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The impact of Sustainability on the Cost of Equity capital of business firms

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"Far better it is to dare mighty things, to win glorious triumphs, even though checkered by failure, than to take rank with those poor spirits who neither enjoy much nor suffer much, because they live in the gray twilight that knows no victory nor defeat."

Theodore Roosevelt

Executive Summary

The world is "on the edge of a fundamental reshaping of finance". This powerful statement comes from Larry Fink's "2020 Letter to CEOs", where the head of the world's largest asset management company advises global CEOs on how to foster long-term value creation.
Mr. Fink is referring to the impact that business sustainability will have on firms' long-term profitability, asserting that companies that fail to align will face a threat to their survival. Therefore, a massive reallocation of capital will hit, and is already hitting, financial markets, where capital will move toward more sustainable firms.

Based on the mounting relevance of this theme, particularly for public companies, this research aims at investigating whether business sustainability performance actually contributes to enhancing shareholder value, focusing specifically on the cost of equity capital. The literature supporting the existence of such a negative relation (the higher the sustainability performance, the lower the cost of equity capital) prescribes that more sustainable firms will (a) increase their investors base, (b) reduce their riskiness, as they will create a goodwill allowing to protect them in case of future adverse events, (c) reduce the information asymmetry with investors, and (b) increase their image and reputation, so that society can accept the firm's business practice.

The study has been performed under a unique research setting, adding value to the existing literature by (a) employing the recently proposed Five-factor model (Fama and French, 2014) as a proxy for the cost of equity capital, (b) incorporating the recent booming period of ESG investing in the sample, (c) testing overall ESG performance as well as E, S and G performance individually, (d) assessing the impact of the relationship across sectors, and finally (e) including in the sample also small firms in terms of market capitalization, contrary to most studies that focus on major stock market indices like the S&P 500 or STOXX 600.

Analyzing a panel of 6'639 firms for the period 2010 to 2020, this research finds that firms are rewarded for their sustainability performance with a lower cost of equity capital and, therefore, a negative relationship between sustainability performance and cost of equity capital exists for what regards developed countries taken as a group.

Specifically, if a firm is able to move from an average sustainability performance to being an "ESG leader", such performance improvement could lead a company to decrease its cost of equity by approximately 0.55%. Although this effect might not seem to be economically significant, it should be contextualized in the low-interest rate environment we are currently living in. In such a case in fact, the abovementioned benefit means that a firm might be able to reduce its cost of equity capital by approximately 10%.

Then, by disaggregating the overall ESG performance in its pillars, the present study finds that the environmental pillar is the main driver of the negative relation between ESG performance and cost of equity. In fact, the relationship is stronger (meaning more negative) for the E pillar, followed by the governance pillar. On the contrary, the relationship between the social pillar and CoE has been found to be not statistically significant. This result can be explained by the fact that the E and G pillars are more directly related to risk reduction and financial performance if compared to the S pillar (Ng and Rezaee, 2015). Indeed, coherently with the theoretical framework, by either (a) reducing environmental liabilities in the case of environmental initiatives or (b) enhancing the effectiveness of corporate governance measures in the case of governance sustainability performance, those dimensions directly decrease a firm's risk exposure. On the other hand, Social sustainability performance may require additional resources but does not directly create shareholder value, and thus is not directly related to the cost of equity.

Among developed countries however, differences emerged when focusing on United States and Europe individually. Regarding the US, the relationship has been found to be stronger (again, meaning more negative) relative to developed countries. On the other hand, as per European firms, although the relation has been found to be statistically significant, its economic significance has been found to be irrelevant. Practical implications for managers constitute in the necessity of including ESG criteria into corporate strategy, treating it as a potential source of competitive advantage. This is certainly true for US-based firms, who would benefit also from a reduction in their cost of equity capital, as well as for EU-based firms, who can implement ESG business strategy without incurring in neither benefits nor costs in terms of risk and return (Humphrey et al., 2012).

Moving to emerging countries instead, the relationship has been found to be negative although not statistically significant and, as such, sustainability performance does not affect a firm's expected returns and, in turn, its cost of equity capital. A possible explanation is that the concept of CSR has advanced in developed countries (in particular in USA and Europe), where it has been perceived positively by the public and managers; whereas, in emerging countries, efforts to improve CSR performance are not valued by the managers as they are perceived to be costly and gather less favorable response from the market (Feng et al., 2015). Although this explanation has been proven valid for emerging countries taken as a group, the findings of the present study disregard this last hypothesis as regards China, where the relationship has been found to be both negative and statistically significant, suggesting that Chinese companies might benefit from improving their sustainability performance in a similar vein as developed countries.

Finally, diving deeper in the existing relationship between sustainability performance and cost of equity for developed countries, the research finds that the magnitude of the correlation varies considerably across sectors, with some where the economic significance of the relation has been found to be very weak (think of *Utilities* and *Real Estate*), while others experience a highly significant correlation (think of *Healthcare* and *Technology*).
A possible explanation could be found in the fact that, in environmentally-sensitive sectors like *Energy* and *Utilities*, sustainability is already deeply integrated in firms' corporate strategy and, as such, investors already expect those companies to achieve high sustainability standards and do not reward them with a lower cost of capital. Managers thus are able to implement ESG strategy with nor costs nor benefits in terms of CoE (Humphrey et al., 2012). On the other side, managers of companies in sectors like *Healthcare* and *Technology* could reduce the firm's cost of equity capital by improving their sustainability performance and, in turn, create shareholders value. Finally, the contribution of this research, provides a possible intuition on why the correlation may vary across sectors which, to the best of the author's knowledge, has not been yet investigated in the academic literature. Indeed, concentration of the ESG scores across the sector and stability over time of a firm's ESG score seem to impact the correlation between sustainability performance and CoE, as on average the effect is larger for sectors characterized by high concentration and stability relative to sectors characterized by low concentration and stability.

Overall, the contribution of this research shows how ESG got out of the realm of pure philosophy and should rather become a primary point of interest in the corporate strategy agenda.

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1. INTRODUCTION

The debate about business sustainability performance is coming at the center of investors, regulators, and firms' attention in the last years. This interest has created both opportunities and challenges for firms and investors, who are striving to identifying whether sustainability actually impacts shareholders value. The aim of this research is to assess whether a firm's ESG performance is correlated to its cost of equity capital, given that the lower the cost of equity, the higher the firm's value. Also, the thesis aims at determining whether the relationship exists in different geographical settings, analyzing both developed and emerging countries as a group and then focusing on the world's main economic centres: the US, Europe, and China. Furthermore, the dissertation will disaggregate the ESG performance in its pillars, and test whether the magnitude and significance of the individual E, S and G factors correlate with the cost of equity capital. Last, a focus will be done on sectors, testing whether there are differences in the relationship across sectors.

RELEVANCE OF THE THEME

The relevance of business sustainability has been mounting in the most recent years, with the financial industry being particularly hit by this already long-existing trend, but that seems to have entered investors agenda only recently: the push towards integrating sustainability of business firms in investment decisions, together with assessing firms' impacts on the environment they operate in and the stakeholders they interact with. As a matter of fact, companies have increasingly come under pressure to be socially conscious and environmentally responsible, with such pressure coming mainly from investors but also from politicians, regulators, and stakeholders.

Corporate Social Responsibility gained the financial world's attention following a 2005 UN Global Compact report, which argued that embedding ESG factors into capital markets would lead to better societal outcomes. Since then, the consideration of ESG issues has witnessed a meteoric rise: since 2006, the *Principles for Responsible Investment* has grown from 63 global asset manager and asset owner signatories with USD 6.5 trillion in assets under management to more than 3,000 signatories with over USD 103 trillion in assets under management.

In the word of Larry Fink, Blackrock's CEO, the world is "on the edge of a fundamental reshaping of finance", caused by a significant and prompt reallocation of capital towards more sustainable firms. This theme is though particularly relevant for listed firms, who turn to capital markets to source the capital needed for growth and long-term success.
Indeed, in its 2020 "Letter to CEOs", BlackRock, the world's largest asset manager, announced that sustainability, including a company's ESG performance, would be its new standard for investing. Also, BlackRock pushed for more sustainability-related disclosure, warning that without disclosures, investors would assume that companies are not adequately managing sustainability risk, which would lead to increasing market skepticism and, in turn, higher cost of capital.

Furthermore, as the *US Sustainable and Impact Investing Trends 2020* report shows, the amount of US-domiciled assets under management using sustainable investing strategies grew from $12.0 trillion at the start of 2018 to $17.1 trillion at the start of 2020, an increase of 42 percent in just three years. This represents one third of the $51.4 trillion in total US assets under professional management. It is worth noting that the most rapid growth has occurred since 2012, with an increase of four times of total AUM in last than a decade.

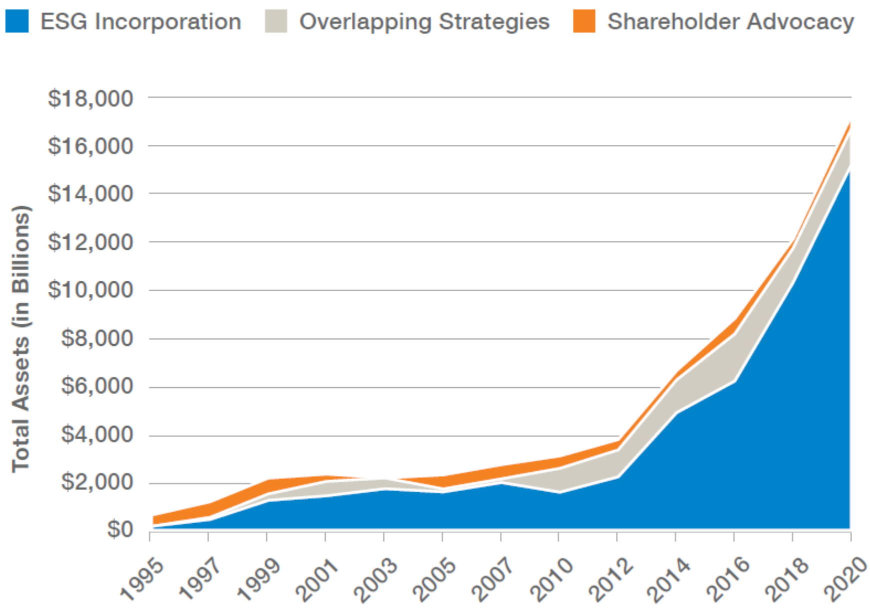


Figure 1 – Sustainable Investing in the United States, 1995-2020.
Source: US SIF Foundation

Regarding political pressure, two important global agreements also happened in 2015, namely the Paris Agreement, where parties agreed to reduce greenhouse gas emissions to limit the average global temperature rise to 2 degrees Celsius, and the publication of the Sustainable Development Goals (SDGs), a collection of 17 global goals set by the United Nations General Assembly as an agenda for the year 2030. These 17 SDGs are an urgent call for action by developing and developed countries and serve as a blueprint for environmental, social and economic decisions for managers and policymakers.

The general public increasingly expects companies to adhere to high ESG-related standards and punish those that fail to do so (Sustainalytics), with the public backlash against ExxonMobil, BP and Volkswagen illustrating consumers' attentiveness towards a firm's sustainability performance. Also, as the words of Niall Fitzerald, former CEO at Unilever, testify, "corporate social responsibility is a hard-edged business decision. Not because it is a nice thing to do or because people are forcing us to do it... because it is good for our business".

In the end, the world is transitioning to a more sustainable economy and the effective management of ESG risks should therefore be associated, *ceteris paribus*, with a superior enterprise value in the long-term, particularly for listed firms, who turn to public markets to source capital.

THE IMPACT OF SUSTAINABILITY ON VALUE

To assess whether the firms' engagement in sustainability activities really creates value for shareholders, it is required to take a closer look at what drives shareholders value, defined as defined as the present value of the future cash flows a firm will generate, and thus:

$$Value = \frac{E(CF_1)}{(1+r)^1} + \frac{E(CF_2)}{(1+r)^2} + \cdots + \frac{E(CF_n)}{(1+r)^n} \quad (1)$$

where $E(CF_t)$ are the expected cash flows at year t and r is the discount rate.

Therefore, following Damodaran (2013) or McKinsey and Co. (2018), for sustainability to create shareholder value, it must impact at least one dimension between (a) Cash Flows, function of revenues generated minus the costs, (b) growth/investment efficiency, measure of how much investment is needed to deliver growth and (c) discount rate, representing the risk faced when investing in a company and thus the uncertainty about future cash flows.

As a matter of fact, according to Sustainalytics, one of the most renowned ESG ratings provider, and the Toronto Stock Exchange Group, the benefits of sustainability are:

- Increased access to capital from both a more diverse investor base that takes ESG factors into consideration when making financial decisions, and financial institutions that apply ESG criteria for the debt financing (Sharfman and Fernando, 2008; El Ghoul et al., 2011; El Ghoul et al., 2018).
- Generation of sustainable earnings, which will be less volatile and thus make the firm less risky (Godfrey, 2005; Li and Foo, 2015).
- Increased ability to achieve compliance with emerging regulatory trends, thus avoiding future litigation costs and potentially earn subsidies and government support (Salvi et al., 2018).
- Cost savings resulting from sustainable supply chains (Sustainalytics).
- Increased ability to attract and retain talent, improved employee loyalty and productivity (Akpinar et al., 2008).
- Enhanced reputation, improved product quality and customer satisfaction (Martìnez-Ferrero and Garcia-Sànchez, 2017; Weber, 2018).

On the other side, there are several costs associated with implementing and disclosing sustainability initiatives, that clearly have a negative impact on cash flows:

- Capital expenditures to be considered a "sustainable" company (e.g., plant, machinery, ...).
- Opportunity costs resulting from managerial time and efforts spent on sustainability.
- The proprietary costs of voluntary disclosures can be significant if the firm reveals valuable information such as trade secrets, information about profitable customers and markets, or operating, organizational, or reporting weakness to unions, regulators, investors, customers, suppliers, or competitors.
- Accounting and reporting costs associated with producing sustainability reports and obtaining quality assurances on such reports.

This dissertation will focus on the effects of sustainability on the discount rate, specifically on the cost of equity capital. The theoretical arguments supporting the existence of such a relationship are mainly four, and are based on the famous *Stakeholder, Agency*, and *Legitimacy* theories.

The first argument prescribes that a high sustainability performance directly decreases firm' risk. For instance, social responsibility enables firms to reduce the probability that they will face social and/or environmental crisis implying higher cash outflows such as government-imposed fines and clean-up costs. By avoiding those future negative cash flows and increasing the ability to achieve compliance with emerging regulatory trends, CSR commitment reduces firm's risk exposure (Godfrey, 2005; El Ghoul et al., 2011; Salvi et al., 2018) and consequently will decrease its cost of equity capital.

The second argument stipulates that socially conscious investors will avoid stocks of firms with poor ESG performance and as a result, their shareholder base will be reduced (Sharfman and Fernando, 2008; Hong and Kacperczyk, 2009). Therefore, when fewer investors hold the stock of a firm, the opportunities for risk diversification are reduced and hence the firm's cost of capital will be higher.

The third argument suggests that sustainability performance reduces asymmetric information. ESG signals the quality of management to investors (Akpinar et al., 2008), and as such it decreases transaction costs between the principal (shareholders) and agents (management).

Finally, the last argument posits that companies continually seek to legitimate themselves, ensuring that they operate within the bounds and norms of their respective societies, as they face different political and social pressures from various stakeholders (Jiménez and Zorio_Grima, 2020). As such, firms disclose ESG information to present a socially responsible image, so that society can accept the firm's business practice. Corporation which fail to do so will be penalized, experiencing also increasing difficulties to raise capital (Deegan et al., 2011).

DATA SOURCES

The dissertation will rely on data provided by the Refinitiv Eikon database for what regards stock prices and measures of sustainability performance. In particular, the Refinitiv ESG score will be used as a proxy of sustainability performance, following other studies as Ioannou and Serafeim 2012; Mackenzie et al. 2013; Cheng et al. 2014; Eccles et al. 2014; Feng et al., 2015; Gupta, 2015; Sassen et al., 2016; Giudici, 2018. Also, other information about stock's fundamentals such as market capitalization, industry classification, and primary country of risk will be retrieved from the same database.

As regards the cost of equity capital, realized returns will be used as a proxy by employing the Fama and French's Five-factor model (Fama and French, 2014), part of the asset-pricing class of models. Data about factors will be retrieved from Prof. French's website.

Finally, to test the relationship, two geographical sample representing developed and emerging countries were employed, with 419'918 and 135'797 firm-month observation respectively representing a total of 6'639 firms for the period between 2010 and 2020.

LITERATURE GAP and ORIGINALITY

Extant literature about the topic is not much developed and many contributions are dated, preceding the recent booming period of sustainable investing that can be dated between 2012 and 2020, when sustainable investing in the US almost quadrupled in size. Consistently with the previously cited theoretical framework, such a trend is supposed to impact substantially the results of the study by increasing the investors base for a sustainable company's stock and therefore reducing its cost of equity capital. It is worth noting that, although preceding this period, the majority of the studies found a negative relationship between sustainability performance and the cost of equity (Sharfman and Fernando, 2008; El Ghoul et al., 2011; Reverte, 2012; Ng and Razaee, 2015; Gupta, 2015).

The theoretical gap identified in extant literature is mainly related to how the cost of equity capital (CoE) is measured in order to test the relationship. The previously cited studies, and the majority of the studies exploring the relationship between sustainability and CoE, use implied cost of capital measures (ICC) as a proxy for CoE. The main reasons for the choice are to be found in the fact that (a) asset-pricing models have been proven to provide "woefully imprecise" estimates of the cost of equity and (b) ICC models can account for unexpected news on a firm’s cash flows or fundamentals, which obviously cannot be not depicted in ex-post measures (Reverte, 2012; Gupta, 2015).

However, ICC models are not far from criticism. A relevant problem of those measures is their reliance on analysts’ forecasts for future earnings and dividends. As a matter of fact, those forecasts suffer from optimism (Kothari, 2001; Easton, 2007) and the from huge error forecasts (Collins and Hopwood, 1980; Brown and Rozeff, 2006). Also, analysts’ estimates are available only for a subset of firms and typically smaller firms are excluded. This causes the sample to be systematically biased towards bigger and less risky firms.

Therefore, a further step that adds relevance to this research is the inclusion of many small firms in the sample, in contrast with most studies that analyze mainly firms part of the major stock market indexes (S&P 500, STOXX 600, …). The sample of this dissertation includes 6’639 different firms, with the market capitalization ranging from $108 million to $ 2’200 billion.

Finally, another motivation underlying the selection of the FF Five-factor model as a proxy of CoE is that asset-pricing models have improved greatly in the recent years, when additional factors have been proposed that improve the explanatory power of such models in a substantial way (Fama and French, 2014; Hou et al., 2015; Fama and French, 2018).

In summary, the relevance of this research is to be found in the overall setting and, to the best of my knowledge, no study has been performed under this framework:

- FF five-factor model;
- Testing overall ESG performance as well as E, S and G performance individually;
- Incorporating the recent booming period of ESG investing;
- Assessing the impact of the relationship across sectors;
- Testing the relationship for a sample comprehending also small firms in terms of market capitalization (as most studies focus on the S&P 500, STOXX 600, …), as this could have important managerial implications.

FINDINGS

The findings of this dissertation show that a firm's ESG performance is negatively correlated with the cost of equity for developed countries. This means that by increasing (decreasing) sustainability performance by one standard deviation (equal to 19.3 for the sample), a firm would decrease (increase) its cost of equity financing by 0.26%. Among develop countries, the relation is also statistically significant for both the United States and Europe.

However, the relation in Europe is of very low magnitude, since an increase (decrease) in sustainability performance by one standard deviation reduces (increases) a firm's cost of equity by just 0.11%. On the other side, the relation in the United States is stronger than the general case of developed countries.

Regarding emerging countries the relationship has been found to be negative although not statistically significant and of low magnitude. However, focusing on China, the correlation between ESG performance and CoE is stronger even than the case of developed countries.

Moving to the individual impact of E, S, and G performance of CoE, the environmental pillar has the strongest negative correlation with CoE, followed by governance, while the mutually exclusive social pillar effect has found to be not statistically significant.

Finally, the studied relationship varies considerably across sectors, with *Healthcare* and *Technology* experiencing the highest impact and the *Real Estate* and *Utilities* the lowest. The determinants of this seem not to be related to the environmental-sensitivity of sectors, given that *Energy* and *Utilities* experience a low correlation relative to other sectors.

STRUCTURE OF THE THESIS

The reminder of this study consists in five chapters.

Chapter 2 analyzes the existing literature regarding the measures for sustainability performance and the cost of equity capital. Those two aspects are of strategic importance for the dissertation and, therefore, this part will be devoted to analyzing in depth these matters. As regards sustainability performance, the section will be divided in two parts, with the first presenting three alternatives to proxy business sustainability performance – indexes, rankings and ratings, while the second will focus on the selected class of measures – ratings – and analyze in depth the methodologies underlying the formation of four main ESG scores.

Regarding the cost of equity capital, two macro-categories have been identified: asset-pricing models and implied cost of capital (ICC) measures. The first category has been selected as a proxy of the cost of equity. As such, the section will be devoted mainly to analyzing the models and the respective critics of asset-pricing models. However, ICC measures will be also analyzed in order to understand benefits and limitations of such models.

Chapter 3 presents the four research questions for the purpose of this dissertation and their underlying theoretical background.

Chapter 4 regards the data sources used, the definition of the measures of sustainability and the cost of equity capital and, finally, the empirical setting of this research.

Chapter 5 concerns the results of the regression models. A descriptive statistics analysis comes first, to have a first insight into variables characteristics, followed by the presentation of the results and the discussion of the findings.

Finally, Chapter 6 contains the conclusions and summarizes the main findings of this work, underlying then its limitations and its possible future developments.

2. LITERATURE REVIEW

This chapter aims at laying the background of the thesis by reviewing the academic literature related to (a) the measurement of sustainability performance and (b) the cost of equity capital.

In the first section, the different tools available to measure the sustainability performance of a business firm will be analyzed. In fact, the recent attention towards sustainability has caused the proliferation of such tools, with an estimated total of 600 ESG ratings globally in 2019 according to the "Rate the Raters" report published by ERM.

