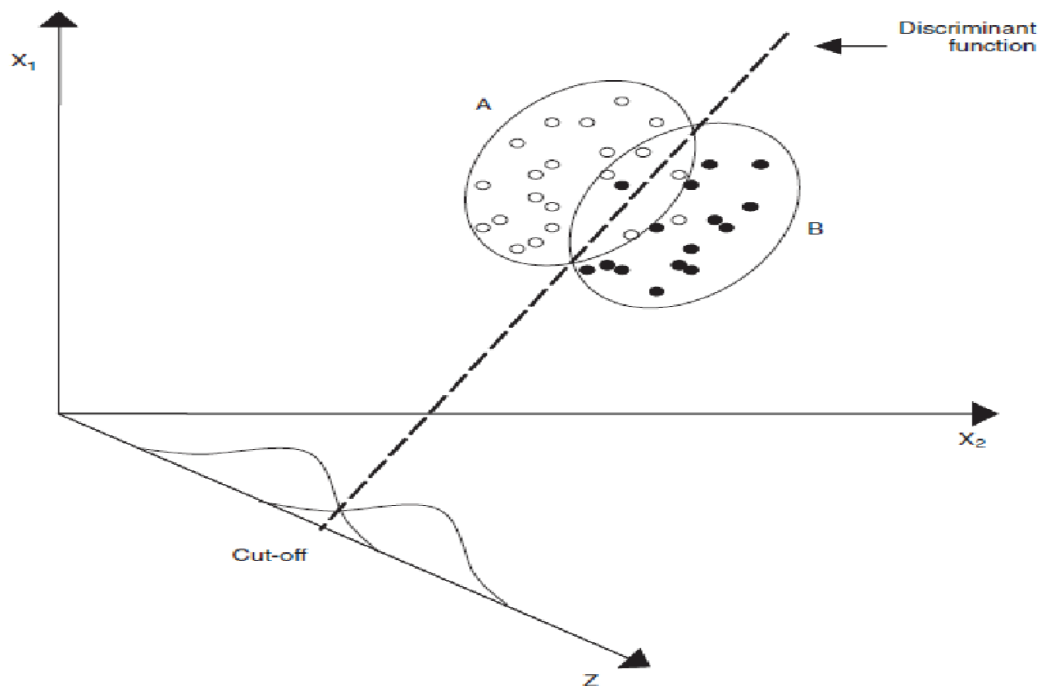
16. A. Resti, A. Sironi, Op.cit., p. 288 (2020)

When classifying data, it is essential to identify a suitable threshold value that distinguishes the two groups. This can be achieved discretionarily by setting a minimum value that must be met to be considered compliant[82], or numerically by using the mean value to divide the sample into two equal groups[83]. Moreover, if a balanced sample is not needed, it is preferable to consider the most accurate cut-off value that correctly discriminates between the two categories.

Chart 16 illustrates potential classification errors when groups are not well separated or, worse, overlapped. The accuracy of the discriminant analysis increases as the distance between the two groups widens, thus reducing the risk of misclassification.

To assess the function's overall significance and effectiveness, Wilks' lambda is the statistical measure used. The lambda value can range from 0 to 1. The smaller the lambda, the greater the discriminatory ability of the function[84].

The MDA technique offers several benefits.:

- The model analyses the complete profile of chosen variable characteristics, which are common to all companies in the sample, simultaneously avoiding any ambiguities.

- The model, through the selection of a limited number of variables, conveys a substantial amount of information.

- MDA also enables the reduction of data dimensionality, thereby simplifying the analysis and interpretation of the results.

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[82] In our model, the two groups are ESG compliant or not compliant. In our case, the size of the two groups is not the same.
[83] "Predicting financial distress of companies: revisiting the Z-score and Zeta models" E.I. Altman (2000)
[84] "Wilks' Lambda of variables in discriminant analysis" M. Duran (2022)

- The model additionally accounts for the correlation between predictor variables and has fewer assumptions compared to other statistical methods.

Conversely, the DA model encounters difficulty in producing an efficient result when there is a small sample size or a non-linear relationship between predictor variables and group membership. Furthermore, accuracy could be affected if the data is not normally distributed.

In brief, discriminant analysis is a valuable statistical method that categorizes objects into two or more exclusive groups using numerous predictor variables. It estimates the coefficients of a linear function for given variables by maximizing the discrimination between groups or minimizing the classification error with known data.

3.1.1 Z score model

As previously discussed, the Altman Z-score is a well-known model that utilizes discriminant analysis.[85] Created by Edward I. Altman in 1968, the primary goal of the Z-score model is to assess the financial wellbeing of a business organization and forecast the likelihood of it entering bankruptcy. To achieve this, the model calculates a series of ratios derived from balance sheet and income statement figures to produce a score that predicts the likelihood of default over a short period, typically two years.

The initial model was designed for a public manufacturing company with a net worth of more than $1 million. Over time, this model has been refined[86] and two additional models have been published for smaller and private companies. Furthermore, it has also been employed as a scoring method for the rating models in other research.

The Altman Z Score model is a credit scoring model that integrates quantifiable financial indicators and a limited number of variables. It is based on a linear formula that gives a weight to each of the five variables by assigning them coefficients:

$$Z \text{ score} = 1{,}2*x_1 + 1{,}4*x_2 + 3{,}3*x_3 + 0{,}6*x_4 + 1*x_5$$

The "x" represents the five financial ratios, while the numbers indicate the weight assigned to each ratio in the linear formula.

The independent variables are:

- x_1 = Working capital/Total asset
- x_2 = Retained Earnings/Total assets
- x_3 = EBIT/Total asset
- x_4 = Market value of equity/Total liabilities
- x_5 = Total sales/Total asset
- Z score = Altman's Z-score

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[85] "Financial ratios, discriminant analysis and prediction of corporate bankruptcy" Edward I. Altman (1968)
[86] "Corporate financial distress and bankruptcy" E. I. Altman (2006)

The Z-score of a company is indicative of its likelihood of bankruptcy. A lower score implies a higher probability of insolvency, while a higher one reflects better financial strength and lower risk of distress.

To assess the level of risk, Altman has determined two cut-off values, to more accurately classify companies. The first cut-off value is 1.8, which delimits the risky companies; all companies with a score lower than 1.8 have a high probability of going bankrupt, and the second cut-off value is 3, which marks the threshold for healthy companies. Companies with a score between 1.8 and 3 fall into a grey area, indicating a moderate chance of filing for bankruptcy. These companies should be monitored closely.

According to Altman's research[87], the model demonstrates a high level of precision in categorizing these companies, with an accuracy range between 80% and 90%. Nevertheless, there is still a chance of 28% for a Type I[88] error and a 6% probability for a Type II[89] error.

3.2 Logistic regression

The logistic regression (or logit model) is a statistical model suited to classify companies. This model has been employed by Ohlson in 1980 for the O-score model for forecasting bankruptcies, along with other scientific studies in more recent times.

Logistic regression delivers a high precision in assessing the likelihood of an event taking place when presented with a set of independent variables[90], where the dependent variable (outcome) is categorical[91].

The logit regression equation comprises a ratio of two exponential functions:

$$P(Y = 1) = \frac{e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}{1 + e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}$$

Here, x represents the independent variable, the α consist in the regression's constant, β denotes the coefficient, which is estimated by maximum likelihood estimation (MLE), while P signifies the dependent variable, denoting the probability of how the company is ranked in one of two groups[92].

MLE has a crucial role, as it is used to establish the predictor variables' weights in the most fitting equation for observed data, maximizing the probability of obtaining observed results with the lowest classification error feasible.

The logistic equation is comprised of two steps. Firstly, the linear function which acts as the exponent of the function is calculated through MLE, allowing the weights of the single independent variable and the constant to be assessed. The final step involves applying the computed function, in the form of an exponent in the exponential ratio above, which enables the calculation of the probability that is ultimately used for the classification task.

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[87] "Predicting financial distress of companies: revisiting the Z-score and Zeta models" E.I. Altman (2000)
[88] Type I error consists of a classification error in which a firm classified as healthy goes bankrupt in two years, this error is the one more dangerous from an investor point of view due to the loss of the invested capital in the company.
[89] Type II error consists in classifying the firm as distressed when it does not go bankrupt, this type does not involve loss of capital but just a miss out of investment opportunities.
[90] "What is logistic regression?" IBM
[91] Binary classification.
[92] "Vantage analytics library " Teradata
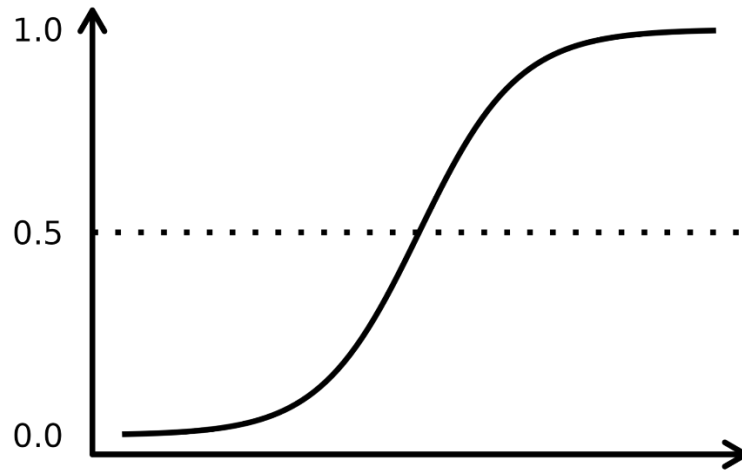
As the outcome is expressed as a probability, the result of the logistic function is limited between 0 and 1, with a cut-off value of 0.5. If a company has a probability greater than 0.5 from the logistic function, it will be considered compliant, while anything below 0.5 will be considered non-compliant.

Since the logistic regression is non-linear and R2 cannot be applied[93], it is necessary to use a pseudo-R2 such as McFadden's R2 (1974) to evaluate the accuracy of the regression. This indicator is composed of a ratio between L_M, which is the log-likelihood value for the fitted model, and L_0, representing the log-likelihood for the null model.

$$R^2_{McF} = 1 - \ln(L_M) / \ln(L_0)$$

The resulting score ranges from 0 to 1, with higher scores indicating better predictive ability. However, achieving a perfect fit with a regression model is highly unlikely, so scores between 0.2 to 0.4 are already considered a good fit[94].

Like all regression models, linear regression (LR) has limitations. in fact, LR has issue solving nonlinear problem since it has a linear decision surface, moreover, multicollinear or repeated information can mislead training parameters. Additionally, LR is sensitive to outliers in the data, which can negatively impact its performance.

3.2.1 O-score model

Similar to Altman's Z-Score, Ohlson's logistic regression aims to evaluate the financial condition of companies using both qualitative and discrete variables to forecast potential insolvencies.

Introduced in 1980 by Ohlson, the O-score model is a multi-factor metric designed as an alternate to the Z-score for predicting financial distress situations[95]. Over time, Ohlson refined the model by adjusting coefficients according to new financial conditions and applying the model to various countries. In 2011, the latest version was introduced for the Iranian market[96].

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[93] "R-squared is not valid for nonlinear regression" J. Frost (2020)
[94] "McFadden's pseudo-R2 interpretation" Cross validated (2020)
[95] "James Ohlson O-score for predicting corporate bankruptcy" S.M Ikhtiar Alam (2022)
[96] "Ohlson's model and its prediction ability in comparison with selected bankruptcy models in conditions of Czech SMEs" D. Kubickova (2015)

Ohlson's model, created through logit regression, includes nine financial ratios that rely on balance sheet data from the companies included in the study sample. The chosen ratios aim to provide an accurate representation of a company's financial situation and likelihood of bankruptcy.

$$Q = -1.32 - 0{,}407 \log\left(\frac{TAt}{GNP}\right) + 6.03 \frac{TLt}{TAt} - 1.43 \frac{WCt}{TAt} + 0{,}0757 \frac{CLt}{CAt} - 1.72\,X - 2.37 \frac{NIt}{TAt} - 1.83 \frac{FFOt}{TLt} + 0.285\,Y + 0.521 \frac{NIt - NIt-1}{|NIt| + |NIt-1|}$$

Where:

- TA: Total Asset
- GNP: Gross National Product price index level
- TL: Total Liabilities
- CL: Current Liabilities
- CA: Current Assets
- X: 1 if TL > TA, otherwise 0
- NI: Net Income
- FFO: Funds From Operations
- Y: 1 if had a net loss for the last two years, otherwise 0

The formula comprises nine independent variables and the relative coefficients associated with each of them, where the specific weight of the variable is based on its relative importance in predicting distress and indicates the relative positive or negative impact on the overall score.

In order to classify companies, the O-score equation needs to be converted to a probability of default, which can be done through the equation.

$$P = e^{O\text{-}score}/(1+e^{O\text{-}score})$$

The likelihood of default separates the sample into two categories; businesses with a score above 0.5 demonstrate a high probability of default[97], while those below 0.5 are deemed healthy.

The Ohlson model is estimated to be around 90% accurate in predicting bankruptcy, surpassing the Z-score model. Although it may still produce false signals, this model remains one of the most accurate, bearing in mind that no regression can guarantee 100% accuracy.

3.3 Models comparison

Knowing the statistical techniques that we are going to use later on in the ESG rating model, to gain a comprehensive understanding of future results and enable comparison, we must examine the disparities between two models used in the ESG rating model.

Although both models aim to classify, however, the differences in approach and assumptions are tangible and can lead to different outcome. The model divergences are the following:

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[97] The positive variable coefficient implies a higher probability of bankruptcy so it has a negative impact on the score.

- Regarding the classification of the dependent variable, it should be noted that Logistic Regression (LR) is suited for solving only binary classification problems, whilst Discriminant Analysis (DA) can handle issues with more than two categories[98].

- DA makes assumptions on the normal distribution of the predictor variables, whereas LR does not have any such requirement but assumes a linear relationship between the variables and log-odds outcome.

- The interpretation of the coefficient is not straightforward using DA, on the contrary, using LR the log-odds of the outcome variable offer valuable insights into the strength and direction of the relationship between the variable and the classification[99].

- Finally, the accuracy of DR is limited when dealing with a small sample size or a large number of variables, whereas LR is more robust and therefore better equipped to deal with such situations.

Considering the distinctive features of the two models, although both DR and LR correspond to the objective of our study, it is feasible to discern a more appropriate match with logistic regression traits. Nevertheless, we will utilize both methodologies to enhance the precision of our findings.

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[98] "Comparison of logistic regression and linear discriminant analysis: a simulation study" M. P. Perme (2004)
[99] "Which test: Logistic regression or discriminant function analysis" P. Steyn (2021)

4 Model Development

After providing a general introduction to the ESG framework and the regression model that will be used, this master's thesis will now delve into the ESG rating model, which forms its core.

The main objective of this paper is to create a precise ESG rating model that can evaluate a company's efficacy using two different regression models and a minimal number of variables.

In this final chapter, we will implement both scoring approaches mentioned before through the use of selected variables for regression analysis and will take as a sample the major financial companies operating in Europe to assess their ESG compliance.

To choose the variable and collect the data have been used the Refinitiv platform, which also provided an example model to assess the rating table that will be later used to evaluate the pillars and overall ESG score. To perform the regression, we have employed the SPSS software and determined the linear and logistic coefficients, the accuracy ratio, the classification results and the ROC curve that have been used to assess the cut-off value for the linear regression.

We will examine each aspect of the ESG rating model in greater detail, beginning with the model structure and concluding with performance analysis and the model's applicability.

4.1 Model structure

As with most rating models, the objective of this model is to provide accurate information that is useful in consciously making investment decisions. Specifically, given the growing significance of ESG standards in investment decisions, this rating model assesses compliance with such policies, offering investors valuable insights to realign their portfolio allocation not only with profit-oriented assets but also with ethical ones.

In particular, this ESG rating model has a relatively small number of variables, with 13 per pillar, while the sample consists of 147 companies all working in the banking and insurance industry with headquarters situated in Europe.

Despite the common variables and sample, this paper addresses two distinct regression models that employ different computational methods, leading to dissimilar outcomes that cannot be directly compared. The various methodologies aid in obtaining a better comprehension of which regression model best suits the classification goal and compensate for potential limitations that either methodology may encounter during computation, thereby boosting the accuracy of the rating model.

To evaluate the accuracy of the regression models, different tools were used due to the varying computation methods. The Wilks' lambda was employed for linear regression, while the McFadden R^2 was utilized for the logistic model. Both tools could yield results from 0 to 1, although with different interpretations. A lower value of lambda indicates higher model accuracy, whereas a value closer to 1 for McFadden R^2 implies a good fit of the regression model to the original data.

Regarding the ESG rating table, each pillar table has been calculated separately to adjust the rating grade to the scoring result from the regression, in order to provide a more precise rating level as close as possible to

Refinitiv's. The two regression models have been graded differently too, with the DA rated from 0 to 100, like credit rating, while the LR uses probabilities from 0% to 100%. The ten rating levels we have used range from AAA, the best grade, to D, the worst, with a B grade used as the cut-off score that separates the compliant group from the other.

To score the overall ESG rating table, the threshold is set as the average of the pillar scores, so that each pillar is given equal weight. The final score is then the average of the three pillar scores, which reflects the overall level of compliance; due to the low environmental impact that financial companies have in their operations[100], it's not necessary to give one pillar more weight than others, so it's possible to score all pillar in the same way. We have employed two distinct regression models as they yield diverse information. When used in combination, they provide a comprehensive overview of the company's condition for the investor. Specifically, logistic regression is a classification tool that determines the likelihood of the company's compliance with certain variables. On the other hand, linear regression assigns a score crucial for rating model construction. Putting them together, the regressions' combined information provides an accurate company rating and reliable compliance probability, offering complete information.

4.1.1 Refinitiv model

Having constructed this ESG rating model, we analyzed the structure and database of the primary ESG rating agency and found Refinitiv to be the most feasible and comprehensive option for collecting data, variables, and samples. Refinitiv is considered one of the top-ranking rating firms in the ESG framework. Its database covers 85% of the global market capitalization, providing a transparent and objective assessment of over 630 ESG variables. The company rates more than 12,500 public and private entities worldwide.[101]

Refinitiv's model captures 630+ measurements grouped into ten categories, forming the three pillars (three for E and G and four for S). Each pillar score is the relative sum of the category weights, whose value may vary depending on the industry sector, mostly for the Environmental and Social pillars while Governance's weight remains the same across all industries. The overall rating is the weighted average of the pillars, which can vary based on the industry of the companies being examined.

The scoring is quantified for each pillar and an overall score is awarded, ranging from 0 to 100. The score is then converted via a table into a rating grade, comparable to credit ratings, for enhanced comprehension and company comparison.

The scoring table is comprised of 12 grades, ranging from A+ to D-, equally divided[102]. A company with a grade above B- is classified as compliant, while one below is deemed non-compliant with ESG standards.

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[100] Regarding industrial companies, the environmental pillar can be more relevant due to the impact that the operation has on the natural and social environment.

[101] "Environmental, Social and Governance score from Refinitiv" Refinitiv (2022)

[102] The grade score range is consistent for all 12 possible grades, with each one covering 8.33 points. The D- grade range is from 0 to 8.33, while the A+ grade range is from 91.66 to 100.

4.2 Variables

Variables play a crucial role in each regression model as they set the criteria with which businesses are evaluated and classified. Therefore, the selection process must be transparent and reasonable.

From Refinitiv's 630+ variables, we have chosen just 13 per pillar (39 variables in total) that most effectively signify and match our categorization objective. We have taken into account various criteria in selecting these variables to build a reliable, fast, and easy-to-apply ESG rating model.

The standards that we have followed for the variable selection are the following:

- The use of the variable has to be widely spread among the major raters.
- An ESG-relevant variable representative of the industry sector.
- Each pillar should have a minimum of two quantitative variables.
- The data have to be publicly available for the majority of companies within the sector.
- The chosen variable should be straightforward to comprehend and resistant to manipulation.
- Availability of the variable data in the company's report

The variable comprises quantitative and qualitative questions, the answers to which can be readily found within the company's reports, such as the annual report, sustainability report, financial statements, or the code of ethics of the evaluated company.

Quantitative variables provide numerical answers and are easily comprehensible. On the other hand, qualitative variables consist of bivalent questions that require either "true" or "false" answers. These questions are often complex and can be misleading with just a simple "yes" or "no" response.

During the variable adequacy evaluation process, it has been essential to scrutinize the relevance of each variable in each pillar optic and objectively assess and adjust the significance of the regression coefficients.

In some instances, it was necessary to replace variables with more consistent options to improve the accuracy of the regression model and achieve a more precise result with higher correct classification.

Therefore, it is crucial to examine the variables and their definitions thoroughly to understand the information we are seeking.

4.2.1 Environmental variables

The environmental aspect is central, as the ESG standards highlight the significance of the operation's impact on the ecosystem. As the dataset comprises financial companies with a reduced pollutant impact, the variables' emphasis has been shifted from quantifying pollution to valuing initiatives and green policies.

Independent variable	Description
Total CO$_2$ Equivalent Emissions to EVIC USD in million*	Total CO$_2$ and CO$_2$ equivalents emission in tons divided by EVIC in US dollars in million.
Energy Use Total (petajoules)*	Total direct and indirect energy consumption in petajoules[103]
Environment Management Team	Does the company have an environmental management team? - in scope are any team that performs the functions dedicated to environmental issues
Environmental Supply Chain Management	Does the company use environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners?
Environmental Investments Initiatives	Does the company report on making proactive environmental investments or expenditures to reduce future risks or increase future opportunities? - investment made in the current fiscal year so as to reduce future risks and increase future opportunities related to the environment or in new technologies to increase future opportunities.
Green Buildings	does the company report about environmentally friendly or green sites or offices? - office/green site where the company engages in some operations
Policy Energy Efficiency	Does the company have a policy to improve its energy efficiency? - in scope are the various forms of processes/mechanisms/procedures to improve energy use in operation efficiently
Renewable Energy Use	Does the company make use of renewable energy? - renewable energy produced/purchased for its own use only
Climate Change Commercial Risks Opportunities	Is the company aware that climate change can represent commercial risks and/or opportunities? - development of new products/services to overcome the threats of climate change to the existing business model of the company
Environment Management Training	Does the company train its employees on environmental issues?
Environmental Partnerships	Does the company report on partnerships or initiatives with specialized NGOs, industry organizations, governmental or supra-governmental organizations, which are focused on improving environmental issues?

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[103] Petajoules (10^{15} J) is equivalent to 1000 terajoules.

Renewable/Clean Energy Products	Does the company develop products or technologies for use in the clean, renewable energy (such as wind, solar, hydro and geo-thermal and biomass power)? - in scope, we also include data on the financing of renewable energy projects
Targets Energy Efficiency	Has the company set targets or objectives to be achieved on energy efficiency? - in scope, are the short-term or long-term reduction target to be achieved on efficiently using the energy from business operations

*Quantitative variable   18.Environmental variables

In detail, the pillar consists of 2 quantitative variables, namely CO_2 emissions and energy usage, and 11 qualitative variables pertaining to environmental practices of the company in critical activities and decision-making, as well as energy management and efficiency. As the sample has a financial nature, eco-friendly partnerships, green investments, and green product offerings play an important role in driving the scores, promoting the collection of green capital and raising awareness about ESG initiatives.

4.2.2   Social variables

The social framework is a significant topic that every company must address. Nowadays, attention to employee work-life balance and safety at work is crucial, and every management team must consider this. From a financial company's perspective, we concentrate on human rights, gender equality, and bribery and corruption practices.

Independent variable	Description
Women Employees*	Percentage of women employees. - percentage of women employees to the total number of employees of the company
Net Employment Creation*	Employment growth over the last year.
Fundamental Human Rights ILO UN	Does the company claim to comply with the fundamental human rights convention of the ILO or support the UN declaration of human rights? - includes the International Labour Organization's (ILO) Declaration on Fundamental Principles and Rights at Work and the United Nations Universal Declaration of Human Rights
Improvement Tools Business Ethics	Does the company have appropriate communication tools (whistle blower, ombudsman, suggestion box, hotline, newsletter, website, etc.) to improve general business ethics?
Product Responsibility Monitoring	Does the company monitor the impact of its products or services on consumers or the community more generally?

	- any evidence that the company monitors the impact of its products and services on consumers are considered
Flexible Working Hours	Does the company claim to provide flexible working hours or working hours that promote a work-life balance?
Policy Freedom of Association	Does the company describe, claim to have or mention the processes in place to ensure the freedom of association of its employees?
Crisis Management Systems	Does the company report on crisis management systems or reputation disaster recovery plans to reduce or minimize the effects of reputation disasters? - any contingency plan in place to resume business with minimum downtime and to ensure that businesses can remain operational through any event or disaster
Policy Employee Health & Safety	Does the company have a policy to improve employee health & safety?
Policy Cyber Security	Does the company have a policy on cyber security in place to protect from cyber-attack, unauthorized access & data leaks, etc.? -cyber security refers to the body of technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access
Day Care Services	Does the company claim to provide day care services for its employees?
Training and Development Policy	Does the company have a policy to support the skills training or career development of its employees?
Policy Bribery and Corruption	Does the company describe in the code of conduct that it strives to avoid bribery and corruption at all its operations? - policy in the code of conduct against the bribery and corruption in its operations

*Quantitative variable   19.Social variables

More specifically, the two numerical questions concern job creation and female employment within the company, while the qualitative question relates to employee safety, skill development and respect for human rights. Additionally, attention is given to communities through data protection, product monitoring and anti-corruption policies.

4.2.3 Governance variables

Lastly, the governance pillar plays an important role, particularly for financial companies, because of the capital management decisions. Board independence and compensation incentives are key indicators of the quality of decisions and the level of risk in company operations.