Among the different tools available to measure sustainability, this dissertation will focus on three specific categories: indexes, rankings, ratings. Those categories have been selected as they represent the most comprehensive ways to measure the overall sustainability performance of business firms (Diez-Cañamero et al., 2020) rather than focusing on an individual dimension of ESG, such as, for example, the "carbon footprint" indicator, which provides a measure of the emission intensity of a firm's operation and therefore clearly focuses just on the E pillar.

Secondly, the three categories are intended mainly to serve shareholders and investors (Eccles et al., 2019; Diez-Cañamero et al., 2020). Since this dissertation focuses on establishing whether a relationship between the cost of equity and sustainability exists, it is fundamental that the measure selected as a proxy of a firm's sustainability performance is clearly visible to investors and integrated in their investment process. Otherwise, a good sustainability performance will for sure not translate in a reduction in the cost of equity capital.

The first part of the section will thus be devoted to describing indexes, rankings and ratings, while the second will describe more in depth the category identified as best suited as a proxy of sustainability performance.

Finally, a descriptive-comparative analysis will be carried out in order to classify such tools and select the most appropriate to measure sustainability in the context of this thesis.

The second section aims at identifying the different models proposed by the academic literature to measure the cost of equity capital. Specifically, two macro-categories have been identified: the asset pricing models and the implied cost of capital measures.
The former models provide an estimate of the expected return of a risky asset based on its sensitivity to a multitude of factors (the β's) and the price of each factor. Examples of the models falling in this category are the Capital Asset Pricing Model (CAPM) and the so-called multi-factor models, which add factors to the CAPM to improve its explanatory power.
The second category – the implied cost of capital measures – reverse-engineers the dividend discount model to obtain the rate of return demanded by investors which is implied by market prices. The most relevant models implemented in the academic literature are variations of the dividend discount model, with differences in how projected earnings are handled over a finite forecasting horizon.

Without entering the debate on which is the best proxy of the cost of equity capital among those classes of models, the section will focus on describing the main models and the assumptions behind them, and, finally, highlighting the benefits and limitations of each one. Asset pricing models will be presented in a more detailed way, since they will be selected as a proxy of the cost of equity capital. Therefore, a section will also be devoted to evaluating the performance of these models. Motivation for the choice will be provided in the conclusions of the section. Regarding ICC models, they will not be employed in the empirical part and, therefore, they will be presented in a less detailed way. However, it is necessary to explore them in order to make an informed decisions and understand pros and cons of each class of models.

2.1 Sustainability Measures

The first strategic choice of the thesis is to determine how to measure the Environmental, Social, and Governance (ESG) performance of a business firm.

ESG means using environmental, social and governance factors – E, S and G – to assess companies on how advanced they are in terms of sustainability and their societal impact of on their stakeholders (S&P Global; Sustainalytics).

Specifically, *Environmental* factors include a company's contribution to climate change through greenhouse gas emissions, along with waste management, water consumption, and energy efficiency (S&P Global). Therefore, the E pillar focuses mainly on combating climate change and in mitigating greenhouse-gas emissions, reflecting how the agreements reached at the 21^{st} Conference of the Parties in Paris (December 2015) are having a strong impact on the assessment of corporate sustainability performance (Escrig-Olmedo et al., 2019).

Social refers to how a company manages its relationship with internal and external stakeholders. Social aspects include human rights, labour standards in the supply chain, exposure to illegal child labour and other issues such as respect for health and safety in the workplace and employee training and education. A social score also increases if a company is well integrated with its local community and therefore has a 'social license' to operate by consensus (Sustainalytics). It is also interesting to highlight that criteria related to supply-chain management and data protection have arisen in the recent period, reflecting the new trends in sustainability assessment that focus on more complex and integrated configurations instead of on companies as isolated structures (Escrig-Olmedo et al., 2019).

Finally, *Governance* refers to the set of rules, principles and controls that define rights, responsibilities, and expectations among different stakeholders in the governance of companies. The most common areas assessed are: functions and committees, board structure, compensation policy, and corruption and bribery (Escrig-Olmedo et al., 2019).

As per Robeco SAM, a well-defined corporate governance system can be used to balance or align interests among stakeholders and can function as a tool to guide decision-making and support a company's long-term strategy.

The recent push towards sustainability in the business world and, more importantly, the push of the investment community to integrate sustainability in investment decisions (e.g., Larry Fink's "Letter to CEOs"), required the creation of a multitude of tools to measure corporate sustainability performance. Specifically, there has been an increasing need to know the extent to which a company's performance is responsible from the point of view of sustainable development. At present, this question is answered using Indexes, Rankings and Ratings (Diez-Cañamero et al., 2020), that will be analyzed hereinafter.

Following the selection of the best suited measure to proxy the sustainability performance of business firms in the context of this dissertation – ESG ratings, the second part of this section will be devoted to dive deeper into the four main rating methodologies, with the intent of performing a descriptive-comparative analyses.

2.1.1 ESG Indexes

Sustainability indexes are stock market indices including companies that meet certain criteria related to their sustainability performance (BBVA). They are designed and built with the goal of providing information to institutional and retail investors that "value the importance of the companies' environmental and social responsibility and corporate governance in their everyday management, in addition to economic results, in their decisions to purchase shares" notes Beatriz Fernández, professor at the Higher Institute of the Environment.

Companies are selected based on a specific assessment performed by index providers. The purpose of indexes is to show the public which companies are acting responsibly within a certain geographic area or industry and serve as a benchmark of listed companies, assisting investor's decision-making process (Orsato et al., 2014).
Constituents are therefore selected trough a Best-in-class approach, and most of the times negative screens are applied to exclude companies belonging to controversial industries. Finally, to build the index, the selected companies are weighted according to specific criteria determined by the index provider.

Examples of the most relevant market indexes with a focus on sustainability are the *Dow Jones World Sustainability Index* (DJSI World), the *MSCI World ESG Leaders Index*, the *STOXX Global ESG Leaders Index* and the *Euronext Vigeo Eiris World 120*. A description of the most important stock market indicies is provided hereinafter.

Name	**Description**
Dow Jones Sustainability World Index	The Dow Jones Sustainability™ World Index comprises global sustainability leaders as identified by S&P Global through the Corporate Sustainability Assessment (CSA). It represents the top 10% of the largest 2,500 companies in the S&P Global BMI index, on the basis of long-term economic, environmental and social criteria.
MSCI World ESG Leaders Index	The MSCI ESG Leaders Indexes are constructed by applying a Best-in-Class selection process to companies in the regional indexes that make up the MSCI ACWI, a global equity index consisting of developed and emerging market countries. The methodology aims to include securities of companies with the highest ESG ratings representing 50% of the market capitalization in each sector and region of the parent Index.
STOXX Global ESG Leaders Index	The STOXX Global ESG Leaders index offers a representation of the leading global companies in terms of environmental, social and governance criteria, based on ESG indicators provided by Sustainalytics. To be included in the index companies must score in the top quartile (25th percentile) in one category and get an above average score (50th percentile) in the other two.
ECPI World ESG Equity Index	The Index is a broad benchmark representative of developed market companies that satisfy ECPI's ESG criteria. The purpose of ECPI is that of providing the user with tradable indices that in their construction and management take into account, in addition to traditional financial criteria, also non-financial dimensions.
Ethibel® Sustainability Index Excellence Global	The ESI indices universe is composed of companies included in the Russell Global Index that display the best performance in the field of Corporate Responsibility. Based on the research outcome provided by Vigeo Eiris, Forum ETHIBEL rates companies on a 6-level rating scale.
Euronext Vigeo Eiris World 120	Vigeo Eiris' indices are composed of the highest-ranking listed companies as evaluated by the agency in terms of their performance in corporate responsibility. Constituent selection is based on data from the Equitics® methodology, developed by Vigeo. Selected companies have achieved the highest ratings in their reference universe.

Table 1 - ESG Indexes (1/2)

Name	Weighting Criteria	Applies Exclusionary Criteria	# Constituents
Dow Jones Sustainability World Index	Free Float adjusted market capitalization	Yes, based on controversial activities	Variable, 322 in 2021
MSCI World ESG Leaders Index	Free Float adjusted market capitalization	Yes, geographical criteria and involvement in controversial industries	Variable, 718 in 2021
STOXX Global ESG Leaders Index	Market Cap. weighted with a weighting factor based on the overall ESG Rating	Yes, involved in controversial weapons and identified as non-compliant	Variable, 397 in 2021
ECPI World ESG Equity Index	Free Float adjusted market capitalization	Yes, ESG and geographical criteria	Variable
Ethibel® Sustainability Index Excellence Global	Free Float adjusted market capitalization	Yes, based on involvement in certain industries and on controversial activities	Variable
Euronext Vigeo Eiris World 120	The final ESG score of the company divided by the total sum of the scores of all components	Yes, based on controversial activities	Fixed, 120

Table 2 - ESG Indexes (2/2)

2.1.2 ESG Rankings

ESG Rankings are lists that classify companies based on their performance and put them in a certain order or group based on a specified grading system (Rate the Raters 2020, SustainAbility). Typically, rankings evaluate the sustainability performance of business firms starting from the assessment process performed by ESG ratings (e.g., *The Sustainability Yearbook* relies on the S&P Global ESG Scores).

Although analyzing a large number of firms, an important limitation of ESG rankings, shared also with ESG indexes, is that they provide an evaluation of the sustainability performance just for the components of the ranking/index. Also, taking as an example *The Sustainability Yearbook*, the only information provided is the “class” where the selected company ranks within the industry – top 1%, 5% or 10%. Therefore, the purpose of ESG Rankings is solely to show which are the top sustainability performing firms.

Examples of the most relevant ESG rankings are *The Sustainability Yearbook* and the *World’s Most Sustainable Corporations Global 100*.

Name	**Description**
The Sustainability Yearbook	The Sustainability Yearbook ranked over 7’000 Corporate Sustainability Assessments from companies across 40 countries and 61 industries. In order to be listed in the Yearbook, companies must be within the top 15% of their industry and must achieve a score within 30% of their industry’s top performing company.
World's Most Sustainable Corporations - Global 100	The Global 100 ranks publicly listed companies with revenues higher than $1B on the basis of its own sustainability assessment. Such assessment comprehends categories like Resource management, Financial Health and Employee management.

Table 3 - ESG Rankings (1/2)

Name	**Outcome of the process**	**# of companies listed**
The Sustainability Yearbook	List of companies meeting the selection criteria. Additionally, companies with an ESG score in the top 1%, 5% and 10% in their industry are included, respectively, in the “Gold Class”, “Silver Class” and “Bronze Class”.	Variable, 631 in 2021
World's Most Sustainable Corporations - Global 100	List of the 100 most sustainable companies in the world and their overall score. Note that the scores are available only for the companies included in the ranking.	Fixed, 100

Table 4 - ESG Rankings (2/2)

2.1.3 ESG Ratings

ESG Ratings are the most numerous between the ESG measures considered. They are provided by rating agencies and constitute one of the most useful and direct instruments employed by companies to signal their contribution to sustainable development to their entire panel of stakeholders (Rate the Raters 2020, SustainAbility).

A first distinction is to be made between (a) measures of the overall sustainability performance of firms and (b) measures that focus specifically on one of the ESG pillar, mainly related to the environmental performance. The advantage of the former class of measures is that they provide both scores for each pillar as well as an aggregate score, which should serve as a synthetic measure of the overall sustainability performance of a company. Regarding the latter instead, an advantage should be that they provide a better evaluation on the dimension they focus on.
Examples of the most relevant sustainability ratings per each class are shown in *Figure 2*.

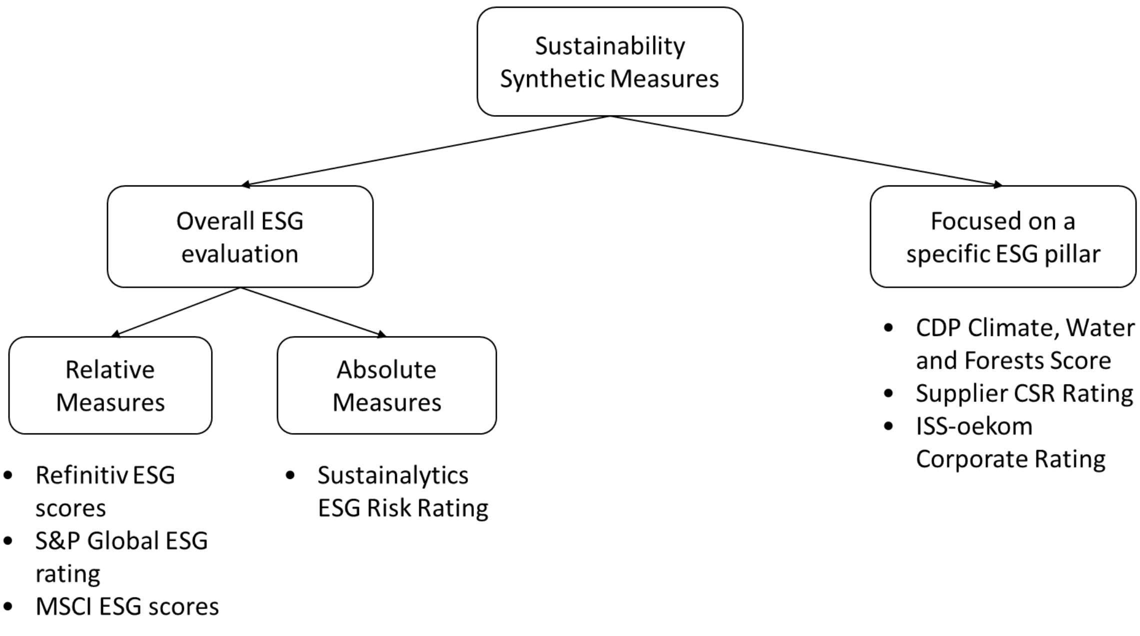


Figure 2 – ESG Rating Classification

ESG rating agencies differ in the practical implementation of the ESG concept, as there is not a standardized way to evaluate the sustainability performance of business firms (Chatterji et al., 2015; Dorfleitner et al., 2015).

The sources of divergence in fact, as identified by Berg et al. (2019), are mainly:

a) the scope, i.e., the difference in the factors considered;
b) the weight of factors;
c) the measurement divergence, i.e., when different agencies measure the same factor differently.

As such, in order to highlight the differences between the measures, the underlying methodologies must be reviewed.

It is necessary to highlight that ESG ratings are the building blocks of indexes and rankings. Besides the previously provided example of *The Sustainability Yearbook*, think of the *Dow Jones Sustainability Indexes*. The index shares with the S&P Global ESG Scores the same starting point (the CSA questionnaire) and methodology, with some minimal adjustments in how to score unanswered questions (S&P Global website).
Also, think of the *MSCI ESG Indexes*, where constituents are selected based on “the highest MSCI ESG Ratings” (MSCI ESG Leaders Factsheet).
Furthermore, indexes and rankings are mainly intended to signal the “status” of a company as a sustainable one. A quantitative evaluation of the ESG performance of firms is available only for the index constituents, in the case of indexes, and are even not available for the case of rankings, which just assign top-performing companies to various levels of sustainability. ESG ratings instead, are available for a large set of companies, e.g., more than 10’000 for the S&P Global ESG Scores, in the form of quantitative scores.

Given these arguments, ESG ratings have been selected as the most appropriate tool to measure the sustainability performance of firms in the context of this dissertation, bearing in mind the inherent limitations of those tools, mainly related to the lack of a standardize way to measure sustainability. As such, the difference in the factors considered and in the measurement of those factors can be highlighted only after analyzing in depth the ratings’ methodologies, and results of the empirical part will be inevitably linked to the ESG rating selected.

Therefore, the next part of this section will be devoted to analyzing in depth the methodology underlying the main ESG scores, to conclude with a descriptive-comparative analysis of the selected ratings.

2.1.4 *Rating Methodologies*

According to the survey part of the "Rate the Raters" report published by ERM, one of the most prominent sustainability consulting firms, there was an estimated total of more than 600 ESG ratings globally in 2019. An exhaustive review is therefore not possible given the highly fragmented market. Instead, only a few agencies will be investigated, the selection of which being carried out according to four criteria.

First, the measures whose geographical scope is regional or national were not considered.

Second, those measures focusing on a specific business sector were not considered.

Third, those that do not have a global ESG vision and whose methodology only evaluates one ESG dimension or factor were not considered; thus excluding the ratings part of the classes of measures focused on a specific pillar like the *CDP Climate, Water and Forests score*.

Finally, relying on the "Rate the Raters" report, the last criterion selects ESG ratings based on their quality and usefulness as recognized by an international pool of more than 300 sustainability professionals from corporates, media, academic, NGO and government sectors. The report in fact, ranks ESG ratings based on their quality (i.e., excellence, robustness, and accuracy of evaluation) and usefulness. The results are shown in *Figure 3* and *4*. Bars indicate the percentage of respondents who viewed the rating as either high quality/useful or low quality/not useful.

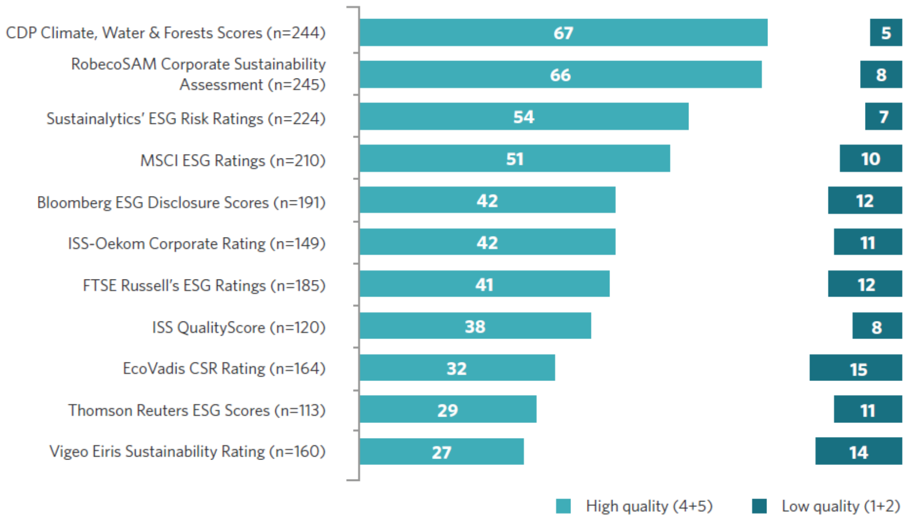


Figure 3 – ESG Ratings quality according to sustainability professionals. Source: Rate the Raters 2019

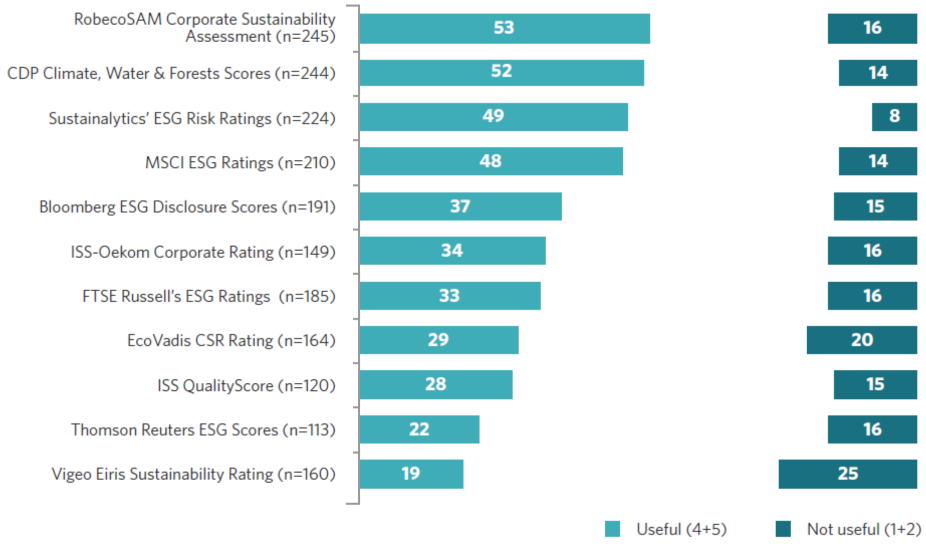


Figure 4 – ESG Ratings usefulness according to sustainability professionals. Source: Rate the Raters 2019

Respondents of the 2019 Sustainability Survey considered RobecoSam (recently acquired by S&P), MSCI, CDP and Sustainalytics as the highest quality and most useful rating providers. Therefore, the next section will investigate the methodologies of the aforementioned ratings, with the exclusion of the CDP rating, consistently with the above defined criteria. Moreover, as this master thesis will rely on the data provided by Refinitiv, the Refinitiv's methodology will also be described.

The following section will then conclude with a comparative analysis of the measures considered.

S&P Global ESG Score

The S&P Global ESG Scores are derived from the SAM Corporate Sustainability Assessment (CSA), performed by the independent rating agency Robeco SAM, which has been acquired by S&P Global in 2019.
The SAM CSA covers more than 10'000 companies and 99% of the global market capitalization and is the process underlying the formation of the *Dow Jones Sustainability Indexes* and the *Sustainability Yearbook*.

The process starts with the collection of approximately 1'000 data points gathered from a questionnaire submitted to each company and various company documents. Then, those datapoints are aggregated in order to answer an average of 100 questions, which are for the most part industry specific.

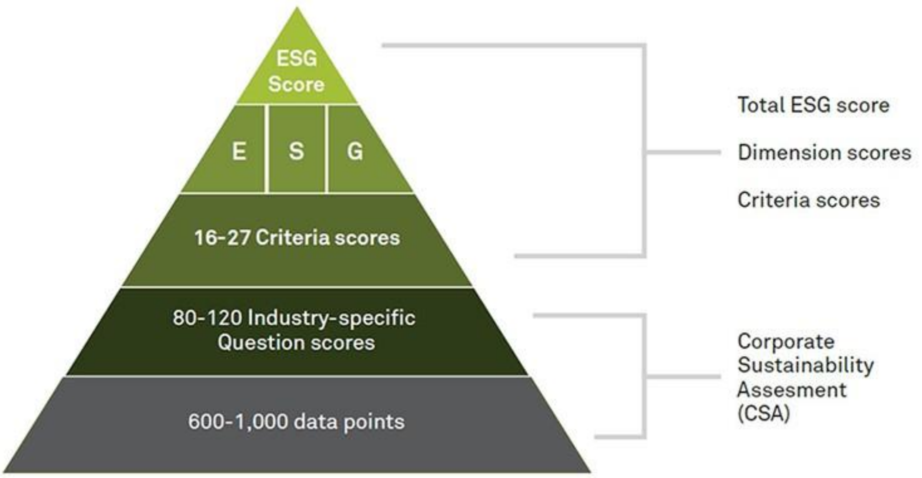


Figure 5 – S&P Global ESG Score process.
Source: SAM

The weighted question scores are then aggregated into an average of 23 *criteria* scores which contribute to the generation of the 3-*dimension* scores – Environmental, Social and Governance dimensions. Finally, the sum of the weighted dimension scores results in the S&P Global ESG Score.