Independent variable	Description
Board Gender Diversity, Percent*	Percentage of female on the board.
Independent Board Members*	Percentage of independent board members as reported by the company
Audit Committee Independence*	Percentage of independent board members on the audit committee as stipulated by the company.
Public Availability Corporate Statutes	Are the company's articles of association, statutes or bylaws publicly available?
Compensation Committee Mgt Independence	Does the company report that all compensation committee members are non-executives?
Sustainability Compensation Incentives	Is the senior executive's compensation linked to CSR/H&S/Sustainability targets?
Compensation Improvement Tools	Does the company have the necessary internal improvement and information tools for the board members to develop appropriate compensation/remuneration to attract and retain key executives? - external consultant/advisors/legal counsel hired for determining compensation for the executives
Global Compact Signatory	Has the company signed the UN Global Compact? - has the company singed the 'United Nations Global Compact' which is a non-binding united nations pact to encourage businesses worldwide to adopt sustainable and socially responsible policies, and to report on their implementation
Board Attendance	Does the company publish information about the attendance of the individual board members at board meetings?
Nomination Committee Mgt Independence	Are the majority of the nomination committee members non-executives?
CEO Compensation Link to TSR	Is the CEO's compensation linked to total shareholder return (TSR)?
Shareholders Approval Stock Compensation Plan	Does the company require that shareholder approval is obtained prior to the adoption of any stock-based compensation plans? - relates to any stock-based compensation plan - equity, stock-option plans, restricted stock compensation, warrants, stock appreciation rights
Policy Shareholder Engagement	Does the company have a policy to facilitate shareholder engagement, resolutions or proposals? - in scope, are the data on company facilitating shareholders to have the right to ask a question to the board or management

*Quantitative variable   20.Governance variables

Governance variables are divided differently, there are three quantitative variables, all of which are expressed as percentage scores for gender diversity, independence of the board and the audit committee. The remaining 10 variables are qualitative and include information on board compensation and incentives as well as availability of data and shareholder rights.

4.3 Sample

Given the abundance of studies on industrial firms and the scarcity of literature on financial firms in the ESG framework, this thesis aims to evaluate an ESG rating model by examining European financial companies[104]. The sample comprises 147 financial companies operating and headquartered in Europe, as shown on the map below.

21. European country in the sample

There are a total of 16 highly developed countries, including the UK and Switzerland, which, although not part of the European Union, are located on the European continent and therefore included in the sample. The sample selection was influenced by data collection challenges due to the lack of information on one or more variables for certain companies[105]. Consequently, some companies were excluded from the analysis.

For further understanding of the sample composition, please refer to the table below.

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[104] Europe in a broader sense, including also United Kingdom and Switzerland.
[105] ESG data are not easy to calculate and sometimes, even if they are available, the company doesn't disclose it to not deteriorate the corporate reputation.
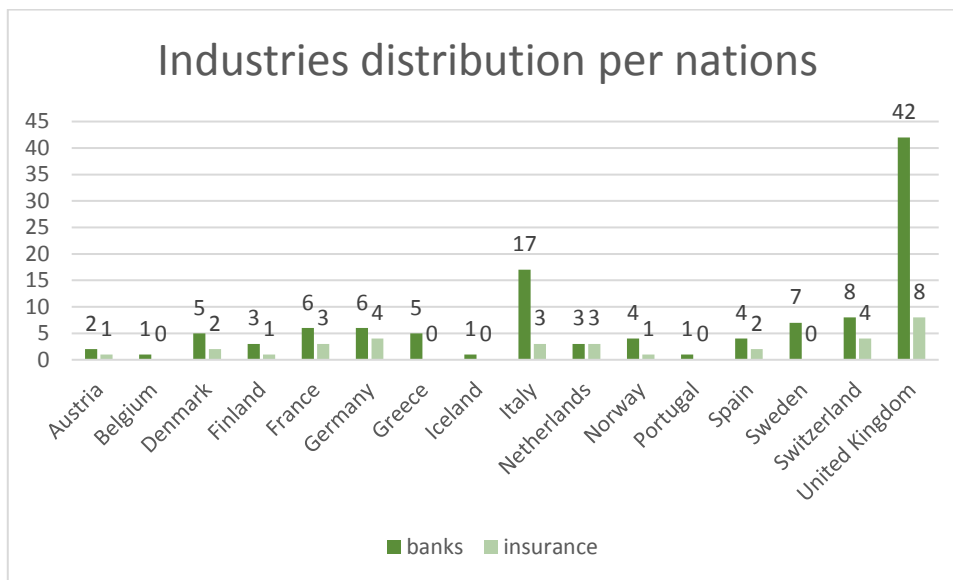
22. Sample composition

Almost a third of the sample comprises UK companies, which were previously regarded as one of Europe's financial benchmarks, before Brexit. Italy has 20 companies in the sample, due to the significant number of banks, intermediaries, and insurance companies subject to high levels of disclosure requirements for Italian firms that promote data availability. Switzerland has 12 companies included in the sample, followed by Germany with 10, and France with 9. The sample also features firms representing smaller nations like Iceland and Greece.
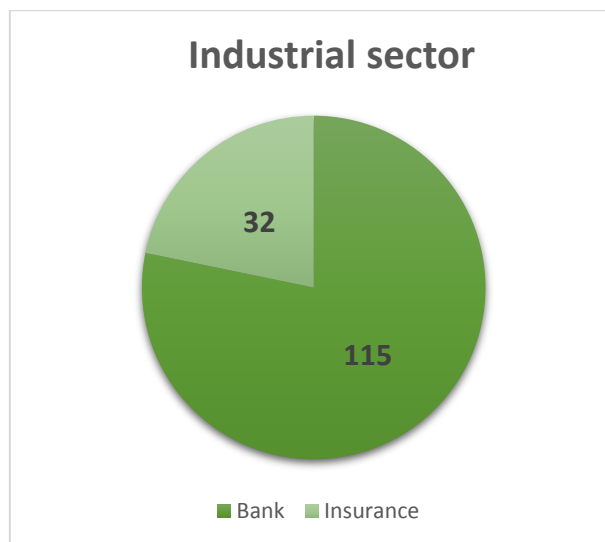
23. Operational sector

Chart 23 presents data on the distribution of sample companies across two sectors: insurance and banking. The insurance sector comprises only 32 companies, while the banking sector has 115. The distribution of companies across various nations appears to be non-linear and does not conform to any particular allocation criteria. Examining the sector allocation of the companies displayed in chart 22., reveals that the banking sector is predominantly represented by the UK and Italy, with half of the companies in the sample originating from these countries. However, each country in the sample has at least one bank. The distribution of insurance

companies is more evenly spread, with 32 insurance companies across 11 countries, yet the UK still accounts for one-quarter of the insurance sample.

To provide a sense of the sample's relevance, the table below displays some information about the entire sample.

Market Cap	1.894.781.486.812
Number of Employees	2.925.884
Total Assets	37.040.721.322.276
Net Income after Tax	186.212.470.989

24. Sample data

The 147 companies possess a market capitalization of slightly below 2 trillion euros and total combined assets exceeding 37 trillion, with an estimated 3 million workers. Moreover, a noteworthy observation highlighting the importance of this sample is the cumulative net income of 186 billion euros.

4.4 Regression models application

Although the two regression models share the same sample and variables, it is important to note that both have a similar model structure, including a regression function, accuracy ratio and cut-off values.

However, their distinct computation methods and underlying assumptions result in different levels of accuracy and classification error.

In order to gain a better understanding of the final outcome, it is crucial to comprehend the calculation process and the steps undertaken for each model, first.

4.4.1 Discriminant analysis application

The Z-score has been used in many studies beyond bankruptcy prediction due to the convenience and effectiveness of multiple discriminant analysis. The Z-score serves as a valuable statistical and data analysis tool. Knowing the theory of discriminant analysis, we can now delve into the ESG rating model. The primary objective is to classify the companies in the sample as either ESG-compliant or non-compliant and to evaluate their performance by assigning a rating, similar to credit ratings, ranging from AAA to D[106].

Our model will employ the following discriminant function:

$$Z = v_1x_1 + v_2x_2 + \ldots + v_{13}x_{13}$$

Where the discriminant coefficients (v) are the focus of the estimation and x represents the independent variable of our model for each of the three pillars. To estimate the coefficients, we utilized DA on the ESG rating assigned by Refinitiv[107] to each company. The objective was to identify the linear combination that minimizes the probability of incorrect classification with the selected independent variables. This regression was conducted for all three ESG pillars and all the companies in our sample. To perform the regression

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[106] The rating grade provides a dipper insight into how compliant the company is, with the B as the threshold used to divide the compliant company from the non-compliant one.
[107] The Refinitiv ESG rating was taken from Refinitiv database.

analysis, we utilized the linear regression function on SPSS software[108] , with Refinitiv's ESG rating score as the dependent variable and our 13 variables acting as predictors. The discriminant coefficients obtained from the regression were applied to each company's corresponding variable data, yielding the Z-score as the resultant score of the linear regression function application. Furthermore, the function's coherence coefficient value was evaluated by the Lambda di Wilks value, which allows us to first assess the regression accuracy. However, this Z-score cannot be interpreted without the use of a cut-off level, which enables the classification of the sample into groups, or the rating class level which evaluates the proficiency of the company.

After developing our discriminant function and calculating all companies' Z-scores, it is necessary to determine threshold values that enable the classification of companies as either compliant or non-compliant. Subsequently, more informative rating grades could be assigned to the companies in order to facilitate investment decision-making and comparison between them. To achieve our classification goal, the SPSS discriminant classification function was utilized. This function calculates both the accuracy and misclassification probability of the entire sample, with the aim of maximizing accuracy and minimizing classification errors. Knowing the optimal classification distribution, the following step was to establish the threshold value that distinguishes the two groups in the most optimal way, as computed earlier. The ROC curve[109] is a highly effective technique in establishing a threshold, enabling the selection of an appropriate divider for the regression, reducing the risk of errors that could remarkably impact investment decisions[110].

In the final step of our linear regression analysis, we assigned the rating grade to each company. This was accomplished by creating a rating table for each pillar, drawing inspiration from Refinitiv's rating table, adjusting the thresholds to better suit our model. To achieve this, we have utilized the cut-off value of a B grade to distinguish between compliant and non-compliant companies. Therefore, to reduce the rating grade from 12 to 10, we calculated the average z-score of each grade, named it with our label, and then merged the DDD, DD and D grades due to the infrequent use and poor information provided by this label.[111]. Moreover, In order to increase the accuracy, it was also necessary to adjust the threshold to match, as closely as possible, the Refinitiv rating grade due to the distortion caused by the misclassified score. Lastly, we have created an overall rating table computing the average rating score across the three pillars. By comparing each company's Z-score with the corresponding rating table[112], we determined the ESG rating score for each company and each pillar, thereby concluding our regression analysis.

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[108] SPSS ("Statistical Package for the Social Sciences") is one of the most used software to manage and analyze data, it was developed by IBM in 2009.

[109] The ROC curve ("Receiver Operating Characteristic curve") is a chart that displays the model's classification performance at different thresholds.

[110] As already discussed in the previous chapter, there are two types of classification error, depending on the aim of the regression one is riskier than the other. In this case, the type I error can be more dangerous due to the misleading investment decision.

[111] With this grade labeling, our rating table is composed of 4 non-compliant grades (CCC, CC, C, D) and 6 compliant ones (AAA, AA, A, BBB, BB, B) with B grade as cut-off value.

[112] The Z-score for each pillar can only be evaluated using its corresponding pillar rating table.

4.4.2 Logistic regression application

The second approach used to construct this rating model is logistic regression, which is specifically designed for classification purposes. In certain cases, due to its non-linear calculation method, it outperforms the Z-score in generating a more precise classification predictor.

The application step is similar to the linear regression model, with the data and scope remaining unchanged. However, the computation method, coefficient and final data differ.

Starting with the logistic model, as anticipated in the previous chapter, the regression function comprises an exponential component and a linear component, which is crucial for the probability calculation.

The linear function is essential in this regression method as it constructs the exponent required for the exponential function, which is necessary for calculating probability.

The exponent is formed by the equation:

$$\text{Exponent} = \alpha + \beta_1 {*} x_1 + \beta_2 {*} x_2 + \ldots + \beta_k {*} x_k$$

Where α is a constant, x represents our variables and β denotes the coefficients. We computed α and βs using the binary logistic function in SPSS software. For this, we utilized the company's binary score from Refinitiv's database as the dependent variable and the pillar variable as the independent variable. Additionally, the binary function provided us with the accuracy of the regression value, which in this case is the McFadden R2, which gives a sense of the significance of the coefficients.

Having the function's exponent, we can further calculate the percentage score of each company through the exponential function:

$$P(Y = 1) = \frac{e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}{1 + e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}$$

The resulting probability may be employed directly to classify the company into one of two groups by using 0.5 as the cut-off value. Companies whose scores are above this value are classified as compliant, whilst those below it are deemed non-compliant. The logistic regression classification makes it easier and quicker to detect the classification error. It is less easy to evaluate the rating table accurately due to the probabilistic outcome resulting from the regression. Similar to the Linear Regression rating table, a rating of B has been assigned to the cut-off point of 0,5. Then, taking into account the marginal differences between the company scores, the other threshold has been modeled, similar to the Linear regression, taking into consideration Refinitiv's rating. The Overall ESG rating table is the mean of the individual pillar ratings. This approach ensures consistency and avoids deviations from the average pillars score.