SAM has separate questionnaires for each of its 61 industries, with general and industry-specific questions. The industry classification employed is the Global Industrial Classification System (GICS®).

The methodology accounts for all relevant ESG issues and places a higher weight on the areas of greatest significance within specific industries, accounting for significant differences in materiality of different ESG criteria across industries.

The result is that for each industry, a specific list of criteria is selected, with the average number of criteria selected being 23, ranging from 16 to 27.

Also, each industry has a specific weighting scheme, based on the significance of each criterion for the determination of the total ESG risk.

	Weight in % of total Score
Economic Dimension	**43**
Brand Management	2
Codes of Business Conduct	5
Corporate Governance	8
Customer Relationship Management	4
Efficiency	3
Fleet Management	3
Information Security/Cybersecurity & System Availability	2
Materiality	2
Policy Influence	2
Privacy Protection	2
Reliability	3
Risk & Crisis Management	4
Supply Chain Management	3
Environmental Dimension	**24**
Climate Strategy	6
Environmental Policy & Management Systems	5
Environmental Reporting	2
Operational Eco-Efficiency	9
Packaging	2
Social Dimension	**33**
Corporate Citizenship and Philanthropy	3
Human Capital Development	5
Human Rights	4
Labor Practice Indicators	5
Passenger Safety	8
Social Reporting	3
Talent Attraction & Retention	5

Figure 6 – CSA criteria and weights for the Airlines industry

For a concrete example of the outcome of this step see *Figure 6*, that shows the 25 criteria selected for the Airline industry and the respective weight as a percentage of the total score.

It is worth mentioning that, although the scores are review annually, the CSA methodology also includes the SAM Media and Stakeholder Analysis (MSA) that continually monitors companies for any specific ESG controversy. MSA cases have the potential to negatively affect the score of one or several criteria, resulting in the adjustment of scores.

After that, the score for each individual ESG dimension is the weighted average of all criteria scores that are part of the pillar and their respective weights.

Finally, the absolute score resulting from the weighted sum of all criteria and dimension scores is normalized within each assessed SAM industry using distribution standardization approaches to place scores between 0 and 100, obtaining thus the final ESG score.

Refinitiv Eikon ESG Score

Refinitiv provides ESG data on over 9,000 listed companies including the companies comprehended in the most relevant stock market indices like MSCI World, MSCI Europe, Russell 1000, S&P 500, and MSCI Emerging Market. The scores are available since full year 2002.

The process starts with the collection of approximately 450 data points, ratios and analytics gathered from public sources such as corporate publications (e.g., annual reports and corporate sustainability reports); news and other media; NGOs reports/websites; and multi-sectors information sources (e.g., GRI, CDP…). Those metrics are the basis to start the scoring process, as they are then aggregated into different categories.

Each of the three pillars – Environmental, Social and Governance – is indeed composed by specific categories. There are a total of 10 categories, namely *Resource Use*, *Emissions* and *Innovation* for the Environmental dimension; *Workforce*, *Human Rights*, *Community* and *Product Responsibility* for the Social dimension; *Management*, *Shareholders* ad *CSR strategy* for the Governance dimension.

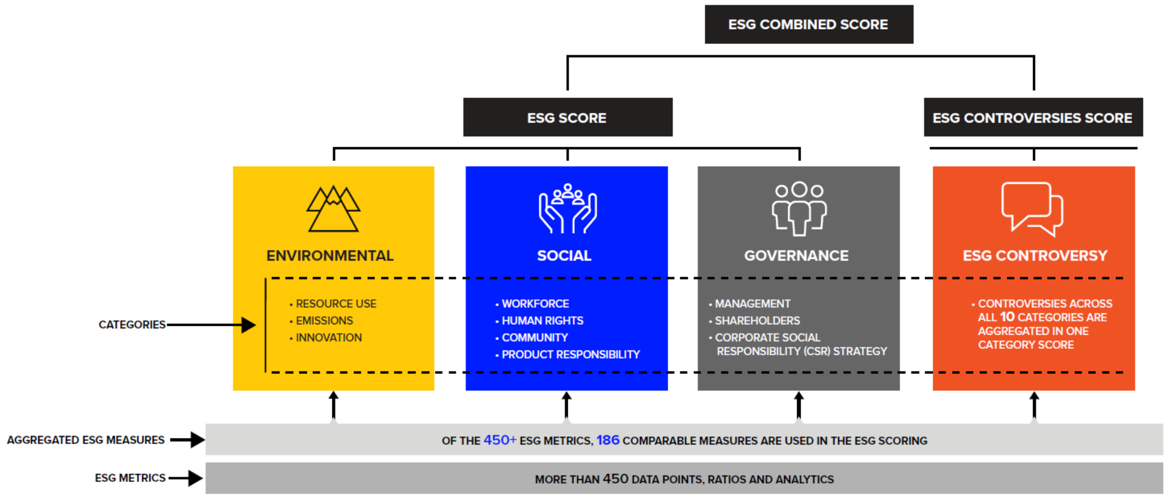


Figure 7 – Refinitiv Methodology as of June 2021

For each category, a score is calculated, based on the aggregation of the different ESG metrics. As an example, the *Emissions* category is made up by 28 metrics which are aggregated to form the *Emissions Score*.

Finally, a percentile rank score is calculated for each category in order to standardize the scores within each specific industry, with the industry classification used being the proprietary Refinitiv Business Classification (TRBC).

The percentile rank score is calculated as follows:

$$\text{Score} = \frac{\#\, firms\ with\ a\ worse\ value + \frac{\#\, firms\ with\ the\ same\ value\ including\ the\ current\ one}{2}}{\#\, firms\ with\ a\ value}$$

Also, as the relative importance of the ESG categories differs across industries, different weights are determined for each industry, based on materiality.
It is worth remarking that, for the environmental and social pillar, each indicator and category is a percentile score within the TRBC industry group of the company. For the governmental score instead, the benchmark is the country.
Finally, the scores of each of the three dimensions – E, S and G - are obtained by doing the weighted average of the categories relative to each dimension.

The output of the process is represented by two final scores:

- ESG score – weighted average of the three dimensions (E, S and G). The scores are based on relative performance of ESG factors with the company's sector (for environmental and social, as these topics are more relevant and material to companies within the same industries) and country of incorporation (for governance, as best governance practices are more consistent within countries).

- ESGC score – overlays the ESG score with ESG controversies (23 controversies) to provide a comprehensive evaluation of the company's sustainability impact and conduct over time. The intent is to discount the ESG performance score based on involvement in non-ethical behavior. The controversies score also addresses the market cap bias from which large cap companies suffer, as they attract more media attention than smaller cap companies (i.e., controversies for small cap companies are counted much more since they are less exposed to media attention). In conclusion, when the controversy score is below the ESG score, the ESGC score is the average of the ESG score and the controversy factor. Otherwise, the ESGC score equals the ESG score.

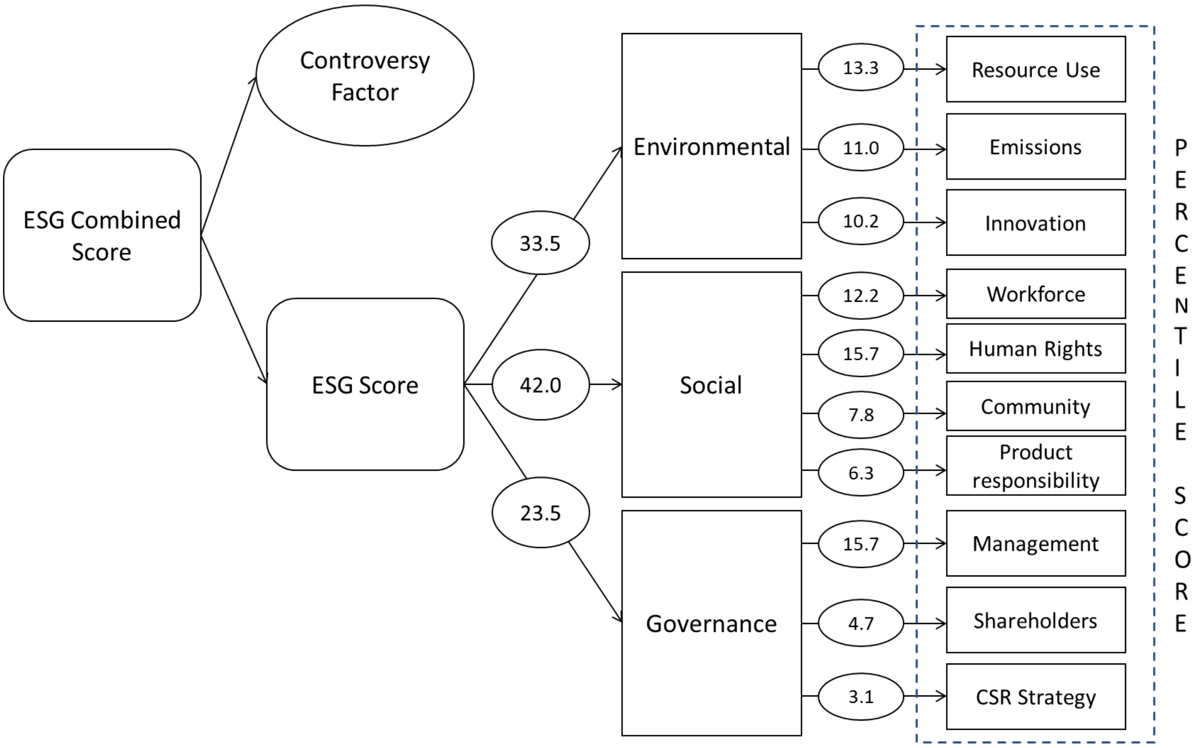


Figure 8 – Refinitiv's Oil & Gas scoring process example. Numbers are in %.

Sustainalytics ESG Risk Rating

The Sustainalytics ESG Risk Rating has been launched in 2018 and now scores the ESG performance of more than 12,000 companies that are in the major global and regional equity and fixed incomes indices.

The ESG Risk Rating measures the degree to which a company's economic value is at risk driven by ESG factors. It is comprised of a quantitative score and a risk category. The quantitative score ranges from 0 to 100 and represents units of unmanaged ESG risk with lower scores representing less unmanaged risk. Also, the scores are grouped into five ESG Risk Categories: Negligible Risk (0–9.99); Low Risk (10–19.99); Medium Risk (20–29.99); High Risk (30–39.99); and Severe Risk (40–100). Those categories help users to interpret the overall ESG Risk Score making the interpretation more direct.

The methodology develops around 3 Central Building Blocks, 20 Material ESG Issues and approximately 40 Industry-specific indicators. Sustainalytics uses its own sector classification system with 42 industries and 139 sub-industries. They indicate that the classification is based on internationally accepted standards, though it is not specified which one.

The three central building blocks that contribute to a company's overall rating are:

- Corporate Governance is a unique common issue; thus it applies to all the companies analyzed, irrespective of the subindustry they are in. It accounts for 20% circa of the final score.
- Material ESG issues are focused on topics that require a common set of management initiatives to be managed. The assessment of material ESG issues occurs at the subindustry level. It is the core of the methodology. To be considered relevant in the ESG Risk Ratings, an issue must have a potentially substantial impact on the economic value of a company.
- Idiosyncratic Issues are 'unpredictable' or unexpected issues in the sense that they are unrelated to the specific subindustry and the business models that can be found in that subindustry. An example may be an accounting scandal in which a company will be involved.

The final score is built by decomposing the risk exposure and management, with the former reflecting the extent to which a company is exposed to material ESG risks, and the second – management – reflecting how well a company is managing its exposure.

Exposure is determined by assessing the ESG risk the respective subindustry is exposed to and multiplying it for a company specific Beta, which reflects the degree to which a company's exposure deviates from the subindustry average. In this way, the exposure of companies operating in the same sub-industry, characterized by roughly similar products and business models, is made company specific.

$$Company\ Exposure = Subindustry\ Exposure * Issue\ Beta \qquad (2)$$

The second step is to determine the portion of the company's exposure that is manageable. This is done by multiplying the company overall exposure for a manageable risk factor (MRF), which is also predefined at a subindustry level.

$$Manageable\ Risk = Company\ Exposure * MRF \qquad (3)$$

The last step is to determine the share of the manageable risk that is effectively managed by the company and, in turn, determine the management gap – i.e., the difference between the manageable risk and the managed risk.
To do this, a score is given to management based on a set of company commitments, actions and outcomes that demonstrate how well a company is managing the ESG risks it is exposed to.

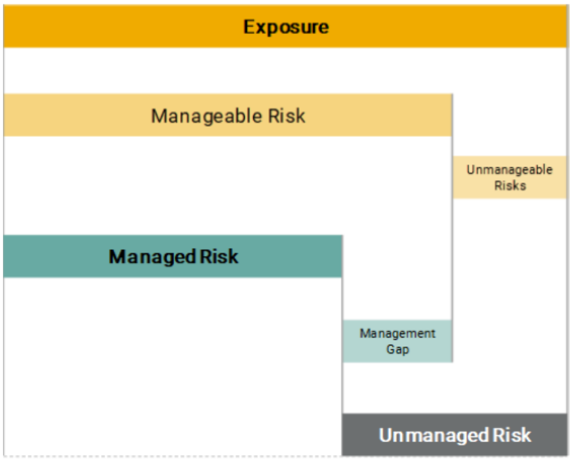
The managed risk is obtained by multiplying the management score for the manageable risk.

$$Managed\ Risk = Manageable\ Risk * Management\ Score \qquad (4)$$

The final ESG Risk Ratings score is calculated as the sum of the individual material ESG issues' unmanaged risk scores. For a summary of the methodology see *Figure 9.*

In conclusion, the final ESG Risk Ratings scores are a measure of the unmanaged risk, which is defined as material ESG risk that has not been managed by a company. It includes two types of risk: unmanageable risk, which cannot be addressed by company initiatives, as well as the management gap. The management gap represents risks that could potentially be managed by a company but are not sufficiently managed according to Sustainalytics' assessment.

The result is that the final scores are absolute measures, meaning that a 'high risk' assessment reflects a comparable degree of unmanaged ESG risk across all subindustries covered. This means that a bank, for example, can be directly compared with an oil company or any other type of company. With the ESG Risk Ratings' scores, Sustainalytics claims to "have introduced a single currency for ESG risk".



Company Exposure	=	Subindustry Exposure	*	Issue Beta		
	=	8	*	1.5	=	**12**
Manageable Risk	=	Company Exposure	*	MRF		
	=	12	*	90%	=	**10.8**
Managed Risk	=	Manageable Risk	*	Management score (as %)		
	=	10.8	*	75%	=	**8.1**
Unmanaged Risk	=	Company Exposure	-	Managed Risk		
	=	12	-	8.1	=	**3.9**

Figure 9 – Sustainalytics' rating process.
Source: Sustainalytics, 2020, p.11

MSCI ESG Rating

MSCI ESG Ratings, established in 1999, are available for more than 8,700 companies included in the most prominent world stock market indexes including the MSCI World index and several developed and emerging market indexes, covering more than 85% of the global market value.

The methodology develops around 35 *key issues*, grouped into 10 *themes* which contribute to the calculation of each *pillar* score. The Environmental and Social pillar scores are calculated in the same way, determining each company's exposure to the key issues and evaluating how the company is managing those key issues.

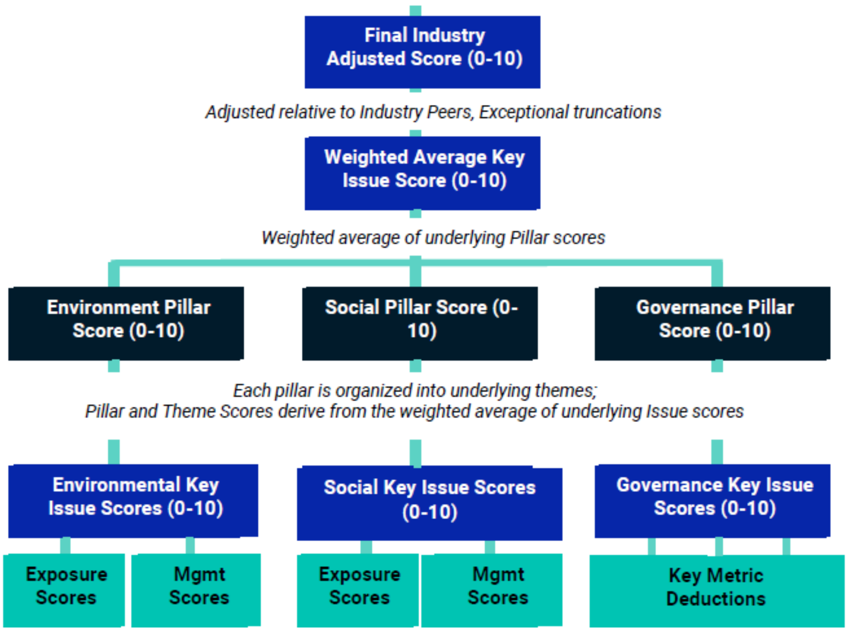


Figure 10 – MSCI ESG rating Methodology.
Source: MSCI

The Governance pillar score instead is determined through a different process. From the maximum score, MSCI applies deductions reflecting key metrics on the boards, the salaries, the ownership & control and the accounting.
Finally, the weighted average of the underlying Pillar scores is adjusted relative to industry peers, with the industry classification being the Global Industrial Classification System (GICS®).

More in detail, the first step of the procedure is to determine the *Key Issues* an industry is exposed to among the 35 *Key Issues*. The goal is to identify what are the most significant ESG risks and opportunities a company faces, assuming that companies in the same sector and thus with similar business models face the same risks. The figure below shows the totality of the key issues and their division among the 10 *themes*.

3 Pillars	10 Themes	35 ESG Key Issues	
Environment	Climate Change	Carbon Emissions Product Carbon Footprint	Financing Environmental Impact Climate Change Vulnerability
	Natural Capital	Water Stress Biodiversity & Land Use	Raw Material Sourcing
	Pollution & Waste	Toxic Emissions & Waste Packaging Material & Waste	Electronic Waste
	Environmental Opportunities	Opportunities in Clean Tech Opportunities in Green Building	Opportunities in Renewable Energy
Social	Human Capital	Labor Management Health & Safety	Human Capital Development Supply Chain Labor Standards
	Product Liability	Product Safety & Quality Chemical Safety Financial Product Safety	Privacy & Data Security Responsible Investment Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing Community Relations	
	Social Opportunities	Access to Communications Access to Finance	Access to Health Care Opportunities in Nutrition & Health
Governance*	Corporate Governance	Ownership & Control Board	Pay Accounting
	Corporate Behavior	Business Ethics Tax Transparency	

Figure 11 – MSCI ESG Key Issue Hierarchy.
Source: MSCI

Next, a score is assigned to each of the key issues identified. To do this, it is necessary to determine (a) how exposed to industry material issues the company is, and (b) how does the company manage each key issue.

MSCI ESG Ratings calculate each company's exposure to key ESG risks based on a granular breakdown of its business: its core product or business segments, the locations of its operations, and other relevant measures such as outsourced production or reliance on government contracts. The Risk exposure is then scored on a 0-10 scale, with 0 representing no exposure and 10 representing very high exposure.

Regarding the Management Score, controversies occurring within the last three years lead to a deduction from the overall management score on each issue. Management is scored on a 0-10 scale, where 0 represents no evidence of management efforts and 10 represents indications of very strong management.

The Risk Exposure Score and Risk Management Score are then combined such that a higher level of exposure requires a higher level of demonstrated management capability in order to achieve the same overall Key Issue Score. A representation of the isocurves for the key issue scores is shown in *Figure 12*.

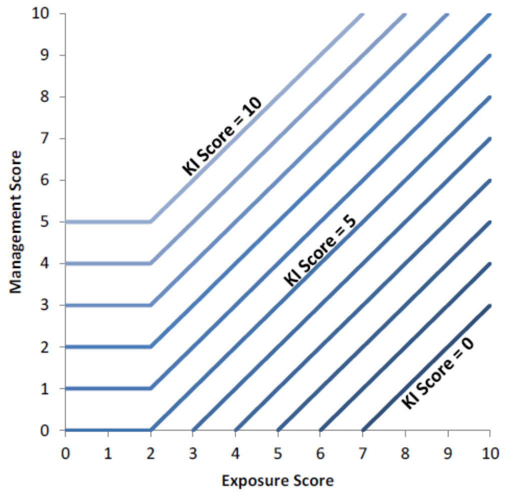


Figure 12 – Isocurves for Key Issue Scores.
Source: MSCI

Once the Key Issues have been selected for a GICS Industry, the weights that determine each Key Issue's contribution to the overall rating are set according to (a) the level of contribution to social or environmental externality and (b) the expected time horizon of risk/opportunity to materialize.

		Expected Time frame for Risk/Opportunity to Materialize	
		Short-Term (<2 years)	Long-Term (5+ years)
Level of Contribution to Environmental or Social Impact	Industry is major contributor to impact	Highest Weight	
	Industry is minor contributor to impact		Lowest Weight

Figure 13 – Framework for Setting Key Issue Weights.

Source: MSCI

As *Figure 13* shows, the weighting criteria is very short-term oriented, giving a higher weight to issues that are expected to materialize within two years.
Multiplying the Key Issues scores for their respective weights, it is possible to compute the Environmental and Social scores.
<Furthermore, a Controversies Assessment is carried out with the goal to identify controversies which may indicate structural problems affecting a company's risk management capabilities. Each controversy case is assessed for the severity of its impact on society or the environment.

To conclude the process, the final ESG Rating is calculated as the weighted average of the pillar scores and is normalized relative to the industry ESG Scores.
It is worth noting that, as MSCI reports, "these assessments are not absolute but are explicitly intended to be interpreted relative to a company's industry peers".

2.1.5 Comparative Analysis

Now that the methodologies have been analyzed, a comparative analysis of the described ratings will be carried out with the intent to highlight the aspect that need to be considered when making use of them.

Table 5 gives a first overview of the ratings analyzed, providing information about the maturity of the rating methodology, the size of the universe of the companies analyzed, the sectorial classification system employed, and the relative number of industries and sub-industries considered and, finally, the number of criteria used to determine the final score.

One of the major differences is to be found in the industry classification system used; S&P Global and MSCI follow the same Global Industrial Classification System (GICS®), while Refinitiv and Sustainalytics use their own classification, with the latter not even specifying clearly which one. This could lead to differences in scores, as the industry a company is part of is fundamental to determine the risk exposure and the weights used to determine the final score.

Moving to the main differences in the methodology employed by each rating agency, summarized in *Table 6*, it can be noted how each of the rating processes considered employs industry specific ESG issues and weights to determine the final score. Although this fact adds subjectivity to the process, given that different rating agencies may consider different issues and/or attribute different weights, the procedure is in my opinion fair, as different business models need to be held accountable for different ESG issues.

Also, the weight attributed to the E, S and G pillar are different among agencies. Given that they are variable across industries, in general S&P Global attributes a higher weight to the Governance pillar (note that this pillar also includes the economic dimension) relative to other ratings. Take as an example the case of a company part of the Oil & Gas industry; Refinitiv attributes 32.5%, 42% and 23.5% weights to the Environmental, Social and Governance pillar respectively, whereas S&P Global weight them 26%, 32% and 42%. This is probably due to the market positioning of the agencies, with S&P Global being clearly focused towards the financial and investor communities.

Name	Launch year	# of companies analyzed	Sectorial classification system	# of industries and sub-industries	# of criteria used
S&P Global ESG Rating	1999	10'000	GICS®	69 industries, 158 sub-industries	1000 data points. 100 industry-specific questions. 23 criteria. 3 ESG pillars.
Refinitiv ESG Rating	2002	9'000	TRBC®	62 industries, 154 sub-industries	450+ datapoints. 186 aggregated metrics. 10 categories. 3 ESG pillars.
Sustainalytics ESG Risk Rating	2018	12'000	Not specified	42 industries, 139 sub-industries	3 Central Building Blocks. 20 Material ESG Issues. 40 Industry-specific indicators
MSCI ESG Rating	1999	8'700	GICS®	69 industries, 158 sub-industries	1000+ data points. 37 ESG Key Issues. 10 ESG Themes. 3 ESG Pillars.

Table 5 – Characteristics of the different ESG Ratings

Moving to the Controversy analysis, every rating performs one, but it is integrated differently in the scores. MSCI and S&P Global include them in the issues' scores calculation, Sustainalytics accounts for them in the management dimension and Refinitiv explicitly calculates a controversy score and integrates it with the final ESG score to form the ESGC score. It is clear how the last methodology makes the Refinitiv ESGC score much more volatile than the other scores. Take the case of ENI Spa provided in the *Appendix* (section "*A. Sustainability*") as an example, where the ESG score has been heavily discounted for controversies in the last years. However, although the score is more volatile, it accounts for controversies in a more transparent way and poses a high importance on them.

Finally, an important factor to take into account is the standardization of the scores. Every rating agency but Sustainalytics provides a relative score, obtained after standardizing the scores by industry. More in detail, S&P and MSCI employ distribution normalization of the scores relative to the industry mean and standard deviation. Scores are normalized at all the levels considered (e.g., S&P normalizes the CSA question scores as well as the pillar and final scores). Refinitiv instead employs a percentile rank formula, based on the relative positioning of the score within the industry group. Also in this case, a percentile rank score is calculated both for the different categories and pillars. Finally, Sustainalytics provides an absolute score, which thus allows for comparability of the risk exposure across different industries.

In conclusion, MSCI, Refinitiv, and S&P provide normalized scores implying that unethical firms can obtain high scores. In contrast, Sustainalytics provides a global score implying that unethical industries have a lower ESG profile. This has important implications in the comparability of the ESG scores, as investors should compare normalized scores by industry. As a matter of fact, an oil firm with a high environmental performance relative to industry peers has certainly still more exposure on the environment than a service provider firm with low environmental rating relative to peers. However, comparing the two scores directly, the oil firm will have a higher rating than the service provider.

Given this potential distortion while comparing the ESG scores of companies across industries the S&P Global ESG Scores, MSCI ESG Risk Scores and the Refinitiv ESG Scores should be reviewed within the context of each industry. On the contrary, if one would compare the scores for companies across different industries, the Sustainalytics ESG Risk Rating should be used.

Name	Industry-specific issues and weights	Score normalization	Controversy analysis	Additional comments
S&P Global ESG Rating	Yes	Normalized by industry	Yes, integrated in the issues' scores	Considers Economic and Governance dimension together and attributes a high weight (40%)
Refinitiv ESG Rating	Yes	Percentile Rank Score by industry	Yes, integrated in the ESGC score	Higher volatility of final score because of controversy analysis
Sustainalytics ESG Risk Rating	Yes	No	Yes, integrated in the management dimension	Focus on the risk and its management
MSCI ESG Rating	Yes	Normalized by industry	Yes, integrated in the issues' scores	Uses varying weights but does not disclose them on its free platform

Table 6 – Comparison of rating processes

2.1.6 Conclusion

This chapter was aimed at analyzing the different tools available to measure sustainability. Specifically, three classes of tools were identified: Indexes, Rankings and Ratings.

Due to scope limitations, ESG rankings and indexes are not best suited for the purpose of measuring sustainability in the context of this thesis. In fact, indexes and rankings provide a measure of sustainability just for a subset of firms, as they are mainly intended as tools to signal the quality of the sustainability performance of the specific firm and therefore do not provide a synthetic measure for a multitude of firms. ESG Ratings instead, offer a synthetic measure for the overall ESG performance of business firm for a multitude of companies.

Limitations in employing ESG ratings are related to the fact that there is not a standardized way to evaluate the sustainability performance of business firms. The sources of divergence being mainly (a) the scope, i.e., the difference in the factors considered, (b) the weight of factors, and (c) the measurement divergence, i.e., when different agencies measure the same factor differently.

As such, a deeper examination was needed, given the lack of theoretical background and the fact that the methodology each rating agency employs deeply affects the final scores. However, the recent push towards sustainability caused the proliferation of such tools, reaching an estimated total of 600 ESG ratings globally in 2019 according to the "Rate the Raters" report published by ERM. An exhaustive review was therefore not possible and only a few ratings were investigated. The selection of such ratings was carried out according to four criteria.

First, those ratings that do not have a global ESG vision and whose methodology only evaluates one ESG dimension or factor were not considered.

Second, the measures whose geographical scope is regional or national were not considered.

Third, those measures focusing on a specific business sector were not considered.

Last, the ratings deemed of the highest usefulness and quality by a panel of sustainability professionals. Moreover, as this master thesis will rely on the data provided by Refinitiv, the Refinitiv's methodology was also described.

The results of the comparative analysis show that there is not a clear winner between the investigated ratings. Instead, they all have different characteristics that need to be taken into consideration when using them.

Regarding the Refinitiv Eikon ESG rating, it should be reminded that the final ESG score is a relative measure, meaning that the score has been standardized by industry group. In turn, one should not compare scores across industries.

Also, the ESG combined score, which is the ESG score discounted for recent controversies, however accounting for an important aspect of the ESG performance, is far more volatile than other measures. Last, it is worth reminding than as there are divergences in how rating agencies actually measure the ESG pillars, results of the empirical part will be strongly dependent on the ESG rating selected. However, the reputation of the Refinitiv Eikon ESG scores serves as a guarantee of the soundness of the rating methodology, as it has already been used in many academic studies.

2.2 The Cost of Equity Capital

The cost of equity capital is the expected rate of return demanded by shareholders for investing in the risky capital of a specific firm. The higher the rate of return, the more costly it is for a firm to finance itself.

Also, the cost of capital is the rate that investors use to discount a firm's future cash flows. The higher the cost of capital, the lower the present value of the firm's future cash flows. Therefore, *ceteris paribus*, firms with a lower cost of capital will have a higher valuation than firms with a higher cost of capital and hence be more attractive to investors.

Since the expected rate of return of investors is unobservable, several models have been developed in the academic literature to estimate the cost of equity capital.

Those can be grouped into two macro-categories:

- **Asset-Pricing Models**: estimates of the expected rate of return demanded by shareholders based on extrapolation from historical data; also known as ex-post measures, since these models use past data – realized returns – to obtain an estimate of the cost of equity capital. Asset-pricing models are built on the premise that a firm's cost of equity is a linear function of its sensitivity to a multitude of factors (the β's) and the price of each factor.

  The most well-known model is the Capital Asset Pricing Model (known as CAPM), developed by Sharpe (1964) and Lintner (1965), but through the following years several other models known as the multi-factor models have been developed. In general, multi-factor models generalize the CAPM by allowing more factors; examples are the Fama and French's Three- and Five-factor models.

- **Implied Cost of Equity**: estimates of the expected rate of return demanded by shareholders based on the price they are willing to pay for a firm's stock, relative to the expected future cash flows. The models are derived from the Dividend Discount Model (DDM) and are based on the premise that the firm's current share price reflects the present value of the expected flows from the firm to shareholders.

  These models are defined as ex-ante measures since they use future earnings forecasts to obtain an estimate of the cost of equity capital by reverse engineering the DDM.

This section will enter in the details of the different models proposed in the academic literature for each macro-category, providing a detailed overview of the features and the key assumptions behind each model, with the ultimate goal of selecting the most appropriate one to answer the thesis research question.

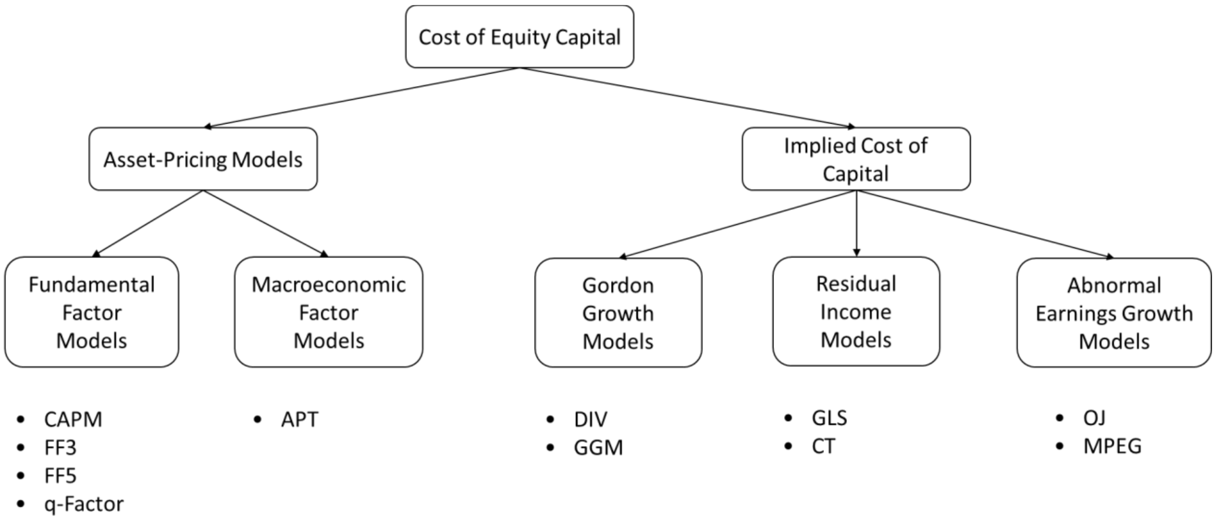


Figure 14 – Cost of Equity Capital Classification

2.2.1 Asset-Pricing Models

As already pointed out, Asset-pricing models explain an asset excess return based on its sensitivity to a multitude of factors (the β's) and the price of each factor. Those factors can be any variable affecting asset returns. Examples of factors include returns on the market portfolio, growth rate of GDP, interest rates, inflation rate, return on some portfolio of stocks or the difference between the returns on two portfolios. Factor models that use macroeconomic variables as factors are called *macroeconomic factor models*.
On the other side, *fundamental factor models* use observable asset characteristics (i.e., fundamentals) as factors.

The most prominent among the Asset-pricing models will be presented hereinafter, starting from the most famous *macroeconomic factor model*, i.e., Arbitrage Pricing Theory, and moving then to the *fundamental factor models*, including the CAPM, the Fama and French factor models and the more recent q-factor models.

2.2.2 Arbitrage Pricing Theory

Arbitrage Pricing Theory (APT) was developed by S. Ross in 1976; it is a multi-factor asset pricing model part of the class of *macroeconomic factor models*, as it is based on the idea that an asset's return can be predicted using the linear relationship between company-specific factors and a number of macroeconomic factors that capture systematic risk.

$$E(R) = R_f + \sum_i \beta_i * factor\ premium_i + \varepsilon \tag{5}$$

APT factors measure the systematic risk that cannot be reduced by the diversification of an investment portfolio. The macroeconomic factors that have been proven most reliable as price predictors include inflation, gross domestic product (GDP), trade surplus, commodities prices, market indices, and exchange rates.

APT assumes markets sometimes misprice securities, before the market eventually corrects and securities move back to fair value. As it will be shown later, this is a key difference from the capital asset pricing model (CAPM), which assumes that markets are efficient.
Because of this, APT employs fewer assumptions than CAPM, with the latter needing lots of unrealistic assumptions to be valid. However, this comes not for free; APT is much more complex and harder to implement, since the model does not provide insight into which factors could be used to explain expected returns. Users of the APT model must in fact determine analytically the relevant factors that might affect the asset's returns, together with determining the asset’s beta in relation to each separate factor.

2.2.3 The Capital Asset Pricing Model

Moving now to *fundamental factor models*, the first one to be presented will be the Capital Asset Pricing Model. The CAPM is a mathematical model that derives from portfolio theory (H. Markowitz), published by Sharpe (1964) and further developed by Lintner (1965).
The model predicts a linear relation (see *Figure 15*) between the expected return of a risky asset and its *Beta*, which is a measure of the asset’s systematic risk.

The model can therefore be expressed through the following equation:

$$E(R) = R_f + \beta * market\, premium + \varepsilon \tag{6}$$

where *E(R)* is the expected return of the asset; r_f is the risk-free rate; β measures the sensitivity of the return from the investment to the return from the market portfolio; *market premium* represents the additional expected return of the market portfolio over the risk-free rate which is required to compensate investors for investing in a risky asset; ε is the error term.

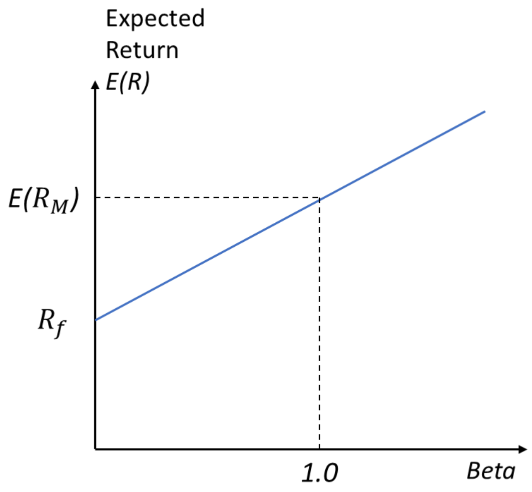


Figure 15 – The Capital Asset Pricing Model

The CAPM is based on the idea that not all risks should affect asset prices. In particular, three types of risk can be identified:

- Total risk: this risk reflects the firm's stock volatility.
- Systematic risk: accounts for the part of the risk explained by how a stock's return responds to general market movements that affect the entire universe of securities.
  It is a non-diversifiable risk, meaning that it could not be eliminated investing in a diversified portfolio. It is measured by the *Beta*.
- Non-Systematic or Idiosyncratic risk: accounts for the risk that cannot be explained by changes in average market portfolio returns. This risk is company-specific; therefore, it can be eliminated by investing in a diversified portfolio. This risk is captured by the error term in the equation.

This implies that, according to the model, differences in the expected return across securities and portfolios are entirely explained by differences in *Beta*, which measures the sensitivity of the asset relative to the market portfolio.
In other words, *Beta* measures the risk accepted by an investor who decides to invest in a specific company rather than in the market portfolio.

Analytically, *Beta* is the ratio between the covariance of the asset – R_i – with the market portfolio – R_m – and the variance of the market portfolio :

$$\beta_i = \frac{Covar\ (R_i; R_m)}{Var\ (R_m)} \tag{7}$$

It is worth to linger on the meaning of the different ranges of values that Beta can assume:

- $\beta < 0$, the asset is negatively correlated with the market; if the market goes up, the asset price will go down.
- $\beta = 0$, the asset is completely uncorrelated with the market.
- $0 < \beta < 1$, the asset is less risky than the average market; it moves in the same direction as the market, but its price fluctuations are lower.
- $\beta = 1$, the asset moves with the market.
- $\beta > 1$, the asset is riskier than the average market, thus its fluctuations are amplified relative to the market portfolio.

If a specific stock's returns – R_i – are plotted against market's returns – R_m, the slope of the line of best fit is the *Beta*, while the intercept is the *Alpha*, which is the additional return expected from the stock when the market return is zero.

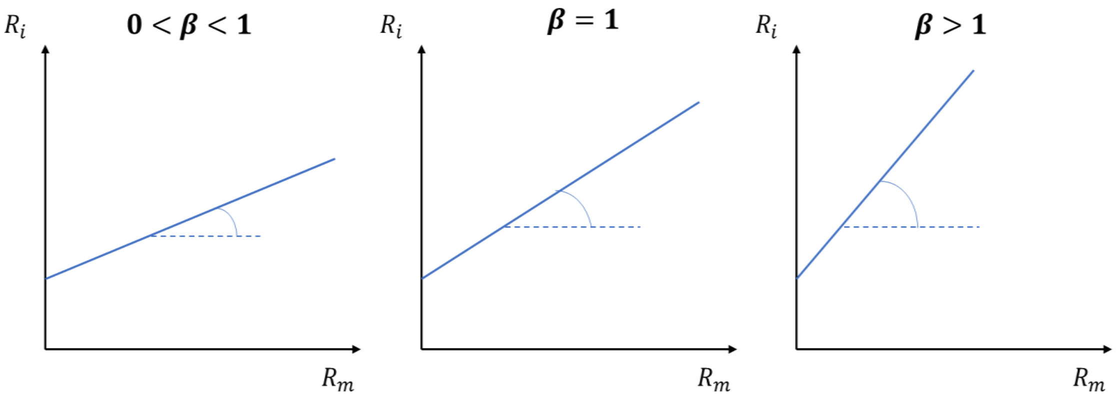


Figure 16 – Stock's Returns agains Market Returns based on different Betas

Referring to *Figure 16*, the first graph represents an asset with beta equal to 0.5; if the price of the market portfolio increases by 2%, the asset's price will increase by 1%, according to CAPM.
In the second graph, the asset is as risky as the market portfolio and thus, if the market prices increase by 2%, also the asset's price will increase by 2%.
Finally, taking an asset with beta equal to 2, if the market prices go up by 2%, the asset' price will increase by 4%.

Assumptions and Critics to CAPM

As already pointed out, the CAPM is an application to the market portfolio of the relation between expected return and portfolio beta that holds in any mean-variance-efficient portfolio. The efficiency of the market portfolio is based on the following assumptions:

1. Investors are risk averse and evaluate their investment portfolios solely in terms of expected return and standard deviation of return measured over the same single holding period.
2. Capital markets are perfect in several senses: all assets are infinitely divisible; there are no transactions costs, short selling restrictions or taxes; information is costless and available to everyone; and all investors can borrow and lend at the risk-free rate.
3. The ε's of different investments are independent.
4. Investors all have access to the same investment opportunities.
5. Investors all make the same estimates of individual asset expected returns, standard deviations of return and the correlations among asset returns.

Although the CAPM is still widely used in the academic and finance world, many critics have been moved to the model.

First, the assumptions at the base of the model are unrealistic, since:

1. Not every investor cares only about expected return and standard deviation of the return, as demonstrated by the behavioral finance literature. In fact, behavioral finance assumes that investors are not fully rational in their actions, but rather constantly allow their decisions to be influenced by human emotions.

2. Markets are not perfect and, in particular, while a large financial institution in normal market conditions and with a good credit rating might be able to borrow at the risk-free rate, the same is not true for smaller investors. As a consequence, the efficient investment frontier for smaller investors will not be the line predicted by the CAPM but rather the parabolic function identified in the figure below.

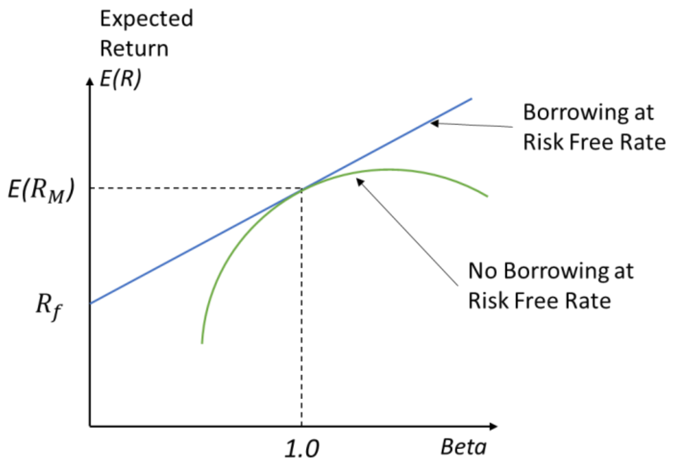


Figure 17 – Efficient Investment Frontier with and without the possibility to borrow at the Risk-free rate.

3. It is not always true that the residual risk - ε's - of different investments are independent; for instance, the ε of two investments in the same sector may be correlated.
4. Investors typically do not have access to the same investments opportunities and expectations are not homogeneous.

Also, Elton et al. (1999), challenges the use of the CAPM as "an unbiased estimate of expected returns". According to the author, the use of average realized returns as a proxy for expected returns relies on a belief that information surprises tend to cancel out over the period of a study. However, this does not explain "realized returns on risky assets that are less than the risk-free rate for the long periods when it has occurred" (for instance, the period from 1973 to 1984).
Therefore, the author argues that "the more logical explanation for these anomalous results is that realized returns are a very poor measure of expected returns". This argument is supported also by Fama and French (1997), who find that standard errors of more than 3.0%

per year are typical when using the CAPM to estimate expected returns, and thus estimates of the cost of equity are “distressingly imprecise”.