4.5 Regression results

Entering the main body of this paper, we will analyze the data obtained from the two regressions of each pillar. Specifically, the focus will be on the regression coefficients, accuracy ratio, correlation between the regression data and Refinitiv's data, and the classification result.

Additionally, it should be noted that the cut-off level discussed in this paragraph will be further analyzed in the subsequent section on the rating table.

To enhance the organization of data explanation, we will discuss each pillar and regression individually, starting with the environmental pillar and concluding with the overall ESG score.

We will not present the individual score for each company due to the abundance of data, which is accurately reflected in the ratios and results listed, to ensure easy comprehensibility.

It is important to note that, given the different computation models of the two regressions, it has been challenging to maximize the significance of variables in both models. As a result, some variables have high accuracy in one regression but lose accuracy in the other.

However, these complications do not significantly affect the performance of either regression.

4.5.1 Environmental pillar

Starting with the environmental aspect, 99 out of 147 companies in the sample comply with environmental standards, scoring above Refinitiv's cut-off point of 50. Compliant companies also have an average Refinitiv score of 61, which corresponds to a B grade[113]. The fact that 67% of companies comply with environmental standards demonstrates the financial sector's dedication to environmental considerations and ESG investment practices.

For both regression methods, the constant has not been used due to the misleading contribution that its coefficient gives to the final score, ultimately reducing the overall accuracy. The constant will be employed in all other regressions.

4.5.1.1 *Linear regression*

Going into the data, let's start with the coefficients resulting from the SPSS's linear regression, which is at the core of this regression model due to the fundamental role that a precise regression plays on the result.

In fact, the coefficients are the basis on which all the results we are going to see are based, and the significance is the first indicator, but not the only one, with which we can measure the trustworthiness of the computed coefficient.

Independent variable	Coefficent	Sign.
Total CO2 Equivalent Emissions To EVIC USD in million	-1,839	0,309
Energy Use Total (petajoules)	3,804**	0,038
Environment Management Team	2,346	0,389
Environmental Supply Chain Management	7,484**	0,015
Environmental Investments Initiatives	7,360***	0,010
Green Buildings	4,746**	0,049

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[113] B grades correspond to BB in our rating table, this is due to the different label of the rating used.

Policy Energy Efficiency	13,285***	0,000
Renewable Energy Use	6,648**	0,029
Climate Change Commercial Risks Opportunities	17,802***	0,000
Environment Management Training	-2,791	0,319
Environmental Partnerships	4,648*	0,076
Renewable/Clean Energy Products	27,428***	0,000
Targets Energy Efficiency	4,999*	0,053

25. Linear regression coefficients and significance (E)

As shown in the table above, we have used the non-standardized coefficients to calculate the Z-score following Refinitiv's scoring from 0 to 100 and to facilitate the comparison of the scores between the two models.

Two of the 13 variables have negative coefficients, indicating a negative correlation between these variables and the company's ESG compliance, while the other 11 variables contribute positively to the company's score. In terms of significance, the regression has 8 highly significant coefficients[114], with a p-value below the 0.05 threshold, and two variables with a low level of significance, with a p-value below 0.1, and only three above this threshold.

Dependent variable	Environmental pillar score
Wilks's Lambda	0,415
Average Z_0	31,790
Average Z_1	73,953
Cut-off	47,343
Correct classification	89,80%
Pearson's correlation	0,835**

26. Linear regression relevant information (E)

Wilks's lambda, the accuracy ratio used in the regression, has a value of 0.415, indicating good regression accuracy. The cut-off level has been set at 47,343 due to the lowest possible classification errors, as recommended by the ROC curve. The chart below indicates roughly 90% correct classification.

Binary Score			Z-score classification		Total
			0	1	
Refinitiv classification	Group	0	39	9	48
		1	6	93	99
	%	0	81,3%	18,8%	100,0
		1	6,1%	93,9%	100,0

27. Environmental classification table (AD)

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[114] The significance thresholds are represented by the asterisk "*" with *** representing high significant variable (p-value below 0,01), ** significant variable (p-value below 0,05) and low significance with * (p-value below 0,1)

There have been 132 accurate classifications out of 15 errors, including 9 false positives (Type I error) and 6 false negatives (Type II error), resulting in an overall success rate of 89.80%.
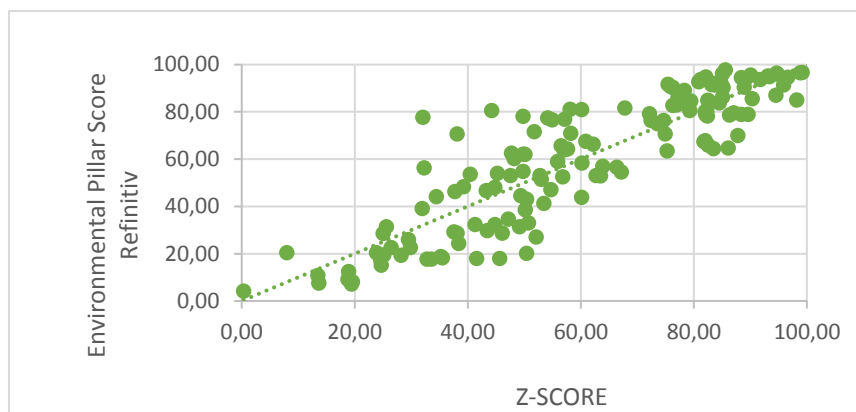
28. Environmental correlation chart (AD)

Finally, the trendline indicating the Pearson's correlation with a rate of 0.835 demonstrates the strong association between the Z-score value and Refinitiv's value, establishing the effectiveness of the regression coefficients.

4.5.1.2 *Logistic regression*

In the second method of the environmental pillar, it is evident that the coefficients and their significance differ due to the varied computation method, even if using identical samples and variables

Independent variable	Coeffcient	Sign.
Total CO2 Equivalent Emissions To EVIC USD in million	-0,960**	0,040
Energy Use Total (petajoules)	3,340**	0,033
Environment Management Team	0,397	0,544
Environmental Supply Chain Management	-0,240	0,713
Environmental Investments Initiatives	2,249**	0,026
Green Buildings	1,565**	0,016
Policy Energy Efficiency	-1,992**	0,019
Renewable Energy Use	-0,700	0,323
Climate Change Commercial Risks Opportunities	-1,661**	0,034
Environment Management Training	0,155	0,807
Environmental Partnerships	0,094	0,880
Renewable/Clean Energy Products	4,024***	0,000
Targets Energy Efficiency	0,871	0,193

29. Logistic regression coefficients and significance (E)

The coefficients in logistic regression do not aim to score from 0 to 100, as in linear regression, but instead determine the exponent used to calculate the percentage score. The accuracy of the selected variables is slightly reduced to 7 significant variables, which is reflected in the classification error percentage of 19%, which is the

highest among the 6 regressions performed. It is also possible to observe that three variables exhibit a negative coefficient sign with a significant level of reliability.

Dependent Variable	Environmental Pillar score
McFadden	0,533
Average Z_0	0,132
Average Z_1	0,868
Cut-off	0,5
Correct classification	80,95%
Pearson's correlation	,741[**]

30. Logistic regression relevant information (E)

The McFadden ratio of 0.533 is a satisfactory measure for establishing a precise regression model. However, as evidenced by the group average, there is a significant disparity between scores that are very low or very high. Regarding the classification threshold, the logistic regression adopts a value of 0.5, which will remain constant across all pillars.

Binary Score			O-score classification		Total
			0	1	
Refinitiv classification	Group	0	44	4	48
		1	24	75	99
	%	0	91,7%	8,3%	100,0
		1	24,2%	75,8%	100,0

31. Environmental classification table (LR)

The classification errors amount to 28, of which 24 are false negatives, the least risky error in investment optics[115], resulting in an overall correct classification rate of 80.95%.

The correlation score of 0.741 proves that the coefficients are reliable, despite the challenges faced in classification.

4.5.2 Social pillar

The Social Pillar presents 120 compliant companies out of 147, more than 80% of the sample, demonstrating the respect of human rights and communities by financial companies. The average score is 66.9, which corresponds to an average rating of B+ according to the Refinitiv table, higher than the average score of the environmental pillar.

4.5.2.1 *Linear regression*

If we look at the linear coefficients, we can see that, in addition to the 13 variables, we have used a constant in the regression, which in this case was necessary to increase the efficiency of the linear function.

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[115] This type of error consists of a missed opportunity and not in a loss of capital due to the bankruptcy

Independent variable	Coeffecient	Sign.
Constant	30,104***	0,001
Women Employees	13,421	0,208
Net Employment Creation	-0,037	0,581
Fundamental Human Rights	6,866***	0,001
Improvement Tools Business Ethics	11,321***	0,000
Product Responsibility Monitoring	5,842**	0,045
Flexible Working Hours	4,234*	0,083
Policy Freedom of Association	9,287***	0,000
Crisis Management Systems	5,917*	0,065
Policy Employee Health & Safety	1,967	0,651
Policy Cyber Security	-1,811	0,674
Day Care Services	5,740***	0,003
Training and Development Policy	0,886	0,832
Policy Bribery and Corruption	2,881	0,293

32. Linear regression coefficients and significance (S)

As shown in the table, 8 social pillar variables are significant, with 5 of them having a high significance coefficient while the remaining 3 have lower significance. Two variables have a small but negative coefficient, which is marked with a low significance score. Nevertheless, they have a low marginal impact and do not interfere with the final score, as reflected in Wilks's ratio of 0.578.

| Dependent variable	Social pillar score
Wilks's Lambda	0,578
Average Z_0	46,695
Average Z_1	70,843
Cut-off	51,02
Correct classification	91,2%
Pearson's correlation	,832**

33. Linear regression relevant information (S)

The average of the two groups confirms the high non-compliant grade, indicating the company's attention to the social framework. The cut-off of 51 proved to be the best divisor for correctly classifying companies, with over 91%.

Binary score			Z-score classification		Total
			0	1	
Refinitiv classification	Group	0	19	8	27
		1	5	115	120
	%	0	70,4%	29,6%	100,0
		1	4,2%	95,8%	100,0

34. Social classification table (AD)

The table shows that the linear regression produced only 13 errors, comprising of 8 Type I errors and 5 Type II errors. The majority of false positive errors were due to the high average non-compliant score, which made it easier to misclassify due to even a slight change in the score.
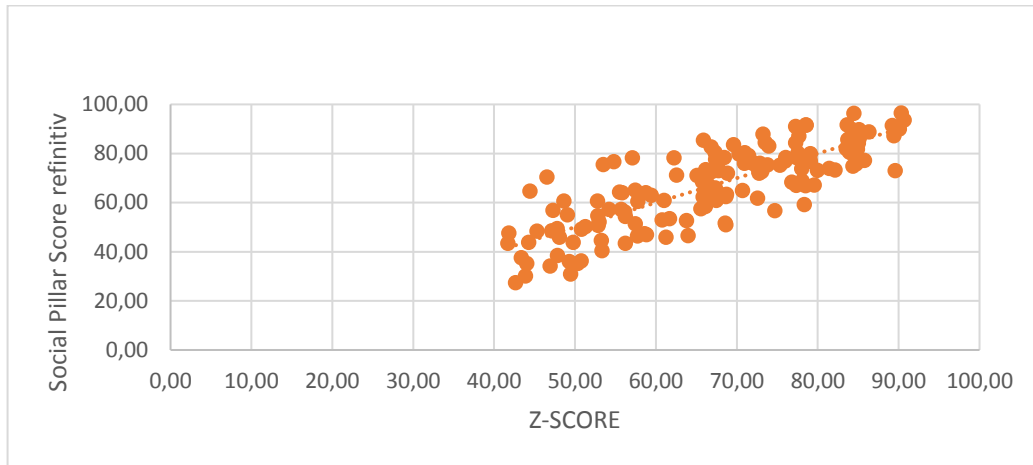
35. social correlation chart (AD)

The correlation between the Refinitiv score and the Z-score is strong and evident, with a value of 0.832. The dots on the chart are located on the right due to the absence of low scores in the social pillar, with all Z-scores ranging from 40 to the beginning of 90.

4.5.2.2 *Logistic regression*

The logistic regression is presented, as the linear one, with a constant. However, the significance of this variable, including also others, is slightly reduced, as seen in the table below. The reason for this phenomenon is due to the transitioning from one regression model to another while retaining the same variables.

Independent variable	Coefficent	Sign.
Constant	5,091	0,209
Women Employees	-0,038	0,141
Net Employment Creation	1,841**	0,035
Fundamental Human Rights	3,042***	0,004
Improvement Tools Business Ethics	-1,091	0,482
Product Responsibility Monitoring	2,415***	0,007
Flexible Working Hours	2,342**	0,015

Policy Freedom of Association	2,015*	0,064
Crisis Management Systems	-0,765	0,575
Policy Employee Health & Safety	-2,148	0,145
Policy Cyber Security	1,744*	0,072
Day Care Services	-0,424	0,699
Training and Development Policy	0,917	0,243
Policy Bribery and Corruption	-4,386	0,172

36. Logistic regression coefficients and significance (S)

The regression has only six significant variables and six negative coefficients. However, we will see that the classification is not affected due to the accuracy of the logistic regression in classification tasks.

It is important to note that a negative coefficient does not necessarily imply lower accuracy. Rather, negative coefficients indicate a correlation between the variable and the score, and often improve accuracy through greater complexity in the function. This is especially true for logistic regression.

Dependent variable	Social pillar score
McFadden	0,472
Average Z_0	0,237
Average Z_1	0,934
Cut-off	0,5
Correct classification	92,50%
Pearson's correlation	,720**

37. Logistic regression relevant information (S)

The McFadden score is 0.472, lower than the environmental score, but still coherent with the Refinitiv score. The high average score of the compliant company is attributed to the good conduct of most of the company within the social framework.

Binary score			O-score classification		Total
			0	1	
Refinitiv classification	Group	0	21	6	27
		1	5	115	120
	%	0	77,8%	22,2%	100,0
		1	4,2%	95,8%	100,0

38. Social classification table (LR)

The classification accuracy stands at 92.5%, with 11 misclassifications out of 147 companies. These are almost equally distributed between Type I and II errors. The Pearson's correlation is 0.720, which is a respectable score and, as anticipated, it is lower than the correlation of the linear regression[116].

4.5.3 Governance pillar

The final pillar comprises 121 compliant companies, representing over 82% of the sample, with an average score of 69. This means that even more companies comply with ESG guidelines than the social pillar. The high percentage of compliant companies highlights the significance and focus financial institutions place on governance.

4.5.3.1 *Linear regression*

Similar to how we did for the other pillars, we commence with examining the coefficients and significance of the variables

Independent variable	Coefficent	Sign.
Constant	11,523*	0,076
Board Gender Diversity, Percent	26,292***	0,003
Independent Board Members, Percent	24,085***	0,000
Audit Committee Independence, Percent	-16,643***	0,003
Public Availability Corporate Statutes	9,145**	0,068
Compensation Committee Mgt Independence	9,051***	0,001
Sustainability Compensation Incentives	9,464***	0,000
Compensation Improvement Tools	7,492***	0,001
Global Compact Signatory	9,404***	0,000
Board Attendance	8,206***	0,000
Nomination Committee Mgt Independence	3,276	0,243
CEO Compensation Link to TSR	4,379**	0,063
Shareholders Approval Stock Compensation Plan	6,157***	0,002
Policy Shareholder Engagement	2,003	0,496

39. Linear regression coefficients and significance (G)

The linear regression yielded highly precise coefficients utilizing just two variables with a non-significant p-value, but 9 with the utmost level of significance. It is noteworthy to underscore the negative coefficient of the audit committee's independence variable, which, having an exceedingly high level of significance, is capable of influencing the pillar rating with an impact of one or possibly two rating levels.

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[116] The correlation between Refinitiv and regression score is expected to be higher for the linear regression due to the scoring task intrinsic to the computation method, while is expected for the logistic regression to have a higher correct classification percentage due to its function nature.

| Dependent variable	Governance pillar score
Wilks's Lambda	0,544
Average Z_0	45,049
Average Z_1	72,806
Cut-off	52,986
Correct classification	92,50%
Pearson's correlation	,814[**]

40. Linear regression relevant information (G)

The Wilks's Lambda of 0.544 does not accurately reflect the variable accuracy discussed earlier, which is instead observable through the classification accuracy and correlation ratio.

As for the social factor, the high level of compliance places the average score of the 0 group very close to the cut-off of 52,986, but in this case, it doesn't have a significant impact on the classification task.

Binary score			Z-score classification		Total
			0	1	
Refinitiv classification	Group	0	18	8	26
		1	3	118	121
	%	0	69,2%	30,8%	100,0
		1	2,5%	97,5%	100,0

41. Governance classification table (AD)

The classification errors are just 11, of which 8 are Type I errors, resulting in one of the highest successful classification percentages of 92.5%. This efficiency can be noticed also through the correlation ratio of 0,814.
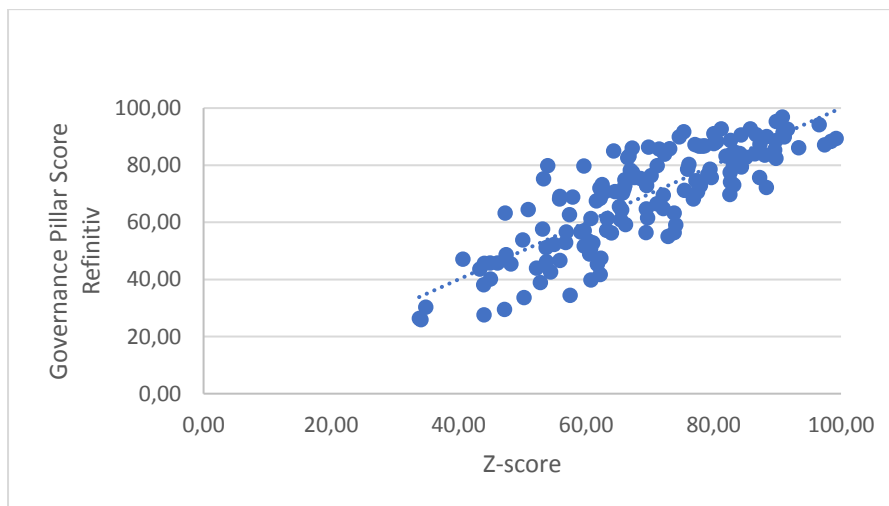
42. Governance correlation chart (AD)

In the chart above, there is a clear correlation between the two scores represented by the trendline that crosses the cluster of dots, showing the consistency with the entire sample.

4.5.3.2 *Logistic regression*

The final regression to be presented is the logistic regression for the governance pillar.

Independent variable	Coefficent	Sign.
Constant	-10,979*	0,076
Board Gender Diversity, Percent	9,118***	0,003
Independent Board Members	5,449***	0,000
Audit Committee Independence	-4,296***	0,003
Public Availability Corporate Statutes	2,328*	0,068
Compensation Committee Mgt Independence	3,368***	0,001
Sustainability Compensation Incentives	1,961***	0,000
Compensation Improvement Tools	2,311***	0,001
Global Compact Signatory	2,391***	0,000
Board Attendance	2,134***	0,000
Nomination Committee Mgt Independence	1,127	0,243
CEO Compensation Link to TSR	1,724*	0,063
Shareholders' Approval Stock Compensation Plan	0,878***	0,002
Policy Shareholder Engagement	-0,889	0,496

43. Logistic regression coefficients and significance (G)

As with the linear regression, the Governance variable has maintained a high level of significance, with 12 out of 14 variables demonstrating significance, including two variables with a negative coefficient as well as the constant. While shareholder engagement policy has little to no significant impact, the other two factors may have a marginal influence on the final score of the pillar.

Dependent variable	Governance pillar score
McFadden	0,680
Average Z0	0,188458
Average Z1	0,946968
Cut-off	0,5
Correct classification	93,20%
Pearson's correlation	,706**

44. Logistic regression relevant information (G)

The McFadden coefficient confirms the consistency of the results, which are evident in the clear differentiation between the two groups as demonstrated by the average scores and the correct classification ratio of 93.2%.

Binary score			O-score classification		Total
			0	1	
Refinitiv classification	Group	0	20	6	26
		1	4	117	121
	%	0	76,9%	23,1%	100
		1	3,3%	96,7%	100

45. Governance classification table (LR)

With only 10 errors, this pillar is the most accurate among this model with just a 6.8% error rate, over half of which stems from false positive predictions. Moreover, the correlation confirms a strong relationship with a ratio of 0.706.

4.5.4 ESG pillar

The overall ESG score is determined by averaging the three pillars score, which are weighted equally, providing a consistent rating. The overall ESG cut-off is the average of the three-pillar cut-off. The scoring and overall rating table follow the same logic. Providing a reliable picture of the overall pillar scoring, without change scoring methodology. This scoring enables the possibility to compare the Refinitiv scoring with our overall ESG score, giving the ability to calculate the classification error of the model.

Binary score			Z-score classification		Total
			0	1	
Refinitiv classification	group	0	14	7	21
		1	6	120	126
	%	0	66,7%	33,3%	100,0
		1	4,8%	95,2%	100,0

46. ESG classification table (AD)

The classification errors are 13, in line with the average of the other pillar classification error, almost equally divided by the type I error and type II.

With this reasoning, the overall ESG cut-off is 50,44 while the correlation between the Refinitiv final score and our final score is 0,899 as indicated in the chart below.
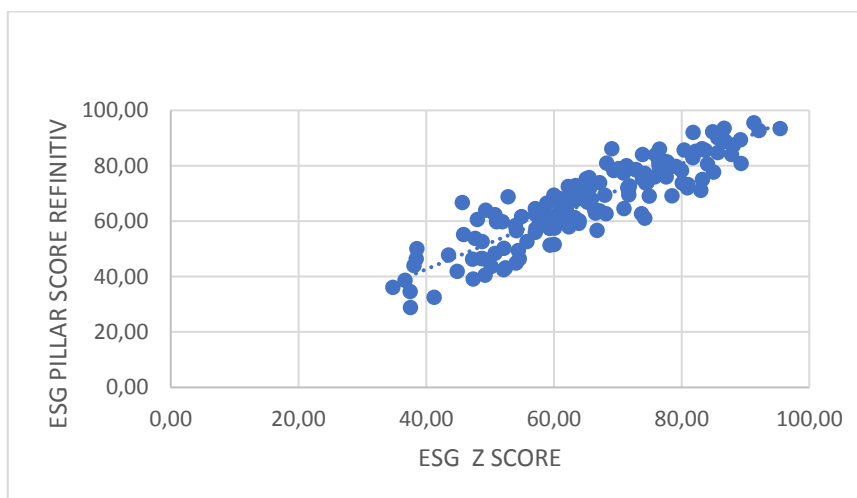
47. ESG correlation chart

The overall correlation is indeed stronger than the correlation of each pillar, demonstrating the model's general consistency with the Refinitiv platform results and proving the reliability of both the variable and regression in accurately predicting a company's rating using 39 variables.

4.6 Rating tables

Having assigned the 8 score[117] for each company, the rating can then be determined as the final step in our paperwork.

As previously discussed, a customized rating table has been developed for each pillar to enhance the evaluation of their distinctive features. The grade level has been adjusted according to the Z-score resulting from both the regression method and taking into account Refinitiv's grade distribution.

In fact, as evident from the results section, each pillar displays a distinctive score distribution. Therefore, to enhance the rating model's accuracy, it is necessary to match the rating table with the corresponding pillar characteristics.

Only ten rating levels have been utilized instead of the twelve Refinitiv rating levels to simplify comprehension while retaining the significance of the information. As we will see shortly, the rating model places greater emphasis on the valuation of compliant companies, given the various forms of compliance, compared to non-compliant companies that still maintain a significant and appropriate valuation.

Going into detail, there are six compliant ratings that accurately classify and provide all necessary information for investor decisions. There are also four non-compliant ratings, three of which maintain the C, CC, and CCC levels in order to uphold evaluation standards and avoid misclassification issues. While the three D grades are merged due to the lower importance of accurately assessing the level of non-compliance of non-investment grade companies and to lighten the model, better focusing on the compliant part.

4.6.1 Environmental rating table

When evaluating the environmental pillar, it's worth noting that Refinitiv's scores are well distributed, ranging from 4 to 98, which makes it necessary to evaluate the whole scale appropriately.

Environmental rating table	DA	LR
AAA	91,110	0,9612
AA	84,783	0,9234
A	69,991	0,8271
BBB	62,308	0,6938
BB	53,930	0,5892
B	47,343	0,5000
CCC	40,250	0,2867
CC	31,915	0,1374

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[117] We have 8 score each because we have 4 main categories and 2 regressions each category.

C	18,942	0,0719
D	<18,942	<0,0719

48. Environmental rating table

The rating ranges in the table are divided, according to Refinitiv's rating classification, by the average score of the company labelled with that grade; due to the approximation of the calculated average, the range of each rating level has been adjusted to account for the misclassification bias. In addition, the B grade, which is the cut-off level, was fixed at the pillar cut-off of 47,343 for the linear regression and 0.5 for the logistic regression. To avoid possible misunderstandings, it's important to note that the score range level of each rating grade is between its score and the score above it, with the exception of the D grade, whose range is the one below its assigned score.