Another source of critics comes from the work of Fama and French (2004), where the authors empirically test the relation between Beta and the average return predicted by the CAPM. The authors find that the intercept is greater than the average risk-free rate, and the coefficient on beta is less than the average excess market return. The evidence is that the relation between beta and average return is flatter than predicted by the CAPM (*Figure 18*).

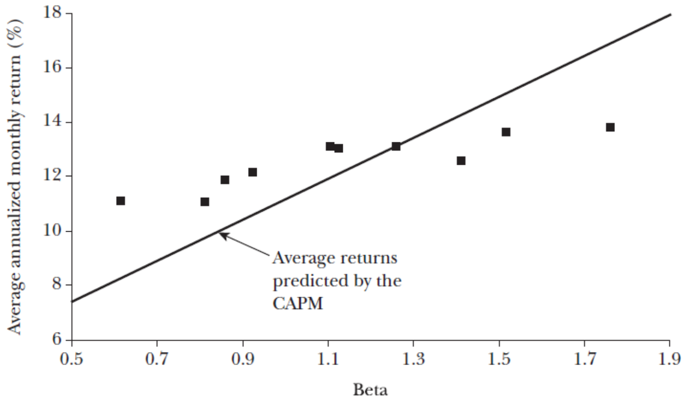


Figure 18 – Average Annualized Monthly Return versus Beta, 1928-2003.
Source: Fama and French (2004)

Furthermore, contrary to what the CAPM predicts (i.e., that differences in expected return across securities and portfolios are entirely explained by differences in market beta), there is ample evidence that much of the variation in expected return is unrelated to market beta:

- Basu’s (1977) evidence that when common stocks are sorted on price-to-earnings ratios, future returns on low P/E stocks are higher than predicted by the CAPM.
- Banz (1981) documents that, when stocks are sorted on market capitalization, average returns on small stocks are higher than predicted by the CAPM. This is also known as the size effect.
- Rosenberg et al., (1985) document that stocks with high book-to-market equity ratios (B/M) have high average returns that are not captured by their betas.
- Bhandari (1988), consistently to what the Modigliani and Miller (1958) propositions prescribe, finds that firms with high leverage (measured as debt-to-equity ratio) are associated with returns that are too high relative to their market betas.

The conclusion to be draw is therefore that, since other variables capture variation in expected return missed by beta, the market portfolio is not efficient and, in the words of Fama and French, "the CAPM is dead in its tracks."

2.2.4 Fama and French Multi-factor Models

Three-Factor Model

Motivated by the inability of the CAPM to explain much of the variation in expected returns, Fama and French (1993) propose a three-factor model in which an asset expected return depends on its sensitivity to market risk (the *Beta*) and the returns on two portfolios meant to mimic additional risk factors, namely size and value.

$$E(R) = r_f + \beta_1 * market\ premium + \beta_2 * SMB + \beta_3 * HML \qquad (8)$$

The mimicking portfolios are SMB (small minus big), which is the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, and HML (high minus low), the difference between the returns on two value portfolios (i.e., stocks with a high book-to-equity ratio) and two growth portfolios (i.e., stocks with a low book-to-equity ratio).
SMB and HML are also known, respectively, as the SIZE and VALUE factors.
Details on how factors and portfolios are constructed are provided in the *Appendix* (section "*B. The Cost of Equity Capital*", subsection "*Fama and French Factors and Portfolio Construction*").

Following the critics to the Capital Asset Pricing Model (i.e., market beta cannot explain the whole variation in expected returns), the authors explore other variables that have been proven to have explanatory power, namely (a) firm size, (b) earnings-to-price ratio, (c) leverage and (d) book-to-market equity ratio.
Firm size and book-to-market equity perform best in explaining the cross-sectional variation in stock returns in the market and, therefore, they are added to the market beta forming the Three-factor model.
As *Figure 19* shows, high B/M stocks historically have outperformed their benchmark as predicted by the CAPM and lowest decile B/M, i.e. growth stocks, have underperformed their benchmark.

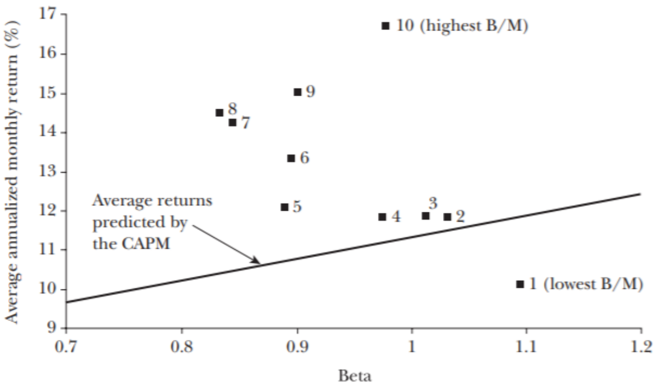


Figure 19 – Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on B/M, 1963-2003. Source: Fama and French (2004)

Also, average annual returns for portfolio of stocks sorted for market size decrease going from the lowest decile – the smallest group of stocks – to the highest decile – the biggest stocks.

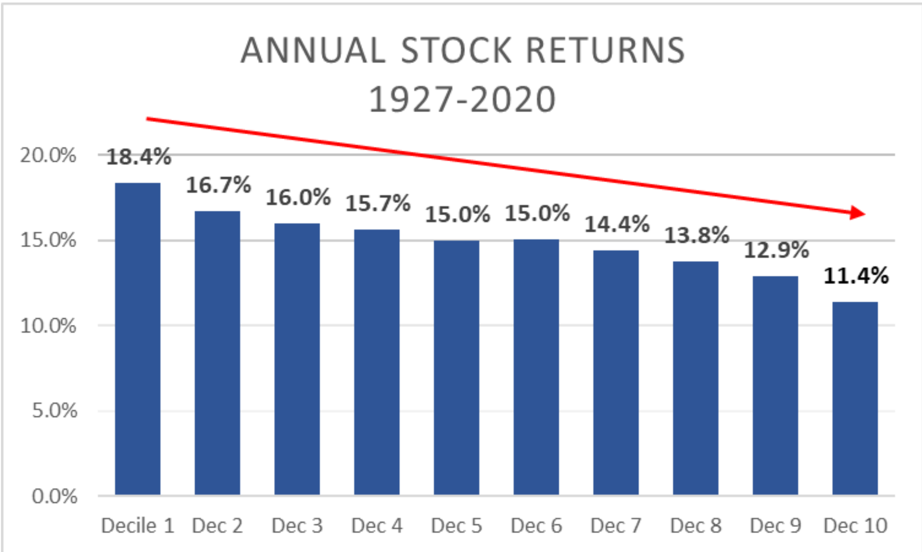


Figure 20 – Annual Stock Returns for stocks sorted on size, 1927-2020. Source: Elaborations on Kenneth French's data library

Nevertheless, the model has not been exempted form criticism. One piece of criticism comes from the authors themselves in Fama and French (2004), where they admit that an important shortcoming of the three-factor model is its empirical motivation. In fact, the small-minus-big (SMB) and high-minus-low (HML) factors are just constructs meant to capture the patterns uncovered by previous work on how average stock returns vary with size and the book-to-market equity ratio.

Moreover, as they point out "the value and size factors are not explicitly about risk; at best, they are proxies for risk". For instance, size per se cannot be a risk factor that affects expected returns, since, if it were the case, small firms would then simply combine to form large firms.

As Pernold (2004) points out, "until the risks that underly the Fama-French factors are identified, the forecast power of their model will be in doubt and the applications will be limited".

Finally, another relevant source of criticism comes from the evidence of Titman et al., (2004) and Novy-Marx (2013), who show that the model is incomplete for expected returns because its three factors miss much of the variation in average returns related to profitability and investment.

The Momentum Factor

The Carhart (1995, 1997) model builds onto the Fama and French Three-factor model and introduces a fourth factor called momentum. The momentum factor is the difference in returns between a portfolio of winners – high momentum stocks – and a portfolio of losers – low momentum stocks.

The idea behind is that stocks that have performed well over the last two to twelve months tend to make high returns over the next one, while stocks that have performed poorly over the past period, tend to make low returns over the next one. Specifically, the additional factor captured is the one-year momentum effect (Jegadeesh and Titman, 1993).

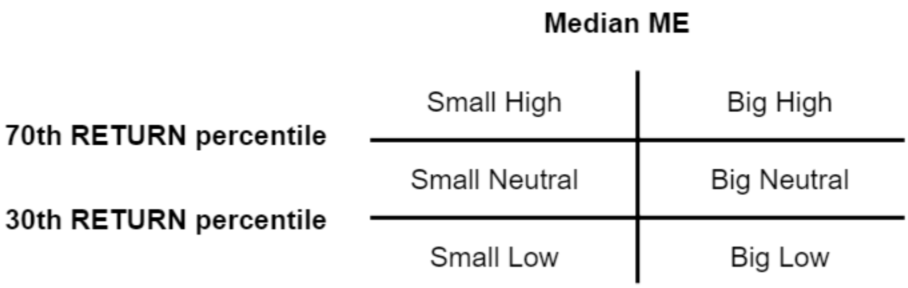
The model was tested in Carhart (1997), where the author investigated momentum for a sample of mutual funds companies. The results indicate that the momentum factor – indicated in *Table 7* as the PR1YR factor, meaning prior-one-year – was statistically significant (t-statistic > 1.96) along with the size and value factors.

Factor Portfolio	Monthly Excess Return	Std Dev	t-stat for Mean = 0
VWRF	0.44	4.39	1.93
RMRF	0.47	4.43	2.01
SMB	0.29	2.89	1.89
HML	0.46	2.59	3.42
PR1YR	0.82	3.49	4.46

Table 7 – Summary statistics on the factor portfolios.
Source: Carhart (1997)

The peculiarity of the so called Four-factor Model is that it uses both risk-based as well as behavioral-based (i.e., the momentum factor) factors to determine an asset’s expected return.

Operationally, the momentum factor is constructed using six value-weight portfolios formed on size and prior returns. The portfolios are the intersections of two portfolios formed on size (market value, ME) and 3 portfolios formed on prior return. The size breakpoint is the median NYSE market equity. The prior return breakpoints are the 30th and 70th NYSE percentiles.



The Momentum factor is the average return on the two high prior return portfolios minus the average return on the two low prior return portfolios.

$$Mom = \frac{(Small\ High + Big\ High)}{2} - \frac{(Small\ Low + Big\ Low)}{2} \qquad (9)$$

Five-Factor Model

Addressing the critics moved to the Three-factor model, Fama and French (2014) recognize that much of the variation in average returns related to profitability and investment is left unexplained by their previous model. This led the authors to examine a model that adds profitability and investment factors to the market, size, and value factors.

Specifically, the two additional factors add to the description of average return provided by the value factor (HML). To provide an explanation of this assertion, the authors start form the famous dividend discount model:

$$P_0 = \sum_{t=1}^{\infty} \frac{DPS_t}{(1+r)^t} \tag{10}$$

where P_0 is the share price at time zero, DPS_t are the expected dividends per share at time t and r is the internal rate of return on expected dividends.

Following Modigliani and Miller (1961), the market value of the firm's stock implied by equation (10) is:

$$M_0 = \sum_{t=1}^{\infty} \frac{E_t - \delta B_t}{(1+r)^t} \tag{11}$$

where M_0 is the market value of equity at time zero, E_t is total equity earnings for period t and δB_t is the change in total book value of equity.

Dividing both terms by time zero book value of equity,

$$\frac{M_0}{B_0} = \frac{\sum_{t=1}^{\infty}(E_t - \delta B_t)/(1+r)^t}{B_0} \tag{12}$$

From equation (12), three considerations can be made:

1. Fixing everything except the current market value – M_0 – and the discount rate – r – a lower M_0, or equivalently, a higher book-to-equity ratio – B/M – implies a higher expected return.
2. Fixing everything except future earnings – E_t – and expected return, higher earnings – profitability – imply a higher expected return.
3. Fixing everything except future growth in the book value of equity – δB_t – and expected return, a higher δB_t – investment – implies a lower expected return.

The resulting Five-factor model takes the following form:

$$E(R) = r_f + \beta_1 * market\ premium + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA \quad (13)$$

Where:

- SMB (Small Minus Big) is the size factor. It is the average return on small stock portfolios minus the average return on big stock portfolios.
- HML (High Minus Low) is the is the value factor. It is the average return on two value portfolios – high book-to-market – minus the average return on two growth portfolios.
- RMW (Robust Minus Weak) is the profitability factor. It is the difference between the average return on two portfolios including stocks with robust operating profitability and the average return on two portfolios including stocks with weak operating profitability.
- CMA (Conservative Minus Aggressive) is the investment factor. It is the difference between the average return on two portfolios including stocks with low – conservative – investments and the average return on two portfolios including stocks with high – aggressive – investments.

The five factors are constructed starting from eighteen value-weighted portfolios, obtained by sorting firms based on size, book-to-market ratio, investments and operating profitability. Details about factors and portfolios construction are provided in the *Appendix* (section "*B. The Cost of Equity Capital*", subsection "*Fama and French Factors and Portfolio Construction*").

2.2.5 q - Factor Models

q^4 - Factor Model

The q-factor model is an empirical asset pricing model proposed by Hou, Xue, and Zhang (2015) which prescribes that the expected return of an asset in excess of the risk-free rate is described by its sensitivities to the market factor, a size factor, an investment factor, and a return on equity factor, yielding the following model:

$$E(R) = r_f + \beta_{MKT} * market\ premium + \beta_{ME} * ME + \beta_{I/A} * I/A + \beta_{ROE} * ROE \quad (14)$$

Where:

- ME (market value of equity): is the size factor. As the SMB factor, it is the difference between the simple average of the returns on the nine small size portfolios and the simple average of the returns on the nine big size portfolios.
- I/A (investment-to-assets): is the investment factor. It is measured as the annual change in total assets divided by one-year-lagged total assets. It is the difference between the simple average of the returns on six low I/A portfolios and the simple average of the returns on six high I/A portfolios.
- ROE (return-on-equity): is the profitability factor. It is calculated as income before extraordinary items divided by one-quarter-lagged book equity. It is the difference between the simple average of the returns on six high Roe portfolios and the simple average of the returns on six low Roe portfolios.

The q^4-model is implemented via the Fama and French (1993) portfolio approach. Again, details on factor construction and portfolio formation are provided in the *Appendix* (section

"*B. The Cost of Equity Capital*", subsection "*q-Factor Model, Factor and Portfolio Construction*").

In summary, the factors are constructed from eighteen portfolios, formed on market equity, investment-to-assets, and ROE. The breakpoint used for the market value of equity is the median NYSE market equity while the breakpoints for the other two factors are the 30th and 70th NYSE percentiles for stocks ranked on investment-to-asset and ROE respectively.

The q-factor model is an empirical implementation of the investment CAPM (Zhang, 2017). The basic philosophy underlying the investment CAPM is to price risky assets from the perspective of firms, as opposed to the one of investors. Mathematically, the investment CAPM is a restatement of the Net Present Value – NPV – rule in Corporate Finance.
The NPV of a project is its present value – discounted value of its future cash flows – minus its investment costs today. The NPV rule says that a manager should invest in a given project if and only if its NPV is greater than or equal to zero. When initially facing many projects with NPV ≥ 0, supposing an unlimited availability of capital, the manager will start with the project with the highest NPV and work her way down the supply curve of projects. For the last project that the manager takes, its NPV should equal zero.

Considering one-period projects, the last project with NPV = 0 means that:

$$\text{Investment costs (I)} = \frac{\text{profitability (NC}F)}{\text{discount rate}} \tag{15}$$

Rewriting the NPV rule yields:

$$\text{Discount rate} = \frac{\text{profitability}}{\text{investment costs}} \tag{16}$$

Thus, high investment relative to low expected profitability must imply low costs of capital, and, conversely, low investment relative to high expected profitability must imply high costs of capital. Indeed, the investment CAPM says that the cross-section of expected returns is be explained by two main factors, (a) investment and (b) expected profitability.

The model predicts that, *ceteris paribus*, high investment stocks should earn lower expected returns than low investment stocks, and that stocks with high expected profitability should earn higher expected returns than stocks with low expected profitability.

Investment predicts returns because, given expected profitability, high investments imply a high present value of future cash flows and, therefore, a low cost of capital.
Accordingly, low investments imply a low present value of future cash flows and, therefore, a high cost of capital.

Profitability predicts returns because high expected profitability relative to low investment must imply high discount rates. The high discount rates are necessary to offset the high expected profitability to induce low net present values of new capital and low investment. If the discount rates were not high enough, firms would observe high net present values of new capital and invest more. Conversely, low expected profitability relative to high investment must imply low discount rates. If the discount rates were not low enough to counteract the low expected profitability, firms would observe low net present values of new capital and invest less.

q^5- *Factor Model*

Finally, Hou et al. (2019) augment the q-factor model with the expected growth factor to yield the q^5-model:

$$\begin{aligned} \mathrm{E(R)} = \; & r_f + \beta_{MKT} * market\ premium + \beta_{ME} * ME \\ & + \beta_{I/A} * I/A + \beta_{ROE} * ROE + \beta_{EG} * \mathrm{EG} \end{aligned} \tag{17}$$

The expected growth factor – EG – is defined as the difference between the simple average of the returns on two high expected growth portfolios – measured as $E_t[\delta I/A]$ (i.e., expected change in investment-to-assets) – and the simple average of the returns on two low $E_t[\delta I/A]$ portfolios.

2.2.6 Performance Evaluation of Asset-Pricing Models

The effectiveness of an asset pricing model can be demonstrated using mainly two approaches: (a) the left-hand-side (LHS) approach and (b) the right-hand-side (RHS) approach.

The former approach – LHS – judges as the most efficient model the one that better explains the cross-section of returns. Operationally, it requires calculating alphas from time-series regressions on a set of tests; the alpha is the intercept of the regression and measures the extra return an asset earns in excess of what the factor model would predict.

The latter approach – RHS – uses spanning regressions to judge whether individual factors add explanatory power to the model. Operationally, a factor from a candidate model is regressed on all the factors in another benchmark model. If the intercept is non-zero, the candidate factor is useful, i.e. it adds to the explanatory power of the benchmark model. If the intercept is zero, the candidate factor provides no incremental information.

Also, in the mean-variance framework, another important metric to consider is the Sharpe Ratio, calculated as the mean return divided by its volatility. The efficient combination of the factors should have a Sharpe Ratio that is greater than or equal to the maximum Sharpe ratio from combining all the anomaly portfolios.

Fama and French (2018) test the performance of the main asset pricing models, namely the CAPM and the three-, five- and six- factor models.

The results of the spanning regressions show that each of the additional factors considered but the SMB factor add explanatory power to the CAPM, given that the t -statistics for the regression intercepts are higher than 1,96 (meaning that the part unexplained by the CAPM is significant on a 95% level).

Also, the authors show that the CAPM and the Three-factor model cannot explain the two additional risk factors of the five-factor model, meaning that adding CMA and RWA to the three-factor model results in an expansion of the mean-variance efficient frontier.

These results are further confirmed by looking at the marginal contribution of each factor to the Sharpe ratio. An increase in the Sharpe ratio means that the factor expands the efficient frontier and the authors demonstrated that each of the factors but HML are statistically significant and give a positive marginal contribution to the Sharpe ratio.

In conclusion, from the evidence provided by Fama and French (2018), the Six-factor is the best performing model among the considered ones, followed by the Five-factor model. Therefore, each of the additional factors proposed increases the explanatory power of the CAPM and the basic Three-factor model.

Considering instead the newly proposed q-factor model, further tests have been performed by Hou, Xue, and Zhang in order to test the effectiveness of their model compared to the Fama and French models.

The authors test their model trough both the monthly Sharpe ratio for each individual factor and the maximum monthly Sharpe ratio achievable by each factor model, including the CAPM, the Fama-French (FF) model, the Carhart model, and the q-factor model.
Based on those metrics, the results suggest that the q-factor model is more efficient than the Fama and French factor model.

Furthermore, following the development of the Five- and Six- factor models by Fama and French, Hou, Xue and Zhang further tests their model, concluding that the q-factor model outperforms the Fama and French models in head-to-head factor spanning tests.
From January 1967 to December 2020, the alphas of the value, investment, profitability, and momentum factors (HML, CMA, RMW, and UMD) of the FF-models relative to the q-model are economically small and statistically insignificant (t-statistic < 1.96). In contrast, the investment and profitability factors (I/A and ROE) have economically larger alphas when regressed on the FF-model and are strongly significant. Results are provided in *Table 8*.
As a consequence, the authors conclude that the q-factor model fully subsumes the Fama and French’s Six-factor model in head-to-head factor spanning tests. Results of the spanning regression are shown hereinafter.

Factors	**Average returns**	**6-factor alphas**	**q-factor alphas**
The investment factor, I/A	0.33	0.09	
	(4.10)	(2.55)	
The Roe factor, ROE	0.51	0.25	
	(4.96)	(4.09)	
HML	0.24		– 0.01
	(1.76)		(– 0.09)
CMA	0.27		0.01
	(3.05)		(0.39)
RMW	0.27		0.02
	(2.77)		(0.30)
UMD	0.62		0.18
	(3.63)		(0.86)

Table 8 – Spanning regression on the FF Six-factor model and the q-factor model. Source: global-q.org

2.2.7 The Implied Cost of Capital

The implied cost of capital (ICC) is the internal rate of return that equates a firm's forecasted cash-flows to its current market price. This stream of literature emerged from the critics to Asset-pricing models, which provide "woefully imprecise" estimates of the cost of capital by focusing on realized past returns.
ICC models derive from an empirical literature that reverse-engineers the dividend discount model to infer markets expectations of the rate of return on equity capital. The main strength of this reverse-engineering approach is that estimates of the expected rate of return are based on forecasts rather than extrapolation from historical data.

As said, the starting point is the dividend discount model, theorized by Williams (1938), according to which the fair price of an asset's stock is the infinite sum of the expected flows from the firm to its shareholders – dividends – discounted for the cost of equity capital.

$$P_0 = \sum_{t=1}^{\infty} \frac{DPS_t}{(1+r)^t} \tag{18}$$

where DPS_t are the expected dividends per share at year t; r is the required rate of return for equity investors; $(1+r)^t$ is the discount factor at year t; and P_0 is the current asset's fair stock price.

The reverse-engineering consists in taking as P_0 the current market price of the asset's stock and as the unknown variable the required rate of return for equity investors. In this sense, it is possible to extract the cost of equity capital implied by the market price.
As an example, if equation (18) is truncated at time 1 and under the assumption that the stock will be sold at the price P_1, the rate of return demanded by equity investors is obtained through the following steps:

$$P_0 = \frac{DPS_1}{(1+r)} + \frac{P_1}{(1+r)} \tag{19}$$

$$(1+r) = \frac{DPS_1 + P_1}{P_0} \tag{20}$$

$$r = \frac{DPS_1 + P_1}{P_0} - 1 \tag{21}$$

As a further development, Gordon and Gordon (1962) introduce the Gordon Growth Model, which assumes a constant growth in dividends in perpetuity, yielding the following formula:

$$P_0 = \frac{DPS_0 * (1+g)}{r-g} = \frac{DPS_1}{r-g} \tag{22}$$

It is worth highlighting the power of this model, which trough a simple formula summarizes the main determinants of stocks prices, being current profitability, expectations of future growth, and the cost of capital.

The most relevant models implemented in the academic literature are variations of the dividend discount model, with differences in how projected earnings are handled over a finite forecasting horizon. The models resulting from the different hypothesis can be grouped in three categories:

1. Gordon Growth:
    - Finite Horizon (Gordon and Gordon, 1997)
    - Target Price (Botosan and Plumlee, 2002)
2. Residual Income:
    - Industry method (Gebhart et al., 2001)
    - Economy wide (Claus and Thomas, 2001)
3. Abnormal Earnings Growth:
    - Economy-wide growth (Ohlson and Juetter-Nauroth, 2003)
    - Modified price to earnings growth ratio (Easton, 2004)

The following part of this section will be devoted to describing the previously identified models. Also, in order to ease the reader, *Table 9* and *Table 10*, at the end of the subsection will summarize all the relevant assumptions underlying the models.

2.2.8 Gordon Growth Models

Finite-horizon Model

The finite-horizon specification of the Gordon Growth model as implemented by Gordon et al. (1997), is obtained by truncating the infinite series of dividends at year 4.

Dividends are forecasted for the first four years and the terminal period dividend per share is assumed to be the earnings per share in period T=5. Earnings per share are assumed to remain constant beyond the forecast horizon, when the model assumes each firm's ROE reverts to its cost of capital. The models can be written as follows:

$$P_0 = \sum_{t=1}^{4} \frac{DPS_t}{(1+ r_{GGM})^t} + \frac{EPS_5}{r_{GGM} * (1+r_{GGM})^4} \tag{23}$$

where DPS_t is the expected dividend per share for year *t* and r_{GGM} is the expected rate of return according to the model.

Additionally, the model requires both the Clean Surplus and the Market Efficiency assumptions. The former is needed to determine the earnings per share at the terminal year, while the latter guarantees that dividend forecasts equal market expectations.

Target Price Model

The implementation of the dividend discount model proposed by Botosan and Plumlee (2002) is obtained by truncating the infinite series of future dividends at year 5 and assuming the terminal value equal to the present value of the share's price at year t=5; yielding the following equation:

$$P_0 = \sum_{t=1}^{5} \frac{DPS_t}{(1+ r_{DIV})^t} + \frac{P_5}{(1+r_{DIV})^5} \tag{24}$$

where DPS_t is the expected dividend per share for year *t*, P_o is the current price of the share, P_5 is the share's price at year t=5, and r_{DIV} is the expected rate of return according to the model.

Again, the model requires the market efficiency assumption for both the dividend per share and the terminal stock price forecasts, but it does not require the clean surplus assumption, since the terminal value is just the market efficient price of the share at the final year of the forecasting period.

2.2.9 *Residual Income Valuation Model*

The residual income valuation model anchors the valuation of equity on book value of equity and adjusts this valuation via future expected residual income.
Specifically, the current stock price equals the current book value of equity plus the present value of future expected abnormal earnings.

Operationally, the model is obtained by substituting the clean-surplus relation into the dividend discount model, yielding:

$$P_0 = BVPS_0 + \sum_{t=1}^{\infty} \frac{EPS_t - r_E * BVPS_{t-1}}{(1 + r_E)^t} \quad (25)$$

where $BVPS_t$ is the book value per share at year *t,* and r_E is the expected rate of return, and EPS_t represents earnings per share at year *t*.

Industry Method Model

The residual income model, as implemented by Gebhardt, Lee and Swaminathan (2001), may be expressed as:

$$P_0 = BVPS_0 + \sum_{t=1}^{11} \frac{(ROE_t - r_{GLS}) * BVPS_{t-1}}{(1 + r_{GLS})^t} + \frac{(ROE_{12} - r_{GLS}) * BVPS_{11}}{r_{GLS} * (1 + r_{GLS})^{11}} \quad (26)$$

where ROE_t is the expected return on equity for year *t* and r_{GLS} is the expected rate of return according to the GLS model.

The forecast horizon equals to the first three years, where analysts' forecasts for earnings are used, the dividend payout ratio is assumed to remain constant, and the clean-surplus relation holds. The last assumption is essential to calculate each year's book value per share.

Beyond year three, the model assumes that the ROE fades linearly to the historical industry median; as per Gebhardt et al. (2001), "the mean reversion in ROE attempts to capture the long-term erosion of abnormal ROE over time and the notion that, in the long-run, individual firms tend to become more like their peers". Finally, after year $t + 12$, residual income is constant.

The main limitation of the model is that the assumed growth rate beyond the short forecast horizon may, and probably will, differ from the growth rate implied by the data, resulting in an unreliable estimate of the implied expected rates of return.
Also, the choice of the appropriate industry group may not be straightforward, as there could be cases where a specific company differs significantly from its industry peers. Take as an example Tesla, which is included in the Automotive industry but is indeed very different from its industry peers.

Economy-Wide Model

The residual income model, as implemented by Claus and Thomas (2001), may be expressed as:

$$P_0 = BVPS_0 + \sum_{t=1}^{5} \frac{(ROE_t - r_{CT}) * BVPS_{t-1}}{(1 + r_{CT})^t} + \frac{(ROE_5 - r_{CT}) * BVPS_4 * (1 + g)}{(r_{CT} - g) * (1 + r_{CT})^5} \quad (27)$$

Differently from Gebhardt et al. (2001), the short-term forecast horizon equals to five years (compared to the three years of the GLS model) and the residual income beyond the forecast horizon is not constant; rather it grows at a constant rate, equal to the risk-free rate minus 3%. This growth rate is an estimate of the expected inflation rate.
In fact, as the difference between ROE and the cost of equity capital declines, residual income will also decline. However, a countervailing effect is the growth in investments, which increases the base on which residual income is generated. Claus and Thomas (2001) assume that growth in investments beyond the forecast horizon will be at the rate of inflation.

The limitation of this approach is that the assumed growth rate beyond the forecast horizon is the same for all firms. While this assumption may be plausible at the country level, it may not be valid at the firm level.

Furthermore, given the current environment of very low interest rates, using the risk-free rate minus 3% as a proxy for inflation may be at least misleading, resulting in a negative growth rate.

2.2.10 Abnormal Earnings Growth Valuation Model

Abnormal Earnings are defined as any earnings in excess of expected earnings, determined as the product between a stock's expected return and its book value.
From a firm perspective, generating positive abnormal earnings is fundamental in order to sell at a premium to book value.
Abnormal growth in earnings is defined as the difference between cum-dividend earnings in period t and "normal earnings", obtained by calculating the future value of period t-1 earnings.

$$AGR_t = EPS_t + r * DPS_{t-1} - (1 + r) * EPS_{t-1} \tag{28}$$

The abnormal growth in earnings model anchors the valuation of equity on capitalized future earnings; it then adjusts this value via future expected abnormal growth in earnings.
The model, which is derived from the dividend capitalization model, takes the following form:

$$\mathrm{P}_0 = \frac{\mathrm{EPS}_1}{\mathrm{r}} + \sum_{\mathrm{t}=2}^{\infty} \frac{\mathrm{AGR}_{\mathrm{t}}}{r} * \frac{1}{(1 + r)^{\mathrm{t}-1}} \tag{29}$$

It is worth highlighting that, since the focus of the model is solely on earnings, it does not require the clean-surplus assumption.

Economy-Wide Growth Model

Ohlson, J., and B. Juettner-Nauroth (2005) further develop the abnormal earnings growth model by imposing a series of assumptions:

- Positive earnings and abnormal growth in earnings for year 1;
- The rate of infinite growth in abnormal earnings equal the risk-free rate minus 3%;

- The short-term growth in abnormal earnings is equal to:

$$g_2 = \frac{EPS_2 - EPS_1}{EPS_1} + \frac{r * DPS_1}{EPS_1} - r \tag{30}$$

Imposing these assumptions to equation (29) yields:

$$\mathrm{P_0} = \frac{\mathrm{EPS_1}}{\mathrm{r_{OJ}}} + \frac{\mathrm{EPS_1} * \left(\frac{\mathrm{EPS_2} - \mathrm{EPS_1}}{\mathrm{EPS_1}} + \frac{\mathrm{r_{OJ}} * \mathrm{DPS_1}}{\mathrm{EPS_1}} - r\right)}{\mathrm{r_{OJ}} * (1 + \mathrm{r_{OJ}} - \gamma)} \tag{31}$$

The model assumes that the infinite growth in abnormal earnings is well represented by the economy-wide growth. As already pointed out when examining the Claus and Thomas (2001) model, an important limitation of this assumption is that the same growth rate is applied to all firms. Also, in operationalizing this approach, one must adapt the infinite growth in abnormal earnings to the current environment, rather than taking the one proposed by the authors (which will result in a negative infinite abnormal growth rate at current risk-free values).

Special Cases: the PE and the PEG Ratios

Supposing now that only earnings forecasts for the future two periods were available (thus setting T=1), equation (29) takes the form:

$$\mathrm{P_0} = \frac{\mathrm{EPS_1}}{\mathrm{r}} + \frac{\mathrm{AGR_2}}{(r - \mathrm{g_{agr}}) * r} \tag{32}$$

Special cases of equation (32) are the PE and the PEG ratio, valuation multiples which are widely used in the finance world to compare stocks.

The PE ratio is obtained by imposing $\mathrm{AGR_2} = 0$, thus assuming that next year's forecast of earnings is sufficient for a valuation.

$$\mathrm{P_0} = \frac{\mathrm{EPS_1}}{\mathrm{r}} \tag{33}$$

And the expected rate of return can be estimated as the inverse of the PE ratio:

$$r = \frac{EPS_1}{P_0} = \frac{1}{PE} \tag{34}$$

The main shortcoming of using the PE ratio is that it does not account for future earnings growth, which is assumed to be equal to zero. Therefore, equation (34) may yield estimates of the cost of capital which are too low.

To overcome this limitation, the use of the PEG ratio, which divides the PE ratio by expected future growth, gained more and more ground.

$$PEG = \frac{PE}{g} \tag{35}$$

Assuming growth in abnormal earnings and first year dividends equal to zero, equation (29) takes the form:

$$r_{PEG} = \sqrt{\frac{EPS_2 - EPS_1}{P_0}} \tag{36}$$

Modified PEG Ratio

The Modified Price-to-Earnings-Growth model is a special case of the two-year abnormal earnings growth model (29), obtained by imposing $g_{agr} = 0$. Compared to the simple PEG ratio, it allows for dividends for the first year to be different from zero. As implemented by Easton (2004), the model takes the following form:

$$P_0 = \frac{EPS_2 + r_{MPEG} * DPS_1 - EPS_1}{{r_{MPEG}}^2} \tag{37}$$

In order to be implemented, the model requires for first year earnings and year 2 abnormal earnings to be positive. The main critic moved to the model is that the growth in earnings per share from year 1 to year 2 may not be indicative of the long-term growth of a company. However, Easton (2007) argues that analysts' long-term growth rate forecasts tend to be over-optimistic, causing the implied expected rate of return to be too high relative to market expectations. Also, the MPEG model requires increasing earnings, and this may systematically bias the sample toward more stable, less risky firms.

ICC Model	Clean-Surplus Assumption	Market-Efficiency Assumption	Short-term Horizon Assumptions	Terminal Value Assumptions
Finite Horizon	YES	YES	• During the forecast horizon, dividend forecasts equal market's expectations.	• Beyond the forecast horizon, each firm's ROE equals its cost of equity capital.
Target Price	NO	YES	• During the forecast horizon, dividend forecasts equal market's expectations.	• Beyond the forecast horizon, forecast of stock price equal market's expectations.
Industry Method	YES	YES	• During the forecast horizon (first three years), forecasts of earnings and book value equal market's expectations. • After the forecast horizon, firm ROE fades linearly to industry ROE.	• Beyond the forecast horizon, firms have a 100% dividend payout ratio, since BVPS must remain constant beyond year 11. • ROE remains at industry median beyond forecast horizon. • Residual income remains constant in perpetuity.
Economy-Wide	YES	YES	• Earnings forecasts from year 1 to year 5 equal the market's expectations. • Book Value forecasts from year 1 to year 4 equal market's expectations.	• Beyond year 5, each firm's residual income grows at a constant rate, which is assumed to be the inflation rate.

Table 9 – ICC models, Assumptions (1/2)

ICC Model	Clean-Surplus Assumption	Market-Efficiency Assumption	Short-term Horizon Assumptions	Terminal Value Assumptions
Economy-Wide Growth	NO	YES	• Earnings forecasts in year 1 and 2 and forecast of dividends in year 1 equal market's expectation. • Year 1 earnings and year 2 abnormal earnings are positive.	• Growth in abnormal earnings is a constant rate for all t. • Estimated abnormal earnings growth rate equals market's expectation.
Modified PEG Ratio Easton (2004)	NO	YES	• Earnings forecasts in year 1 and 2 and forecast of dividends in year 1 equal market's expectation. • Year 1 earnings and year 2 abnormal earnings are positive.	• Beyond the forecast horizon, zero growth in abnormal earnings.

Table 10 – ICC models, Assumptions (2/2)

2.2.11 Conclusion

This section had the main goal to analyze in depth the different possibilities to measure the cost of equity capital for business firms. As already discussed, two macro-categories have been identified:

a) asset-pricing models, which explain an asset excess return based on its sensitivity to a multitude of factors (the β's) and the price of each factor;
b) implied cost of capital measures, that are estimates of the expected rate of return demanded by shareholders implied by current market prices and expected future cash flows.

The thesis does not want to enter the debate on which class of models is the best.

The main arguments supporting that the Cost of Equity obtained with ex-ante models is a better proxy than ex-post realized stock returns is that the former are more reliant on cross-sectional variation among companies (Reverte, 2012), since they can account for unexpected news on a firm's cash flow or fundamentals, which obviously cannot be not depicted in ex-post measures (Gupta, 2015). Also, ex-ante models do not need long-time series to be robust (Reverte, 2012).

However, problems could emerge also from using ICC measures. In fact, an important characteristic of the implied cost of capital measures is their reliance on analysts' earnings forecasts. Several studies have shown that analysts are biased in their forecasts, suffering from optimism (Kothari, 2001), and that, at the firm-level, the forecast error in huge.
Indeed, Collins and Hopwood (1980) and Brown and Rozeff (2006) have tested earnings forecasts provided by Value Line, one of the most renewed provider of earnings forecasts data, and found that analyst's error in forecasting next quarter earnings per share was respectively 31.7% and 28.4%. Additionally, they found that forecasts tended to be highly correlated across analysts.
Another very relevant aspect to consider is the availability of those forecast for small firms. Most often small firms have no analyst coverage and thus their earnings forecasts are not available. As a consequence, using analyst earnings forecasts to obtain an estimate of the implied cost of capital may create a bias in the sample, as only larger firms, which are typically covered by a higher number of analysts, will be included.

On the contrary, asset-pricing models main critics revolved around the series of anomalies which those models failed to explain. However, the emergence of new factors allowed multi-factor models to improve considerably their explanatory power.
Furthermore, availability is not a concern for those models, as neither is the reliance on analysts' forecasts. As such, the class of models selected to proxy the cost of equity have been the asset-pricing models. In summary, the main motivations of the choice are:

- the emergence of new factors and models that explain better stock's realized returns;
- some important limitations of ICC models, being their reliance on analysts' earnings forecasts and availability of those forecasts for smaller firms.
- fill a literature gap. In fact, by investigating the theoretical background regarding the relationship between sustainability and the cost of equity capital (extensively discussed in the next chapter), most of the studies relied on ICC models, with only a few implementing asset-pricing models (Sharfman and Fernando, 2008; Humphrey et. al, 2012; Suto and Takehara, 2017);

As discussed in the subsection "2.2.6 *Performance Evaluation of Asset-Pricing Models"*, the best performing models across the class are the q-factor models (Hou et al., 2015), which have been proven to outperform the Fama and French factor models in head-to-head factor spanning tests. However performing better, q-factor models will not be employed in this dissertation because of some methodological constraints related to factor's availability.
The q-factors are in fact available only for the US market, thus hindering the possibility of determining if the relation exists at a global level, as this dissertation would investigate. On the other hand, the Fama and French factors are available for a multitude of geographic areas.

Regarding the Fama and French models instead, the six-factor model has been proven to be the best performing one (Fama and French, 2018), followed by the five-factor model. However, the theoretical motivation of the momentum factor is somehow controversial (Fama and French, 2014), since it does not capture a type of risk a firm faces but is rather a behavioral based measure.

3. THEORETICAL BACKGROUND and RESEARCH QUESTIONS

3.1. Theoretical Framework

Corporate social responsibility (CSR) has been extensively studied in the academic literature, with the start of the debate that can be dated to 1970, when Milton Friedman introduced *Shareholders Theory*, prescribing that managers should not spend company resources on environmental and social initiatives, which are seen just as a cost that destroys shareholder value. Contrary to that theory, Freeman's *Stakeholder Theory* and other subsequent contributions started to challenge this view, asserting the need to integrate CSR into company's decisions in order to foster long-term value creation.

However, the debate did not gain traction until recently, with the push of the investment community to integrate sustainability in investing decisions. This required the development of ESG criteria to make such business' efforts measurable through quantifiable indicators. Differently from CSR that aims to make a business accountable, ESG aims to provide a concrete set of numbers which can be used by investors and consumers as a benchmark of a company's overall sustainability performance.

This thesis is specifically interested in investigating whether there is a relationship between sustainability and one of the factors driving shareholders' wealth: the Cost of Equity capital (CoE). Under the framework of several theories, namely *Stakeholder*, *Agency* and *Legitimacy Theory*, existing research posits that sustainable companies benefit from a lower CoE (Jiménez and Zorio-Grima, 2020).

According to *Stakeholder Theory*, the firm's goal is to maximize shareholder's earnings yet protecting stakeholder's interests (Freeman, 1984; Jensen, 2002). The corporation is in fact seen as an ecosystem of related groups, all of whom need to be considered and satisfied to keep the company healthy and successful in the long-term. In the end, a firm cannot maximize value if it ignores the interests of its stakeholders.

Building on this, Jensen (2002) offers a theory of "enlightened stakeholder value maximization", recognizing "maximization of the long run value of the firm as the criterion for making the requisite trade-offs among its stakeholders". Focusing on sustainability compels firms to evaluate the tradeoffs among competing, conflicting, or complementing short-term and long-term interests of shareholders, society, creditors, employees, and the environment. Corporate social responsibility is therefore fundamental to be considered and integrated in business decisions if the goal is shareholders' wealth maximization and, consequently, management should act on behalf of both – stakeholders and capital providers (Aras and Crowther, 2007).

The practical implications of stakeholder theory are mainly two:

- a positive sustainability performance reduces a firm's intrinsic risk, and finally CoE (Li and Foo, 2015).
- there are a growing number of socially responsible investors who invest in shares from sustainable firms (Kapstein, 2001).

In this sense, the relation between cost of equity and business sustainability is negative according to most studies in the field.

Starting from the first argument, it lies on the investor perception that sustainability directly decreases firm' risk. Corporate social responsibility enables firms to reduce the probability and cost of adverse events in the form of social and/or environmental crisis implying higher cash outflows such as costly government-imposed fines and clean-up costs. By avoiding those future negative cash flows, ESG commitment reduces firm's risk exposure (Godfrey, 2005; El Ghoul et al., 2011) and consequently will decrease its cost of equity capital, acting as a hedging device. Accordingly, as per Salvi et al. (2018), CSR practices have the potential to create a type of goodwill or moral capital for more sustainable firms that acts as protection when negative events occur, preserving shareholder value and reducing the firms' cost of equity.

Among the related stream of research that explores the link between sustainability and firm risk, on one hand Boutin-Dufresne and Savaria (2004) and Lee and Faff (2009) document that low-CSR firms exhibit significantly higher idiosyncratic risk, while on the other Albuquerque et al. (2013) document that low-CSR firms have higher systematic risk.

Consistently with the former, Sharfman and Fernando (2008) show that the higher the level of environmental risk management, the lower the firm's systematic risk (the *Beta*) and, therefore, the lower the cost of equity. As the firm lowers its systematic risk profile through improved environmental risk management, it experiences less volatility in its performance, and the authors argue that the market appears to reward such behavior with lower costs of equity capital.

Furthermore, Sassen et al. (2016) study the effect of CSR on firm's total, systematic and idiosyncratic risk for a large European panel dataset. They find that on one hand the aggregate ESG score does not affect firm's systematic risk; on the other the higher the aggregate score, the lower the total and idiosyncratic risk. Therefore, they argue that, although an effective ESG risk-management strategy might increase a company's flexibility to deal with broad economic downturns (Sharfman and Fernando, 2008) and thereby lower a company's systematic risk, systematic risk is driven more by industry-specific than by firm-specific characteristics.

The second argument derived from stakeholder theory stipulates that socially conscious investors will avoid stocks of firms with poor CSR and, as a result, their shareholder base will be reduced (Sharfman and Fernando, 2008, Hong et al., 2009, El Ghoul et al., 2011). This reduction translates in a limited risk sharing opportunities and, therefore, lower stock prices and higher cost of equity capital.

Indeed, the capital market equilibrium model theorized by Merton (1987) implies that increasing the relative size of a firm's investor base will result in lower cost of capital and higher market value for the firm. In a similar vein, as demonstrated by Heinkel et al. (2001), when fewer investors hold the stock of a firm, the opportunities for risk diversification are reduced and hence the firm's cost of capital will be higher.