Focusing on the cut-off level, it has been determined using the ROC curve in an attempt to minimize classification.
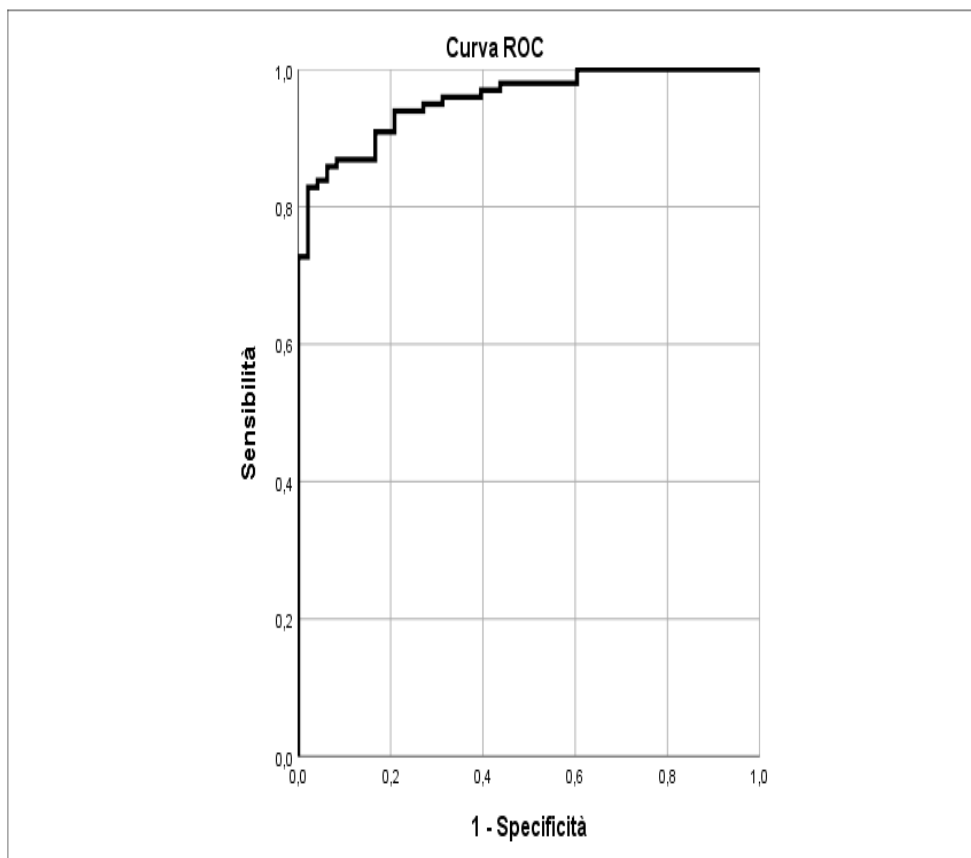
49. Environmental ROC curve

The ROC curve visualizes the classification errors with various thresholds, enabling the researcher to minimize either type of error or select the threshold that refers to the lowest possible number of errors. In this paper, we aimed to reduce the occurrence of errors by selecting the threshold nearest to the top left corner, which represents the most efficient threshold in terms of classification.

Going to the score distribution analysis, in the chart below we can visualize the Z-score distribution into the rating classes.
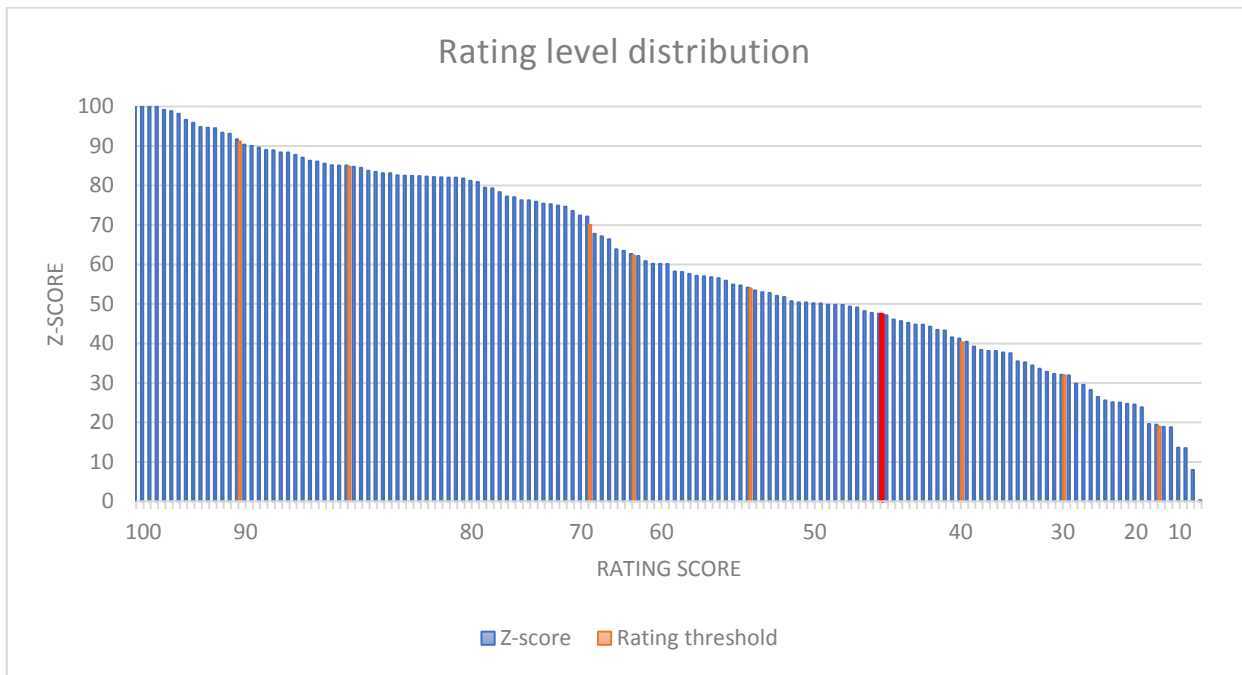
50. Environmental rating distribution (AD)

To gain an understanding of how the rating classes categorize the Z-scores of the sample, on the left axis are plotted the Z-score value while on the bottom the rating score scale.

It should be noted that the rating classes do not all have the same size, nor do the rating levels have the same distance between them. It is noteworthy that almost half of the companies in the sample have a Z-score higher than 70, and two thirds are above the cut-off level marked with the red line.
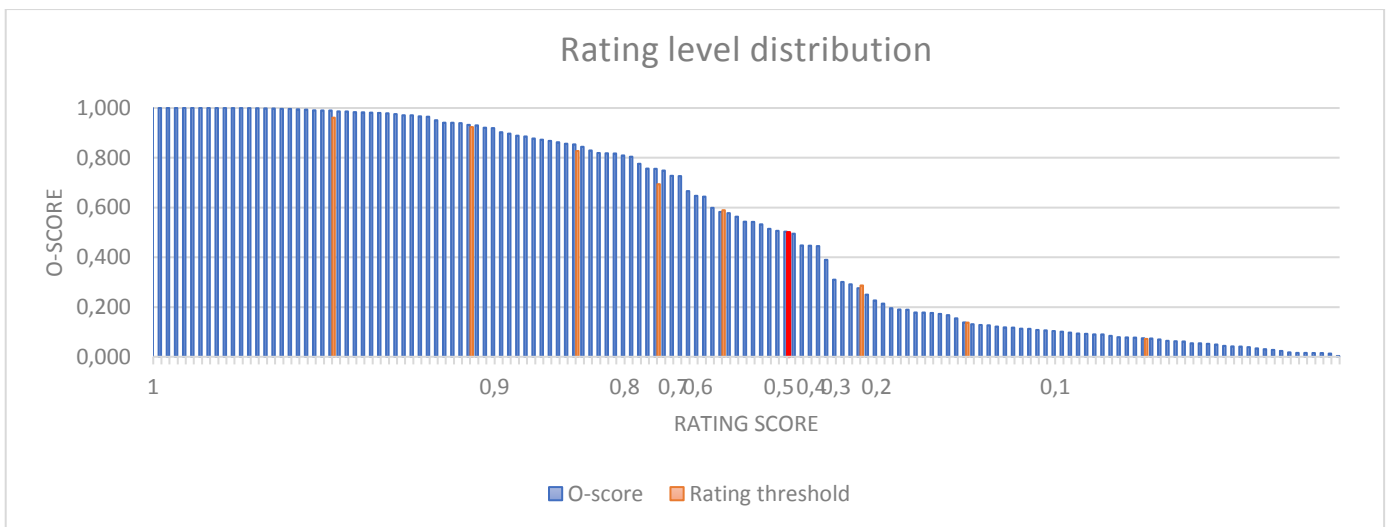
51. Environmental rating distribution (LR)

Regarding the logistic rating, as we expected, the rating level range are smaller on the tails while are more consistent in the middle grade. This happens because the nature of classification that is inherent in logistic regression aims to widen the difference as much as possible between the two groups in order to decrease classification errors. Therefore, to accurately classify scores, it is necessary to have smaller classes at the extremes due to the large number of scores, and a wider range in the middle due to the significant gap between one score and the next.

4.6.2 Social rating table

Before delving into the social table, it is crucial to note that the Z-score distribution differs from the environmental pillar. Therefore, the rating table will have a distinct rating range to better align with the score characteristics. Refinitiv's score range falls between 27 and 97, resulting in a narrower rating table. This demonstrates a higher level of compliance with the social framework of the companies in comparison to the environmental one.

| Social Rating table	DA	LR
AAA	90,07	0,9994
AA	80,91	0,9979
A	73,45	0,9793
BBB	68,74	0,8225
BB	62,42	0,7419
B	51,02	0,5000
CCC	45,3	0,3314
CC	37,87	0,2297
C	29,39	0,0868
D	<29,39	<0,0868

52. Social rating table

The table presents a higher D grade score due to the previously discussed distribution for both logistic and linear regression. However, it shows a lower score for the compliant rating grade, which enables better evaluation of all companies' score shapes.

The cut-off score of 51,02 is reflecting the higher average score of the company.
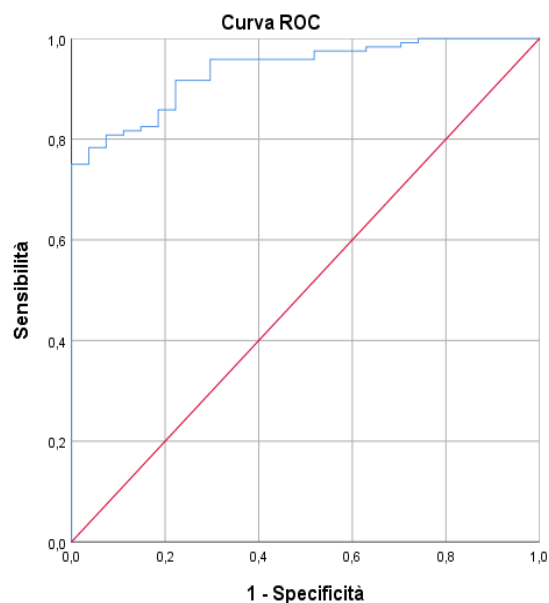
53. Social ROC curve

The ROC curve for the social component is slightly shifted to the right compared to the environmental one, indicating a higher potential for Type I errors, which is indeed the predominant error in the social pillar regression, with a cumulative regression number of 14 Type I errors compared to 10 Type II errors.
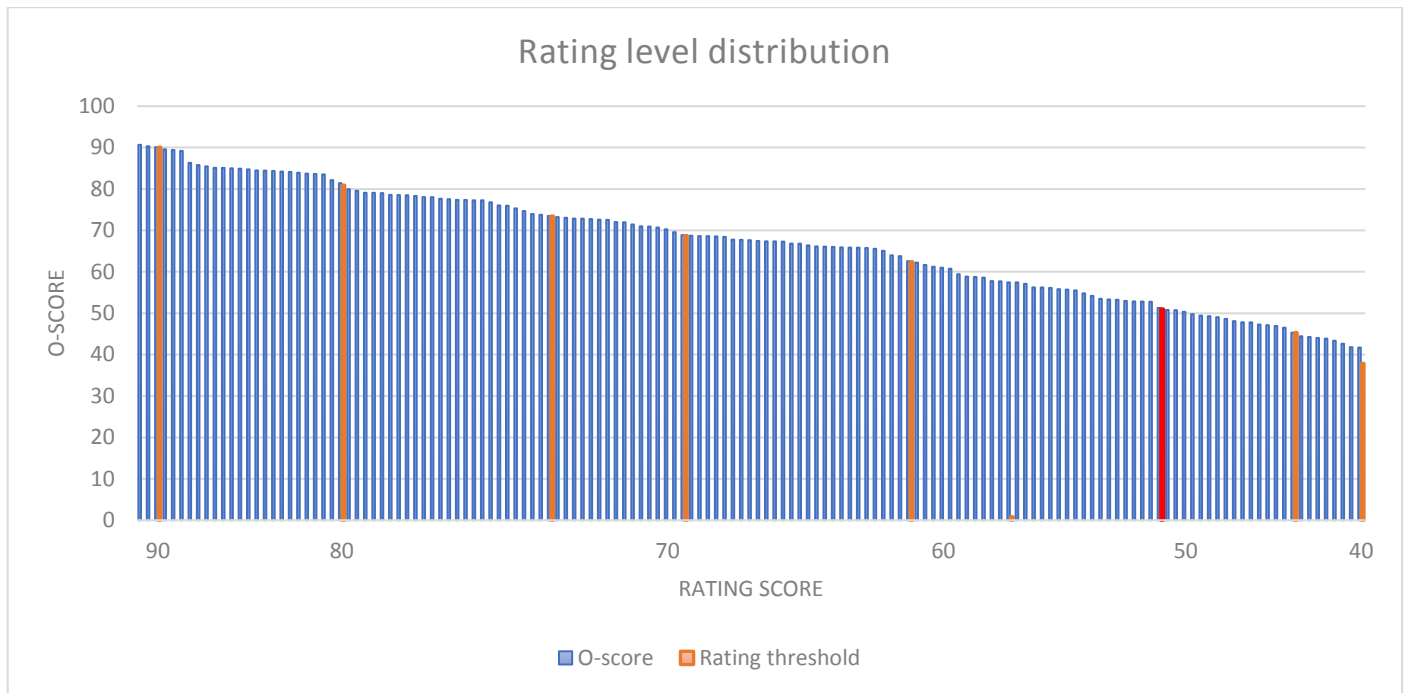
54. Social rating distribution (AD)