Sharfman and Fernando, (2008) were able to confirm that firms with more dispersion in the number of shareholders experienced lower costs of equity capital, and that improved environmental risk management increases the dispersion of shares as more individual investors wish to acquire the stock of less environmentally risky firms.

Michaels and Gruning (2017) indicate that German firms publishing CSR reports take benefit from additional capital sources and lower their Cost of Equity. Similarly, El Ghoul et al. (2011) find that, for a large sample of US firms, low CSR firms tend to have a smaller investors base due to investor preferences and information asymmetry.

Moving to the second theory supporting the existence of a negative relation between business sustainability and the cost of equity capital, *Agency Theory* (Jensen and Meckling, 1976) prescribes that disclosure of financial and non-financial information diminishes information asymmetries, thus eliminating the “principal–agent problem” (Healy and Palepu, 2001) between principals (equity capital providers) and agents (management), since the latter may act according to their “economic self-interest”, possibly expropriating the firm’s assets against the shareholders’ interest because of misuse of private information.

As per Akpinar et al. (2008), a high sustainability performance signals the quality of management to investors, and as such it decreases monitoring and auditing costs. Indeed, due to information asymmetry between stakeholders and the firm’s management, gathering reliable information and verifying whether management activities are aligned with the interest of stakeholders is costly. In this context, a good sustainability performance may signal the quality of management to investors, and as such decrease transaction costs. In this sense, a high (low) sustainability performance may decrease (increase) the required risk premium for holding the company’s stock and, in turn, decrease (increase) the firm’s cost of equity.

Subsequent contributions, as per Cho et al. (2013), find that both positive and negative CSR performance reduce information asymmetry. Moreover, the authors find that the influence of negative CSR performance is much stronger than that of positive CSR performance in reducing information asymmetry. Similarly, Cui et al. (2018) confirm the inverse association between CSR engagement information asymmetry for an extensive U.S. sample, after controlling for various firm characteristics.

Cajias et al. (2014) also investigate the impact of CSR ratings of US firms on their cost of capital for the period, 2003–2010. Involvement in CSR lowers a firm’s information asymmetry. Finally, in a multi-country study, El Ghoul et al. (2018) prove that disclosing and enhancing corporate environmental responsibility decreases CoE.

The last theory supporting the existence of a negative relation between sustainability and CoE is *Legitimacy Theory*. The theory posits that companies continually seek to ensure that they operate within the bounds and norms of their respective societies, as they face different political and social pressures from various stakeholders (Jiménez and Zorio_Grima, 2020). As such, firms disclose ESG information to present a socially responsible image, so that society can accept the firm’s business practice.

Therefore, firms in controversial or sensitive industries, who often create negative externalities, are expected to disclose more detailed ESG information and pose particular effort in achieving a high sustainability performance in order to legitimize themselves and, in turn, reduce their cost of equity capital (Li et al., 2017; Martìnez-Ferrero and Garcìa-Sànchez, 2017; Michaels and Gruning, 2017; Weber, 2018).

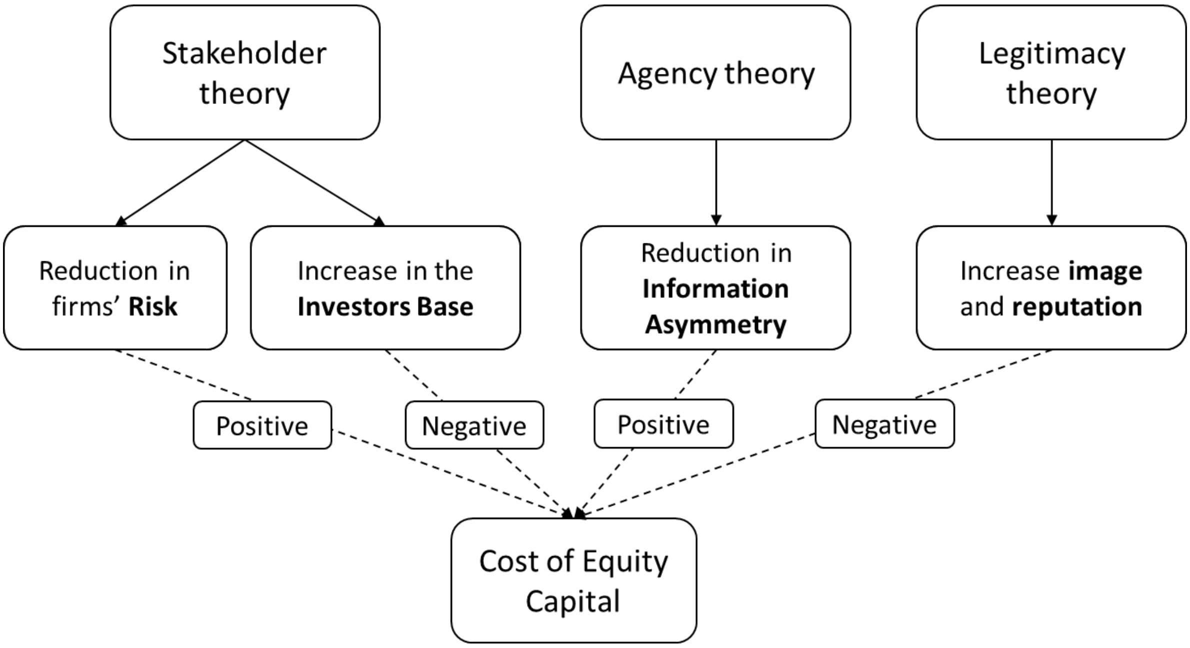


Figure 21 – Theoretical Framework and the effects of a positive sustainability performance on the cost of equity capital (dotted arrows).
Source: Jiménez and Zorio-Grima (2020) and own elaborations.

Figure 21 summarizes the main arguments part of the abovementioned theoretical framework. The effects of sustainability on the cost of equity are to be interpreted in the following way:

- the higher the firm's risk, the higher its CoE (positive relation);
- the bigger a firm's investors base, the lower its CoE (negative relation);
- the higher a firm's information asymmetry, the higher its CoE (positive relation);
- the better a firm's image and reputation, the lower its CoE (negative relation).

3.2. Research Questions

RQ_1 and RQ_2: the relation between sustainability and the cost of equity

To summarize, the literature supporting the hypothesis of a relation between sustainability and the cost of equity capital relies mainly on four arguments.

The first argument, derived from Agency theory, suggests that a high sustainability performance reduces asymmetric information. Other two arguments, derived from Stakeholder theory, lie on the investor perception that sustainability directly decreases firm' risk and that socially conscious investors will avoid stocks of firms with poor CSR and, as a result, their shareholder base will be reduced.

Lastly, according to Legitimacy theory, firms aim at achieving a high ESG performance in order to legitimize themselves and improve their image among stakeholders.

These arguments taken together support existence of a negative relationship between sustainability and the cost of equity capital, i.e., *ceteris paribus*, the higher (lower) the sustainability performance of a firm, the lower (higher) its cost of equity capital.

The first research question of the thesis aims at investigating exactly this topic, and takes the following form:

RQ_1: *Is sustainability negatively related with the cost of equity capital?*

Due to some methodological constraints that will be discussed in the next chapter, a differentiation will be made between developed and emerging countries. Thus, the first research question can be rephrased as follows:

RQ_{1_a}: *Is sustainability negatively related with the cost of equity capital in developed countries?*

RQ_{1_b}: *Is sustainability negatively related with the cost of equity capital in emerging countries?*

Besides some studies that found a positive (Richardson and Welker, 2001) or non-conclusive relationship (Humphrey et al. 2012; Eom and Nam, 2017; Suto and Takehara, 2017) between business sustainability and CoE, most academic studies prove a negative link in Anglo-Saxon countries (Sharfman and Fernando, 2008; El Ghoul et al., 2011; Dhaliwal et al., 2011; Ng and Razaee, 2015; Weber, 2018; Hmaittane et al., 2019), Asian countries (Xu et al., 2015; Li and Foo, 2015; Li and Liu, 2018) and multi-country studies with samples including developed and emerging countries (Feng et al., 2015; Martinez-Ferrero and Garcia-Sanchez, 2017; El Ghoul et al., 2018; Gupta, 2018).

Feng et al. (2015) find that CSR disclosure decrease the firm's CoE in North America and Europe yet with no effect in Asia. The authors argue that the concept of CSR has advanced in the USA and Europe, where it has been perceived positively by the public and managers; whereas, in Asia, CoE rises when CSR scores of firms increase. Efforts to improve CSR performance are not valued by the managers as they are perceived to be costly and gather less favorable response from the market.

Among the studies focusing on the United States of America, besides the already cited studies that find a negative relation between CoE and sustainability (Sharfman and Fernando, 2008; El Ghoul et al., 2011); Ng and Rezaee (2015) explore the issue for a sample with over 3000 firms from 1990 to 2013. Using a summary measure of ESG sustainability, the authors found a significant negative relationship between ESG and the cost of equity.
Furthermore, Hmaittane et al. (2019), using MSCI ESG STATS (KLD) as a proxy for sustainability performance, found a negative relation between the ex-ante cost of equity capital and sustainability for firms belonging to controversial industry sectors (alcohol, tobacco, gambling, military, firearms, nuclear power, oil and gas, cement and biotechnology) during the period 1991-2012.

Regarding Europe, there are few studies examining this research question at an aggregate level. One of those is Sassen et al. (2016), which investigate the relation between risk and sustainability for a panel of European firms. Rather, different studies focus on specific countries; for instance Humphrey et al. (2012) examine firms from the United Kingdom; Reverte et al. (2012) focus on Spanish listed firms and Michaels and Gruning (2017) on German firms.
Results are mixed, Humphrey et al. (2012) find no difference in the risk-adjusted performance of high sustainability performing firms and low performing ones, Sassen et al. (2016) found that sustainability performance does not affect systematic risk, and in turn CoE; Reverte et al. (2012) find instead that there is a negative relation between CSR and cost of

equity capital and Michaels and Gruning (2017) indicate that German firms publishing CSR reports take benefit from additional capital sources and lower their CoE.

Regarding Asia, Li and Liu (2018) demonstrate that greater CSR quality disclosures from sensitive industry firms listed in China diminish CoE.
Chen et al. (2020) study the relation for Taiwanese firms with results showing that strong CSR performers outperform poor CSR performers.
On the contrary, Suto and Takehara (2017) cannot evidence a significant relation between CoE and corporate social performance from Japanese listed firms.
Lastly, in Asia, Dahiya and Singh (2020) confirm the correlation between CoE and ESG proxies considering Indian manufacturing firms.

It is worth noting that most of the academic studies explored the relation between sustainability and CoE using an ex-ante implied cost of capital (ICC) measure, with few exceptions employing asset-pricing models to obtain a proxy of CoE (Sharfman and Fernando, 2008; Humphrey et al., 2012; Suto and Takehara, 2017).

Driven by the availability of the Fama and French factors for specific countries, this thesis aims at further exploring whether, withing the world's main economic areas – United States, Europe, and China – the relation between sustainability and CoE is different in terms of magnitude and/or significance.

Therefore, the second research question takes the following form:

$\boldsymbol{RQ_2}$**:** *Is the relation negative and significant for firms operating in different geographic areas (US, Europe and China)?*

RQ_3: *the impact of each ESG Pillar on the Cost of Equity*

Next, this thesis would disaggregate the overall ESG measure in its components and investigate if all of the ESG pillar have an effect on the cost of equity or, rather, the effect of one pillar is dominant in respect to the other.

In the academic literature, the *Environmental* pillar has been the most studied among the ESG pillars. Among the research that investigate a relationship between environmental sustainability and the cost of equity, different proxy for environmental sustainability of business firms have been used; examples of a non-complete list of proxies used are:

a) firm's emission intensity or carbon footprint (Kim et al., 2015; Bui et al., 2020);
b) environmental scores provided by rating agencies such as KLD, owned by MSCI (Sharfman and Fernando, 2008), Thomson Reuters Asset4 (Gupta, 2015; Sassen et al., 2016), and S&P Global (El Ghoul et al., 2018).

Regarding the former class, researchers find emission intensity to be positively related with the CoE, i.e., the higher the emission intensity of a firm, the higher its cost of equity. Moreover, the intensity is found to grow larger in high emitting industries, consistently with the aforementioned theoretical framework.

Regarding the latter class, researchers mostly find a negative relation between the environmental sustainability score and the cost of equity capital, with Gupta (2015) finding for example that firms can reduce the cost of equity by 0.77% if they move from bottom 25% to the top 25% in their environmental score.
A notable exception is provided by Sassen et al., (2016), who find that environmental performance generally decreases idiosyncratic risk, whereas it has a negative effect on total and systematic risk only in environmentally sensitive industries. Therefore, by not impacting systematic risk, it should not have an impact on CoE.

Regarding the *Social* pillar, Sassen et al., (2016) find that a firm's social performance decreases its idiosyncratic, systematic, and total risk and thus it should be negatively related with the cost of equity.

Ng and Rezaee (2015) argue that only environmental and governance sustainability performance reduce the cost of equity, while social sustainability are not significantly related to the cost of equity capital. The authors argue that the result is probably explained by the more direct relationship of these dimensions on risk reduction and financial performance.

Finally, as far as the *Governance* pillar is concerned, empirical evidence is mixed; with Sassen et al., (2016) being unable to detect significant effects for corporate governance performance on a firm's risk; while other studies (Ashbaugh et al., 2004; Chen et al., 2009; Pham et al., 2012) find that firms with strong corporate governance mechanisms are associated with a reduction in perceived risk and asymmetry of information of the firm, thereby decreasing their cost of equity capital.

The third research question of the thesis aims at investigating whether a negative relation between the pillars and the cost of equity capital exists and if the relation is mutually exclusive when the three dimension are considered together.

Therefore, the third research question takes the form:

$\boldsymbol{RQ_3}$: Is each of the three ESG pillar (i.e., Environmental, Social and Governance) negatively correlated with the cost of equity capital?
Is the correlation mutually exclusive?

RQ_4: the relation in different sectors

The last research question this thesis aims to answer is whether there are differences in the correlation between sustainability and CoE across different sectors. This issue has been explored in the existing literature mainly for the so-called "controversial industries", defined by Cai et al., (2012) as those sectors "which are typically characterized by social taboos, moral debates, and political pressures, including sinful industries, such as tobacco, gambling, alcohol, and adult entertainment as well as industries involved with emerging environmental, social, or ethical issues, i.e., weapons, nuclear, oil, cement, and biotech".

Referring to the previously developed theoretical framework, *Legitimacy theory* provides the best argument to explain why sensitive companies known as "sin firms" benefit more than "normal" firms, in terms of CoE reduction, from a positive ESG performance. According to the theory, organizations are categorized as legitimate when audiences perceive them as institutions defending social principles and values and not just private firms' interests. In this sense, disclosing additional CSR information or posting a good sustainability performance serves to improve a firm's image and reputation (Weber, 2018) and consequently reduce its CoE (Li et al., 2017; Michaels and Gruning, 2017).
As El Ghoul et al. (2011) show, participation in two ''sin'' industries, namely, tobacco and nuclear power, increases firms' cost of equity, supporting the argument that involvement in unethical industries (characterized tough by a weak overall ESG profile) harms shareholders' wealth. Also, Cajias et al. (2014) show that firms' CSR strategies differ significantly across industry sectors, with customer-orientated companies such as telecommunications and automobile outperform asset-driven sectors such as real estate or chemical companies.

Furthermore, according to Kim et al. (2015), the positive relationship between carbon intensity and the cost of equity capital, grows stronger for firms in low carbon-emitting industries. Similarly, Reverte (2012) argues that the negative relationship between sustainability and the cost of equity capital is more pronounced for those firms operating in environmentally sensitive industries[1].

Finally, Hmaittane et al., (2019) find that CSR engagement significantly reduces the implied cost of equity capital in all controversial industry sectors, taken as a group, as well as in each one of these sectors individually.

By following the "Refinitiv Business Classification" and aggregating industries at a higher level – thus in the thirteen available business sectors, this thesis aims at investigating first if there are differences in the relation between sustainability and the cost of equity among different sectors[2]. Expecting significant differences in the relationship among sectors consistently with the above cited literature, the second step of this research question is to further explore whether there are structural differences that lead to different betas among sectors.

Therefore, the fourth research question takes the following form:

$\boldsymbol{RQ_{4\_a}}$**:** *Is the relation between sustainability and the cost of equity capital different among sectors?*

Finally, expecting to find differences in the relationship across sectors, the thesis wants to further explore whether there are structural differences that lead to different betas among sectors. The proposed structural differences to test are based on (a) the variability and (b) the stability over time of the ESG score within each sector. In conclusion, the fourth research question can be further developed, and takes the following form:

$\boldsymbol{RQ_{4\_b}}$**:** *Are there structural differences, related to the variability of the ESG score, that lead to a different effect of sustainability on the cost of equity capital?*

[1] Based on prior literature, the 'more sensitive' sectors identified are: mining, oil and gas, chemicals, forestry and paper, steel and other metals, electricity, gas distribution, and water.

[2] Basic Materials, Consumer Cyclicals, Consumer non-Cyclicals, Energy, Financials, Healthcare, Industrials, Real Estate, Technology and Utilities.

Author(s)	Years Covered	Sample	Countries	CoE proxy	ESG Proxy	Relation Found
Richardson and Welker (2001)	1990–1992	324 firm-year obs.	Canada	ICC	SMAC/UQAM CSR performance ratings	Positive
Sharfman and Fernando (2008)	2001	267 firm-year obs.	USA	CAPM	E performance from MSCI ESG STATS (KLD) database.	Negative
Dhaliwal et al. (2011)	1993–2007	294 firms	USA	ICC	Standalone CSR reports and MSCI ESG STATS (KLD) database.	Negative
El Ghoul et al. (2011)	1992–2007	12’915 firm-year obs.	USA	ICC	MSCI ESG STATS (KLD) database.	Negative
Reverte (2012)	2003–2008	114 firm-year obs.	Spain	ICC	ESG ratings provided by OCSR	Negative
Humphrey et al. (2012)	2002–2010	256 firms	UK	Three-factor model plus momentum	ESG score from SAM database, now S&P Global	Non-conclusive
Cajias et al. (2014)	2003–2010	2’300 firms	USA	ICC	MSCI ESG STATS (KLD) database.	Negative

Table 11 – Summary Literature Review (1/3)

Author(s)	Years Covered	Sample	Countries	CoE proxy	ESG Proxy	Relation Found
Feng et al. (2015)	2002–2010	10’803 firm-year obs.	25 countries (North America, Europe, Asia)	ICC	Thomson Reuters ASSET4 database	Negative in North America and Europe. No-effect in Asia.
Ng and Rezaee (2015)	1990–2013	3000 firms	USA	ICC	MSCI ESG STATS (KLD) database.	Negative
Kim et al. (2015)	2007–2011	379 firm-year obs.	South Korea	ICC	Greenhouse Gas Emissions (GHG) divided by sales.	Positive
Li and Foo (2015)	2008–2012	1335 listed firms	China	ICC	CSR report quality scores from the HEXUN Web site.	Negative
Gupta (2015)	2002–2012	23’301 firm-year obs.	43 countries	ICC	E score from Thomson Reuters ASSET4 database.	Negative
Sassen et al. (2016)	2002–2014	8’752 firm-year obs.	Europe	Systematic Risk	ESG score from Thomson Reuters ASSET4 database.	Effect of E only in environmentally sensitive industries; strong effect of S; no effect of G.

Table 12 – Summary Literature Review (2/3)

Author(s)	**Years Covered**	**Sample**	**Countries**	**CoE proxy**	**ESG Proxy**	**Relation Found**
Suto and Takehara (2017)	2008–2013	3’556 firm-year obs.	Japan	Three-factor model	CSR questionnaire survey sent to all listed firms in Japanese capital markets.	Non-conclusive
Li et al. (2017)	2009–2014	161 firms	China	ICC	Carbon information disclosure	Negative
Michaels and Gruning (2017)	2013–2014	264 firms	Germany	ICC	CSR scores based on artificial intelligence	Negative
El Ghoul et al. (2018)	2002–2011	7’122 firm-year obs.	30 countries	ICC	E performance proxied as E costs divided by total assets. Data from S&P.	Negative
Weber (2018)	2005–2013	260 firms	USA	ICC	CSR reports based on GRI levels.	Negative
Hmaittane et al. (2019)	1991–2012	2’006 firms	USA	ICC	MSCI ESG STATS (KLD) database	Negative

Table 13 – Summary Literature Review (3/3)

4. DATA and METHODOLOGY

4.1 Sample and Datasets

To test the research questions developed in the previous section, this thesis relied on data retreived from the Refinitiv Eikon database and Prof. Kenneth French's data library.

The sample is formed by the companies included in the Refinitiv Global Index with a market capitalization higher than $ 100M, comprehending 12'089 companies from both developed and emerging countires. Among those companies, 6'639 had at least one ESG rating and were thus included in the final sample. Data are from the period 2010 to 2020 included, with a monthly frequency of observations, resulting thus in 132 months of observations for the period. As a result, the sample is made by 558'210 monthly observations for 6'639 different firms.

The monthly frequency of observations was determined after facing a trade-off between (a)size of the panel data and (b) methodological and statistical requirements. In fact, the time-series regressions employed in the thesis require the highest frequency of observation possible. Hovewer, opting for weekly or even daily observations would have increased the size of the dataset exponentially. On the oher side, a monthly frequency of observation is to be prefered to a yearly one; therefore a monthly frequency of observation was choosen.

To test the research questions, for each company in the sample the following data were retrieved from the Refinitiv Eikon database: firms' stock prices; the ESG combined score; the firm's economic sector, industry group, market capitalization and the primary country of risk.

Stock prices represent the price each stock closed the trading day on the first day of each month (eg., the price Apple shares closed on 01/01/2020). Note that, in order to calculate a stock's monthly returns for the 132 months considered, data about one more month were downloaded, *i.e.* january 2021, for a total of 133 monthly observations for stock prices.

Simple monthly returns are calculated trough the following formula:

$$Returns = \left(\frac{P_t}{P_{t-1}} - 1\right) * 100 \qquad (38)$$

The economic sector and industry group are from the TRBC industry classification. The classification has three levels of granularity, comprehending 13 economic sectors, 29 business sectors and 58 industry groups. Each firm's economic sector and industry group were downloaded as both will be useful for the empirical part of the study. In fact, economic sector represent the the highest level of aggregation among the industry classification, while the industry group level is the level at which ESG scores are standardized.