The distribution of Z-scores is more uniform than that of the environmental scores, with the vast majority of companies receiving a compliant rating. It is worth noting that Z-score values do not fall below 40, rendering two rating levels superfluous, whereas only 3 companies occupy the top rating grade, resulting in further compression in the middle rating table.
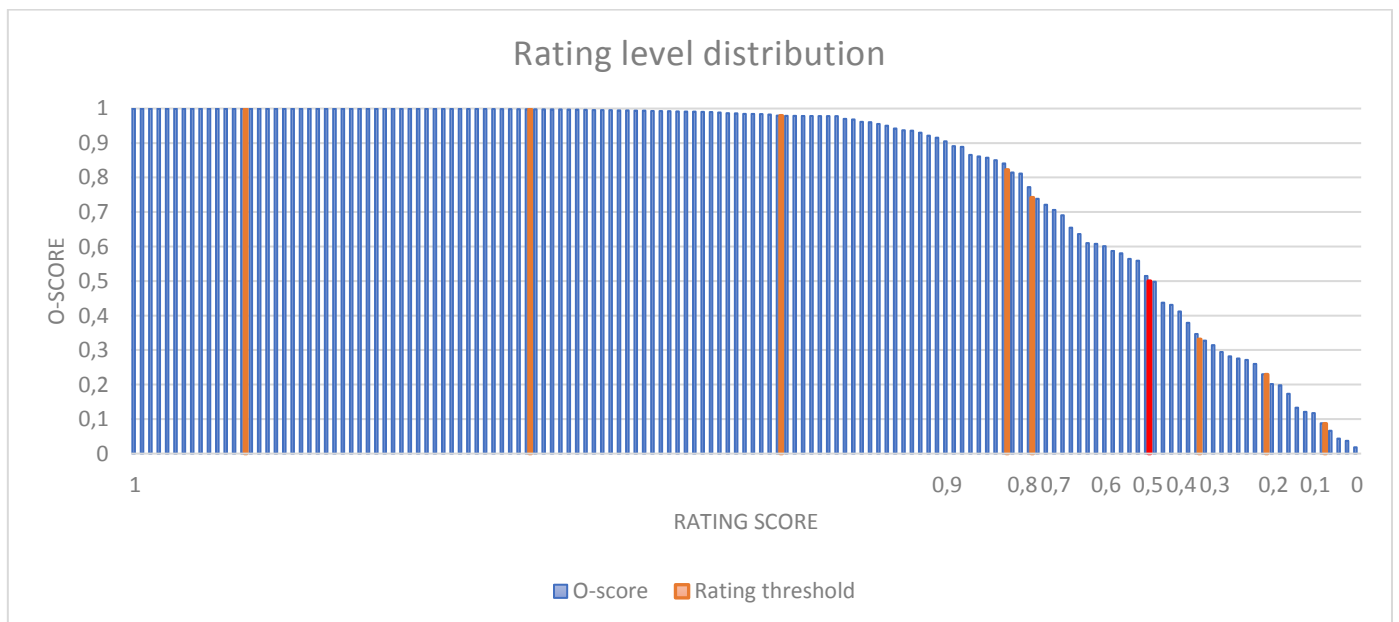
55. Social rating distribution (LR)

As with the Z-score distribution, the logistic scores heavily cluster to the left of the chart, with almost half of the companies scoring above 0.9. Despite this score distribution, the rating threshold considers it, resulting in

three precise thresholds that accurately divide the company with such high scores. Conversely, the non-compliant score still accurately ranks the few companies with low scores.

4.6.3 Governance rating table

The distribution of governance scores is comparable to that of the social pillar, with only a few non-compliant companies. In fact, the lowest Refinitiv score is 26, and over half of the companies score above 70. With a sample average score of 66,9.

Governance Rating table	DA	LR
AAA	90,82	0,9992
AA	82,69	0,9923
A	73,73	0,9278
BBB	69,51	0,8587
BB	64,80	0,7628
B	52,98	0,5000
CCC	45,76	0,2917
CC	38,77	0,2031
C	27,47	0,0645
D	<27,47	<0,0645

56. Governance rating table

The range and level width of the two regressions differ significantly, with the Z-score table adopting a relatively high score threshold for the lower grade (D) due to the scarce observations at that score. On the other hand, smaller ranges are utilized for other grades. In contrast, the logistic regression has a broader range, covering almost the entire scale.
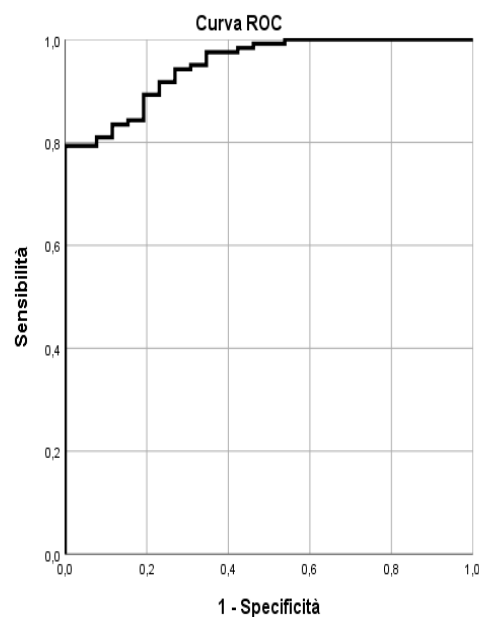

57. Governance ROC curve

The regression's high confidence and low classification errors support the use of a high cut-off of 52.98, reducing the chance of threshold deviation from this value.
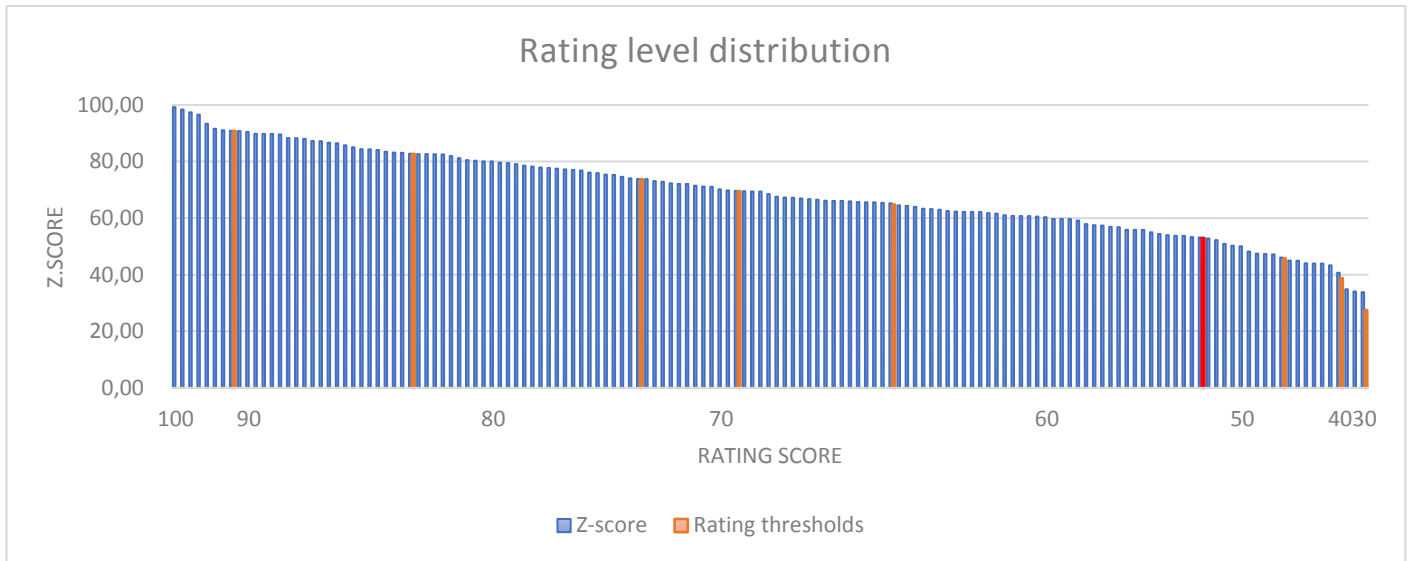
58. Social rating distribution (AD)

The distribution of Z-scores among the 121 compliant companies out of 147 is non-uniform. Similar to the social pillar, the lower range has not been utilized due to the absence of companies with extremely low scores. Confirmed by the over two-thirds of the companies are placed in the B to A grade range.
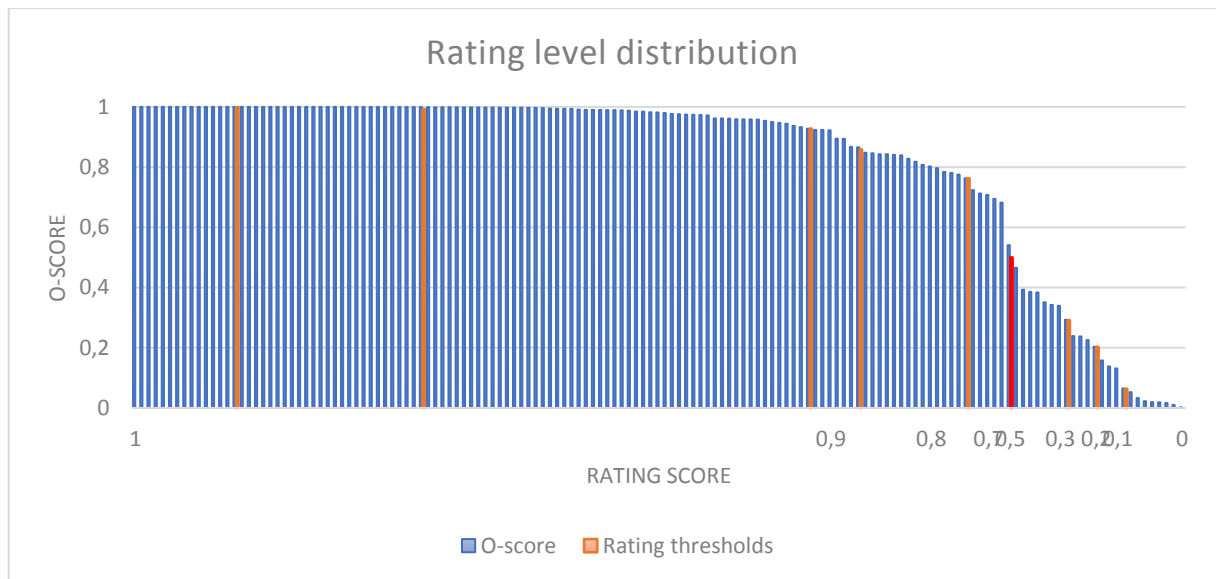
59. Social rating distribution (LR)

As previously noted, the logistic score distribution is disproportionately skewed towards higher scores, further amplified by the fact that more than two-thirds of the sample is in the compliant group, making it difficult to separate the classes equally. In fact, half of the sample is between 1 and 0.9, owing to the high level of compliance exhibited by the company. This substantially reduces the observations between 0.7 and 0.3 due to the nature of logistic regression classification.

4.6.4   ESG rating table

The ESG rating table is made up of the average of the three pillar scores, with the pillar scores combined into a final score that provides an overall picture of the company's compliance and efforts to align with ESG standards.

Rating table	ENVIRONMENTAL		SOCIAL		GOVERNANCE		ESG	
	DA	LR	DA	LR	DA	LR	DA	LR
AAA	91,110	0,9612	90,07	0,9994	90,820	0,9992	90,67	0,987
AA	84,780	0,9234	80,91	0,9979	82,690	0,9923	82,79	0,971
A	69,990	0,8271	73,45	0,9793	73,730	0,9278	72,39	0,911
BBB	62,300	0,6938	68,74	0,8225	69,510	0,8587	66,85	0,792
BB	53,930	0,5892	62,42	0,7419	64,800	0,7628	60,38	0,698
B	**47,340**	**0,5000**	**51,02**	**0,5**	**52,98**	**0,5000**	**50,45**	**0,500**
CCC	40,250	0,2867	45,3	0,3314	45,760	0,2917	43,77	0,303
CC	31,910	0,1374	37,87	0,2297	38,770	0,2031	36,18	0,190
C	18,940	0,0719	29,39	0,0868	27,470	0,0645	25,27	0,0744
D	<18,94	<0,0719	<29,39	<0,0868	<27,47	<0,0645	<25,27	<0,0744

Cut-off value (label to the left of rows B through C)

60. ESG rating table

Calculating the ESG range is straightforward, with the logistic cut-off at 0.5 as for all other pillars, and the ESG linear regression cut-off at 50.45. As the rating range is similar for all pillars, the overall ESG does not deviate much from the individual pillar ratings. Comparing the ESG Z-score with the Refinitiv score shows the close relationship between the scores, with our approximation fitting the Refinitiv score with a small deviation, which is physiological for a regression model.
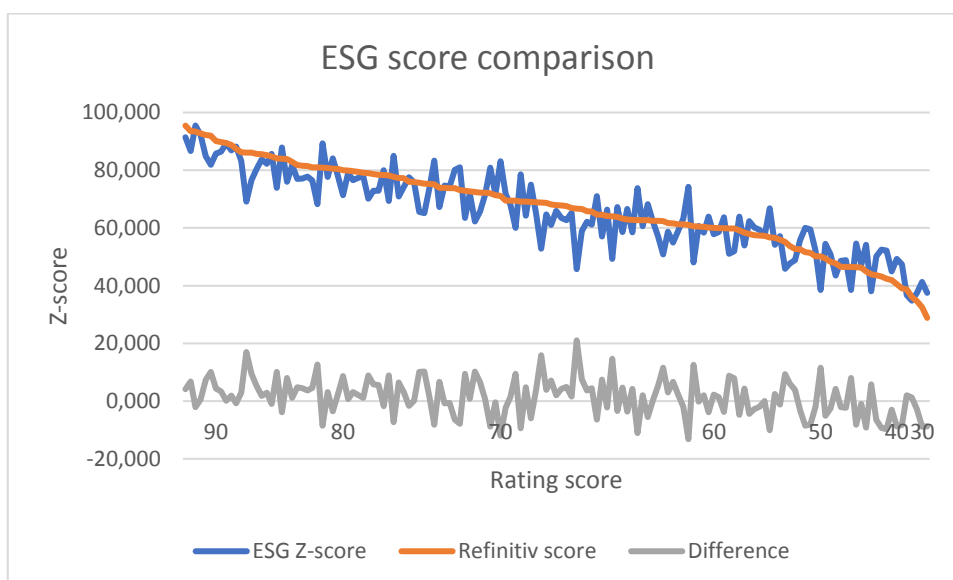
61. ESG rating comparison

Looking more closely at the chart, we can see that the difference between the two ratings is often in the single digits, and in most cases the Z-score model underestimates the actual Refinitiv rating, which increases the reliability of the model. In fact, a small negative difference is beneficial for a regression model as it avoids the misleading optimism and classification errors that can lead to investment decisions that are riskier than originally intended.

More specifically, the ESG Z-score from 100 to 80 visibly underestimates the Refinitiv score to increase the robustness of the rating, while going to the non-compliant rating range, the regression model seems to be slightly higher than the

Refinitiv score. To alleviate the overestimation while maintaining consistency, the cut-off values are marginally higher than the Refinitiv cut-off of 50.

Rating table comparison	AAA	AA	A	BBB	BB	B	CCC	CC	C	DDD	DD	D
Refinitiv score	91,67	83,34	75,01	66,67	58,34	50,00	41,67	33,34	25,00	16,67	8,33	0,00
ESG Z-score	90,67	82,79	72,39	66,85	60,38	50,45	43,77	36,18	25,27	<25,27		

62. Rating table comparison

Considering the previously discussed physiological deviation, the ESG rating table incorporates the Z-score model's conservative scoring by offsetting with a marginally lower rating range for the first 4 rating grades, while increasing the rate threshold for non-compliant companies. These adjustments enhance the reliability of the Z-score model. Examining the degree of score divergence between the overall ESG score and that determined by Refinitiv, with a tolerance error of one level grade, only 8.84% of companies exhibit a divergent error of over one level. This figure reduces to 0.68% if we consider the error above 2 levels.

4.7 Performance analysis

To summarize the results we have discussed, let's get a deeper understanding by comparing the main coefficients and data.

| Correct classification percentage	E	S	G	ESG
AD	89,8%	91,2%	92,5%	91,12%
LR	81,0%	92,5%	93,2%	86,39%
Average	85,4%	91,85%	92,85	88,75%

63. Correct classification comparison

Starting from the correct classification ratio, it's possible to see that the overall ESG ratio is 91,12 % using the discriminant analysis and 86,39% using the logistic regression were classified correctly. The results have been affected by the lowest score reported in the logistic regression of the E pillar. However, the ratio of the other two pillars using the logistic regression were higher than the ESG pillar. Nevertheless, the classification ratios are positive, and the accuracy is satisfactory for a regression model.

Correlation result	DA	LR	Average
E	83,5%	74,1%	78,8%
S	81,4%	70,6%	76,0%
G	83,2%	72,0%	77,6%
ESG	89,9%	80,6%	85,3%

64. Correlation comparison

Regarding the correlation between the Refinitiv score and the regression score, it is unsurprising that the linear regression exhibits greater score similarity than the logistic regression. In numbers, while AD results are all above 80%, the logistic one has only the overall ESG score above that threshold. In fact, the overall ESG

correlation score is always higher than the pillar score due to the error reduction provided by the synergies resulting from the small deviation of each pillar regression score from the Refinitiv score.
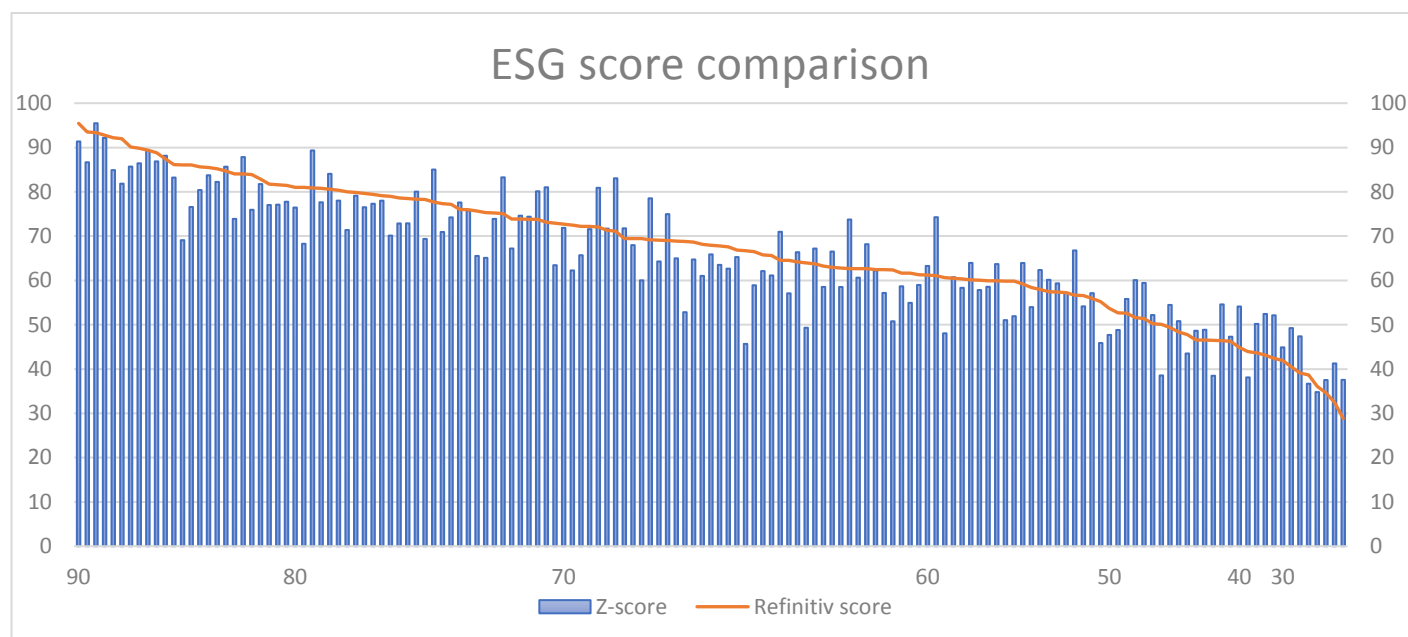
65. ESG rating comparison

To gain another perspective on chart 61 and fully comprehend the 89.9% correlation between the scores, the chart above illustrates the distinctions between the Refinitiv score and the ESG score. The evidence suggests that the rating model has a classification error margin of just under 9%, which is limited around the cut-off level. The correct rating assignment, on the other hand, shows 91,16% accuracy when we consider a tolerance error limited to one grade level difference, increasing to 99.32% when there is at most a two-grade level divergence. These statistical findings reflect the high accuracy and reliability of the rating model.

4.8   Future development

Given the increasing significance of the ESG framework in investment decisions, this ESG rating model will be highly valuable and increasingly utilized by both retail and institutional investors. As such, it is important to understand any limitations and issues in order to further develop the model.

While the model boasts high levels of accuracy and reliability, there is still scope for improvement and broader application.

Firstly, the model has been affected by the low availability of data, in fact, when selecting the variable, many of the companies in the potential sample missed one or more data of the selected variable, thus reducing the sample size. In the future, expanding the collection and availability of data could enhance the sample size, thereby increasing the accuracy of the model by more effectively training the regression coefficients.

Other potential improvements include using more suitable variables that maximize regression potential given the diversity of regression methods and scarce data available.

Additionally, the model can be applied not only to other European countries but also to non-European nations such as the US and Asian markets.

Due to the demonstrated accuracy of the data presented in the previous paragraph, the potential applications of this rating model could be broadened. It could be employed for ESG evaluation of IPOs, to compare companies with the market standard or to assess interest rates for green investment instruments.

Finally, to establish this rating model as an alternative to traditional rating agencies, it is crucial to ensure comparability with results of other rating agencies. However, due to the absence of standardization among rating agencies, achieving comparability would result in scoring deviations, making it challenging to achieve.

5   Conclusion

The ESG framework has become crucial for scrutinizing current business practices and investments in the contemporary world. Its growing relevance is emphasized by the increased awareness of sustainability, ethical responsibility and corporate governance in our globally interconnected landscape. Multiple institutions have stressed the significance of incorporating ESG factors into investment decisions as a portfolio risk management best practice for investors and institutions. In order to evaluate financial company's efforts in the transition to sustainable business, our objective is to develop an ESG rating model to assess the level of ESG compliance of financial companies. To facilitate investment decision-making by providing a means of evaluating and comparing companies in the European financial industry.

Based on the literature, we have affirmed the positive correlation between ESG score and key financial performance, as well as the huge relevance of the ESG capital market, which now accounts for almost a third of all invested capital. Our study aims to fill a gap in the literature by examining an ESG scoring model designed specifically for financial institutions, which has received little attention to date in comparison with the manufacturer and commodities industries.

For the analysis we used a collection of 39 variables and one constant per regression, excluding the environmental pillar. The analysis has yielded 30 out of 41 significant coefficients for the linear regression and 25 out of 41 for the logistic regression, both satisfactory for an accurate classification thanks to the reliability of the two regression models.

The limited sample of 147 companies did not affect the accuracy of categorization and correlation with the Refinitiv score. In fact, all eight measurements achieved a correct classification rate exceeding 80%, with five of them surpassing 90%. Moreover, the overall ESG correct classification rate corresponds to 91.12% for the linear regression and 86.39% for the logistic regression. Regarding correlation, as expected, the linear regression produced the highest score, with all four measurements exceeding 80%, of which the correlation between the Refinitiv ESG score and the overall ESG Z-score was just below 90%. However, due to its computational nature, the correlation of the logistic regression score was between 70% and 80%, with the overall logistic ESG correlation reaching 80.6%.

It is important to note that the linear total ESG score, which is our final output, has the highest coherence with Refinitiv's score and a classification error of only 8.88%. The overall score is determined by averaging the scores of three categories. This enhances result accuracy by compensating for individual score deviations and reducing overall error. Demonstrating the robustness and effectiveness of our modelling strategy.

To achieve a better alignment between the score and the rating grade, we constructed a specific rating table with 10 grade levels, taking into account the regression distortion of the score, which slightly modified the rating range level. We ensured consistency with Refinitiv's rating score, as evidenced by the deviation of overall ESG rating levels from Refinitiv's ratings, which exceed one degree just in the 8.84% of cases, this difference drops to 0.68% beyond two degrees, demonstrating once again the reliability of our score.

Based on the results obtained, it can be concluded that our rating model can accurately classify and score ESG ratings for financial companies, achieving a correct classification in the 91.12% of cases. Furthermore, our model assigns a rating grade that diverges from Refinitiv's grade by a maximum of one grade level in 91.16% of cases. Even though there is still potential for improvement to reduce classification errors and increase the accuracy of the scores, the model is currently reliable in its assessment and suitable for evaluating companies' ESG efforts and for investment purposes.

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