The primary country of risk is instead determined by Refinitiv using four sources of data, which are, in order of importance: revenue distribution by geography, the location of a company's headquarters, the country where its primary equity security listing trades, and financial reporting currency. The model provides estimates on the countries to which a company is exposed, and estimates a fractional contribution to each. The fraction is a value between 0 and 1, where a higher value indicates the company has higher exposure to the country. The primary country of risk is the country with the largest contribution.

Finally, the Fama and French factors were downloaded from Professor's Kenneth French data library. The monthly factor downloaded were the market factor (Mkt), SMB, HML, RMW, CMA and the monthly risk-free rate on the US treasury.
Note that all the portfolio returns forming the factors are calculated in dollar terms, which raises the issue of exchange rates affecting the returns of non-US firms. As an example, think of an emerging market company posting a very positive monthly return in its own currency; if during the same time the emerging market currency has weakened against the dollar, the resulting stock performance would be less positive if taken in dollar-terms.

For a summary of the variables employed in the thesis, refer to *Table 14.*

Variable	Definition	Source
Prices	Stock price at the end of the last trading day of the month.	Refinitiv Eikon database
Returns	Monthly stock returns.	Own calculations; equation (38)
$ESGC_{score}$	ESG combined score.	Refinitiv Eikon database
Sector	Economic sector the firm belongs to according to the TRBC classification.	Refinitiv Eikon database
Industry Group	Industry group the firm belongs to according to the TRBC classification.	Refinitiv Eikon database
Market Cap.	Market capitalization of the firm (price times shares outstanding) at the balance sheet's closing date.	Refinitiv Eikon database
Primary Country of Risk	Country to which the company is most exposed to.	Refinitiv Eikon database
Mkt	Additional expected return of the market portfolio over the risk-free rate	Prof. French's database
SMB	Size factor; difference between the returns of small stocks and big stocks.	Prof. French's database
HML	Value factor; difference between the returns of value stocks and growth stocks.	Prof. French's database
RMW	Profitability factor; difference between the returns of firms with robust profitability and firms with weak profitability.	Prof. French's database
CMA	Investment factor; difference between the returns of firms with conservative investments minus firms with an aggressive one.	Prof. French's database
RF	US one month T-bill rate.	Prof. French's database

Table 14 – Variables Definition

4.2 Measures

4.2.1 Measure of Sustainability

For the purpose of measuring sustainability, the options analyzed in the chapter "*Literature Review*" are: (a) ESG indexes, (b) ESG rankings and (c) ESG ratings.

Due to scope limitations, ESG rankings and indexes are not best suited for the purpose of measuring sustainability in the context of this thesis. In fact, indexes and rankings provide a measure of sustainability just for a subset of firms – the firms included in the final index or ranking. As a matter of fact, they are mainly intended as tools to signal the quality of the sustainability performance of a specific firm, and do not provide a synthetic measure for a multitude of firms. On the contrary, ESG Ratings are available for a large number of small and big firms, offering a synthetic measure for the overall ESG performance. As such, they are the best suited measure of the overall firm's sustainability performance.

The main limitation in using ESG rating as a proxy for sustainability is that, as there is not a standardized way to evaluate the sustainability performance of business firms, agencies differ in the practical implementation of the ESG concept (Chatterji et al., 2015; Dorfleitner et al., 2015). The sources of divergence in fact, as identified by Berg et al. (2019), are mainly (a) the scope, i.e., the difference in the factors considered, (b) the weight of factors and (c) the measurement divergence, i.e., when different agencies measure the same factor differently.

The divergence in the evaluation in the performance of a firm between different rating agencies makes the empirical results of the thesis strongly reliant on the ESG rating used. However, as per Jiménez et al. (2021), "this proxy is commonly used as good proxy for the level of sustainable behavior or activities of the company", with the most widely used databases being MSCI ESG STATS (KLD), Thomson Reuters ASSET4 and S&P Global (SAM).

In particular, this master thesis will rely on the data provided by Refinitiv/Thomson Reuters Eikon, following many other studies in the field (as Ioannou and Serafeim 2012; Mackenzie et al. 2013; Cheng et al. 2014; Eccles et al. 2014; Feng et al., 2015; Gupta, 2015; Sassen et al., 2016; Giudici, 2018).

Thus, the synthetic measures of sustainability available on the Refinitiv Eikon database are: (a) the simple ESG score and (b) the ESG combined score (ESGC).

The simple ESG score is the result of the weighted average of the three pillar scores (E, S and G). The scores are based on relative performance of ESG factors with (a) the company's sector, for environmental and social, as these topics are more relevant and material to companies within the same industries and (b) country of incorporation, for governance, as best governance practices are more consistent within countries.

The ESGC score instead, overlays the ESG score with ESG controversies (23 controversies) to provide a comprehensive evaluation of the company's sustainability impact and conduct over time. The intent is to discount the ESG performance score based on involvement in non-ethical behavior. When the controversy score is below the ESG score, the ESGC score is the average of the ESG score and the controversy factor. Otherwise, the ESGC score equals the ESG score.

The score selected as a measure of sustainability has been the ESG combined score. Although the score is more volatile based on the high potential discount on the final score because of controversies, it accounts for relevant issues when considering the sustainability performance of a company, i.e. controversies. In fact, as the argument about the relation between sustainability and the cost of equity relies on the perception shareholders have about the riskiness of the company and the ability of its management, controversies play a crucial role, as less investors will be willing to hold shares in companies involved in controversies.

Finally, it is worth noting that, while using the Refinitiv ESG combined score, a percentile rank score is calculated at the industry group level, based on the relative performance of the company within the group. Therefore, the scores should not be compared among different industry groups.

4.2.2 Measure of the Cost of Equity Capital

As extensively discussed in the chapter "*Literature Review*", there are two main classes of measures for the cost of equity capital, namely (a) the asset pricing models and (b) the implied cost of capital measures.

The former are estimates of the expected rate of return demanded by shareholders based on a multitude of risk factors and their sensitivity (the β's).

Instead, the implied cost of equity capital is the internal rate of return that equates a firm's forecasted cash-flows to its current market price.

Most of the research exploring the relation between sustainability and the cost of equity has relied on the implied cost of capital models, see *Tables 11, 12, and 13* in chapter 3, "*Theoretical Background and Research Questions*".

Reverte (2012) argues that the CoE obtained with ex-ante models is a better proxy than ex-post realized stock returns., since it is more reliant on cross-sectional variation amongst the companies, and it does not need long-time series to be robust.

Also, Gupta (2015) supports the use of ex-ante models arguing that they can account for unexpected news on cash flow or a firm's fundamentals, which obviously cannot be not depicted in ex-post measures.

The present study, however, uses the Fama and French Five-factor model to explain the variation in the cost of equity capital, relying though on an ex-post measure among the asset-pricing models. The decision was taken based on two main arguments, being (a) the availability of newly proposed factors (CMA and RMW) that provide a better estimation for expected returns, thus improving the explanatory power of asset-pricing models and (b) some important limitations recognized among the ICC models.

In fact, an important characteristic of the implied cost of capital measures is their reliance on analysts' earnings forecasts. However, several studies have shown that analysts are biased in their forecasts, suffering from optimism (Kothari, 2001; Easton, 2007), and that, at the firm-level, the forecast error in huge.

Indeed, Collins and Hopwood (1980) and Brown and Rozeff (2006) have tested earnings forecasts provided by Value Line, one of the most renewed provider of earnings forecasts data, and found that analyst's error in forecasting next quarter earnings per share was respectively 31.7% and 28.4%. Additionally, they found that forecasts tended to be highly correlated across analysts.

Another very relevant aspect to consider is the availability of those forecast for small firms. Most often small firms have no analyst coverage and thus their earnings forecasts are not available. As a consequence, using analyst earnings forecasts to obtain an estimate of the implied cost of capital may create a bias in the sample, as only larger firms, which are typically covered by a higher number of analysts, will be included.

To the best of my knowledge, no study has been done using the more recent Fama and French five-factor model as a measure of the cost of equity capital. Sharfman and Fernando (2008) explore the relation by employing the CAPM, Humphrey et. al, (2012) employ the Four-factor model, while Suto and Takehara (2017) employ the Three-factor model.
Additionally, those studies are dated and thus do not include the more recent data representing the booming period of ESG investing, which may have had an important effect on the investigated relationship between sustainability and the cost of equity capital.

Although there are other factor models that have been demonstrated to explain realized returns better that the Fama and French models (e.g., the q-factor model), factors availability played an important role in the selection of the best measure for the cost of equity. The q-factors are in fact available only for the US market, thus hindering the possibility of determining if the relation exists at a global level. On the other hand, the Fama and French factors are available for a multitude of geographic areas. Examples of the those are: developed countries, developed ex-US, North America, United States of America, Europe, Japan, emerging countries, Asia Pacific and Asia Pacific ex-Japan.

Among the Fama and French models instead, although the six-factor model has been the best performing one, the momentum factor is somehow controversial since it does not capture a type of risk a firm faces and is not link with a firm's risk characteristic.
In conclusion, the Fama and French five-factor model will be used in the context of this thesis, with expected excess returns serving as a proxy of the cost of equity capital.

4.3 Empirical Models

In this research, a multiple linear regression model was used to study the relationship between dependent variable (realized excess returns, a proxy for the cost of equity capital) and several independent variables (the FF five factors and the firm's ESG combined score). The generic form of the linear regression model is the following one:

$$y_i = \alpha + \beta_1 * x_{i1} + \beta_2 * x_{i2} + \cdots + \beta_n * x_{in} + \varepsilon_i \tag{39}$$

Where y is the dependent or explained variable, $x_1,\ldots, x_n$ are the independent or explanatory variables, $\beta_1,\ldots,$ β_n are the coefficients of the independent variables, the subscript *i* represents the month, α is the constant term and ε is the error term, which in the case of asset-pricing models should represent the firm's idiosyncratic risk.

The empirical analysis have been performed using the statistical software *R* and specifically the *plm*, *dplyr*, *dtplyr*, *corrplot*, and *apaTables* libraries.

RQ_1 *and* RQ_2*: the relation between sustainability and the cost of equity*

Specifically, in order to answer the first two research questions of this dissertation, the following relationship has been tested:

$$\begin{aligned}(Returns - RF) = {} & \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \\ & + \beta_5 * CMA + \beta_6 * ESGC_{score} + \varepsilon\end{aligned} \tag{40}$$

The model regresses monthly excess returns, calculated as the difference between a stock's monthly realized returns (*Returns*) and the monthly risk-free rate (*RF*), against the Fama and French five factors (i.e., the market factor *Mkt*, the size factor *SMB*, the value factor *HML*, the profitability factor *RMW* and the investment factor *CMA*) and the ESGC score.

The aim of the model is to explore whether the ESG combined score explains part of the variation of the cost of equity capital, proxied with the stock's excess returns.

In order to account for the standardization of ESG scores at the industry group level that makes those scores not comparable across industries, a fixed-effects regression has been run

by adding a within estimator representing industry groups. As such, the fixed-effects model allows for a different intercept (α) for each industry group.
Note that the results are equivalent to a regression model where a categorical variable representing the firm's industry group is added. The difference is just to be seen in the visualization of the results, which in the case of the latter model – the one that adds the categorical variables – will show each industry group contribution to the intercept, therefore displaying 54 more *betas* in the results. Using a within estimator instead will just show the effects of the five-factors and the ESG score. For this reason, the value of the intercept will not be displayed in the results.

Regarding the factors employed, RQ_{1_a} and RQ_{1_b} will employ, respectively, the developed and emerging countries factors (again, factor construction is provided in the *Appendix*). Instead, as far as RQ_2 is concerned, the factors employed are the United States, European and Emerging countries factors for the US, Europe and China respectively. Also, the three different partitions are obtained by filtering the initial panel dataset for those specific countries.

Then, in order to test robustness of the results, two slightly different relationship have been tested, being the (a) six-factor model, which augments the five-factor model by adding the momentum factor, and (b) the three-factor model, which employs just the market, size and value factors as explanatory variables.

Also, correlations among factors has been checked through the correlation matrix method. If some correlation among variables are found, then it means that the two variables associated cannot be put in the same model.
In the case of multicollinearity between a pair of variables in fact, small changes in data may produce wide swings in the parameter estimates, coefficients may have very high standard errors and low significance levels even though the R^2 of the regression may be high, coefficients may have the "wrong" sign, opposed to what expected, or improbable magnitudes. As a consequence, even if multicollinearity does not affect the value of R^2 (as already said, the model could still be statistically significant), it can affect the ability to interpret the effect of the single variables on the entire model (Brooks, 2014).

RQ_3: *the impact of each ESG Pillar on the Cost of Equity*

Moving to RQ_3, aiming at testing whether each ESG pillar taken singularly is correlated with CoE, two regression have been employed. The first model, equation (41), aims at capturing the contribution of each pillar separately, while the second, equation (42), aims at capturing the mutually exclusive effect of the singular E, S and G.

The first regression takes the following form:

$$(Return - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \\ + \beta_5 * CMA + \beta_6 * Pillar_{score} + \varepsilon \tag{41}$$

The second regression takes the following form:

$$(Return - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \\ + \beta_5 * CMA + \beta_6 * E_{score} + \beta_7 * S_{score} + \beta_8 * G_{score} + \varepsilon \tag{42}$$

Those relationships have been tested only for developed countries, since the result from the previous two research question indicate that the relation is significant only for those countries.

Again, a fixed-effects regression was run, with a within estimator representing the industry group. Pillar data were again retrieved from Refinitiv and, as such, are standardized across industry group. Worth noting is that the pillar score is not discounted for controversies as it is the case for the ESG combined score.

RQ_4: the relation in different sectors

Finally, RQ_{4_a} test the same relationship as for RQ_1 and RQ_2 – equation (40), but separately for each sector[3]. This means that, starting from the developed countries dataset, different subsets are created, each one representing a particular sector. Then, relation (40) is tested separately for each set of data.

To test RQ_{4_b}, the *betas* related to the ESG score obtained from RQ_{4_a} are mapped on a two dimension matrix, provided hereinafter in *Figure 22*. Those two dimensions are (a) stability over time, on the *x-axis* and (b) concentration, on the *y-axis*.

Stability over time follows a time-series approach and is calculated at the firm level trough the following two-step procedure:

1. For each firm, calculate the standard deviation of the ESGC score over time.
2. Calculate the average of the previously obtained standard deviations.

Concentration of the ESGC score follows a cross-sectional approach and is calculated within each sector trough the following two-step procedure:

1. For each year, calculate the standard deviation of the ESGC score across the companies that are part of the sector.
2. Calculate the average of the previously obtained standard deviations.

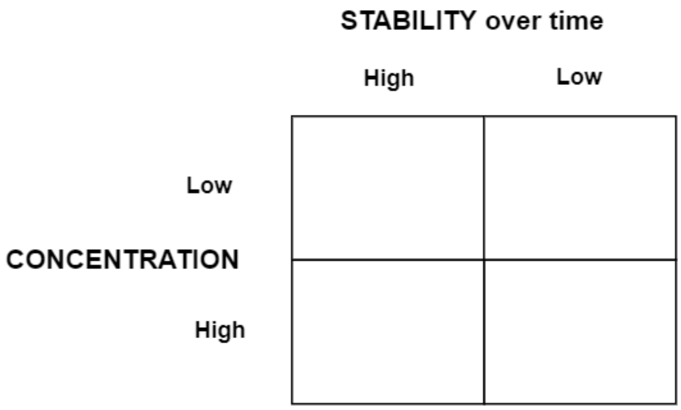


Figure 22 – RQ_{4_b} Matrix

[3] Basic Materials, Consumer Cyclicals, Consumer non-Cyclicals, Energy, Financials, Healthcare, Industrials, Real Estate, Technology and Utilities.

5. RESULTS

5.1 Descriptive Statistics

The starting dataset is a subset of all available listed firms comprehended in the Refinitiv Global Index, with a market capitalization higher than $ 100M and having at least one ESG rating for the period 2010 to 2020. This subset has a total of 558’210 monthly observations for 6’639 different firms.

Then, due to the already cited methodological constrains related to factors availability, the starting dataset is divided into two partitions. The first one comprehends firms whose primary country of risk is among developed countries, while the second comprehends firms whose primary country of risk is among emerging countries.
The first subset, representing developed countries, has a total of 419’918 monthly observations for 5’027 different firms, while the emerging countries subset has a total of 135’797 monthly observations for 1’612 different firms. Descriptive statistics for those partitions and the overall dataset are shown hereinafter.

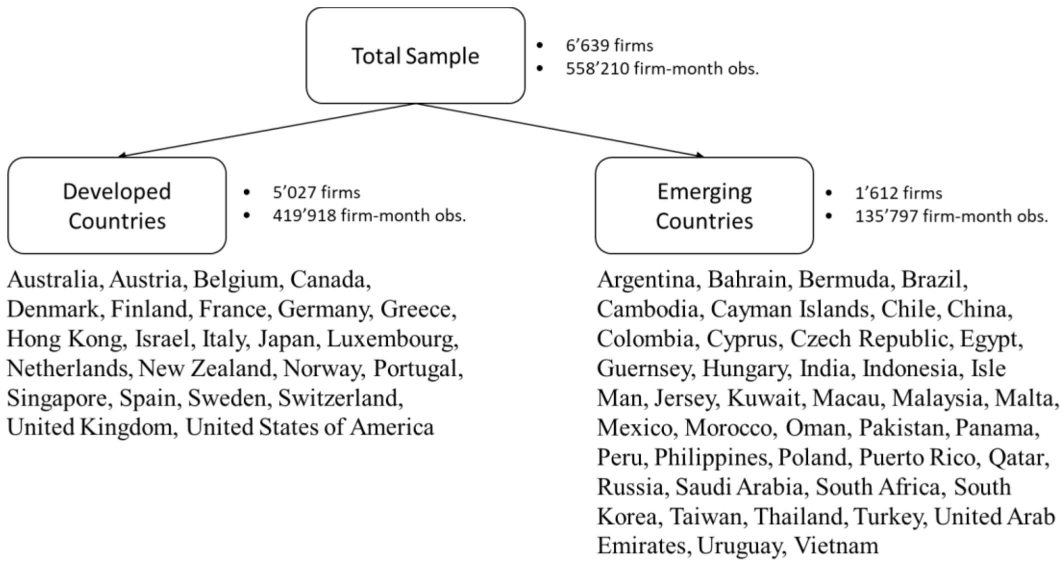


Figure 23 – Total Sample, Developed, and Emerging countries datasets

	Average	*Median*	*SD*	*Max.*	*Min.*
Market Cap	$20.3 B	$5.5 B	$75.7 B	$2’104 B	$0.108 B
ESG score	43.1	42.4	19.6	93.5	0.1
Monthly Realized Return	1.0%	0.67%	12.1%	484.8%	– 79.9%

Table 15 – Descriptive Statistics for the Overall Dataset

	Average	*Median*	*SD*	*Max.*	*Min.*
Market Cap	$22.0 B	$5.5 B	$83.6 B	$2’104 B	$0.108 B
ESG score	43.3	42.3	19.3	93.5	0.5
Monthly Realized Return	1.12%	0.83%	11.68%	484.8%	– 79.9%

Table 16 – Descriptive Statistics for the “Developed countries” Dataset

	Average	*Median*	*SD*	*Max.*	*Min.*
Market Cap	$14.7 B	$5.1 B	$43.1 B	$742 B	$0.116 B
ESG score	42.7	42.8	20.4	92.3	0.1
Monthly Realized Return	0.61%	0.14%	11.55%	243%	– 79.8%

Table 17 – Descriptive Statistics for the “Emerging countries” Dataset

As *Tables 18* and *19* show, only 11 among the 13 economic sectors are represented in the panel data; *Government Activity* and *Institutions, Associations and Organizations* are not represented. Also, each sector is well represented in the panel, except for the *Academic Services* sector, represented by very few different firms.

	Academic Services	*Basic Materials*	*Consumer Cyclicals*	*Consumer non-Cyclicals*	*Energy*	*Financials*
Developed Countries	11	421	739	304	234	615
Emerging Countries	6	174	200	164	102	314
Total	17	595	939	468	336	929

Table 18 – Nr. of Firms by Sector (1/2)

	Healthcare	*Industrials*	*Real Estate*	*Technology*	*Utilities*
Developed Countries	622	807	452	659	165
Emerging Countries	81	179	107	191	94
Total	703	986	559	850	259

Table 19 – Nr. of Firms by Sector (2/2)

Table 20 and *21* report, respectively, the descriptive statistics of the Fama and French factors for both developed and emerging countries.

	Average	***Median***	***SD***	***Max.***	***Min.***
Mkt	0.90	1.19	4.24	13.34	– 13.77
SMB	– 0.01	– 0.11	1.41	3.96	– 4.44
HML	– 0.41	– 0.51	2.05	4.39	– 9.30
RMW	0.28	0.32	1.15	2.73	– 2.77
CMA	– 0.11	– 0.22	1.11	2.75	– 3.18
RF	0.04	0.01	0.06	0.21	0

Table 20 – Descriptive Statistics; Developed Countries Factors

	Average	***Median***	***SD***	***Max.***	***Min.***
Mkt	0.62	0.69	5.05	12.15	– 17.09
SMB	– 0.05	– 0.08	1.44	4.19	– 3.36
HML	0.02	– 0.06	1.89	6.06	– 6.89
RMW	0.31	0.28	1.17	2.66	– 3.02
CMA	0.08	0.15	1.40	5.89	– 3.95
RF	0.04	0.01	0.06	0.21	0

Table 21 – Descriptive Statistics; Emerging Countries Factors

It is worth remarking that some considerations can be made on expectations about the factors' betas, given that the median market cap of the firms' monthly observations is quite low – $ 5.5B. In particular, I expect the beta of the market factor – which is the CAPM *Beta* – to be higher than 1, since small stocks tend to be riskier than the overall market. Also, I expect the sample to behave like small stocks and therefore the SMB factor's beta to be positive. Hypothesis on other factors' beta cannot be made on the basis of size.

Regarding the ESG combined score, used as a proxy for the overall sustainability performance, besides the descriptive statistics previously provided, the box plot of the ESGC score divided by sector is provided hereinafter.

It is worth highlighting that the median ESG combined score is not centred in 50 for most of the sectors, contrary to what one could expect given the standardization of the scores at the industry group level. This is due to the already cited controversy adjustment the "simple ESG score" is subject to, which has the potential only to decrease the final score.

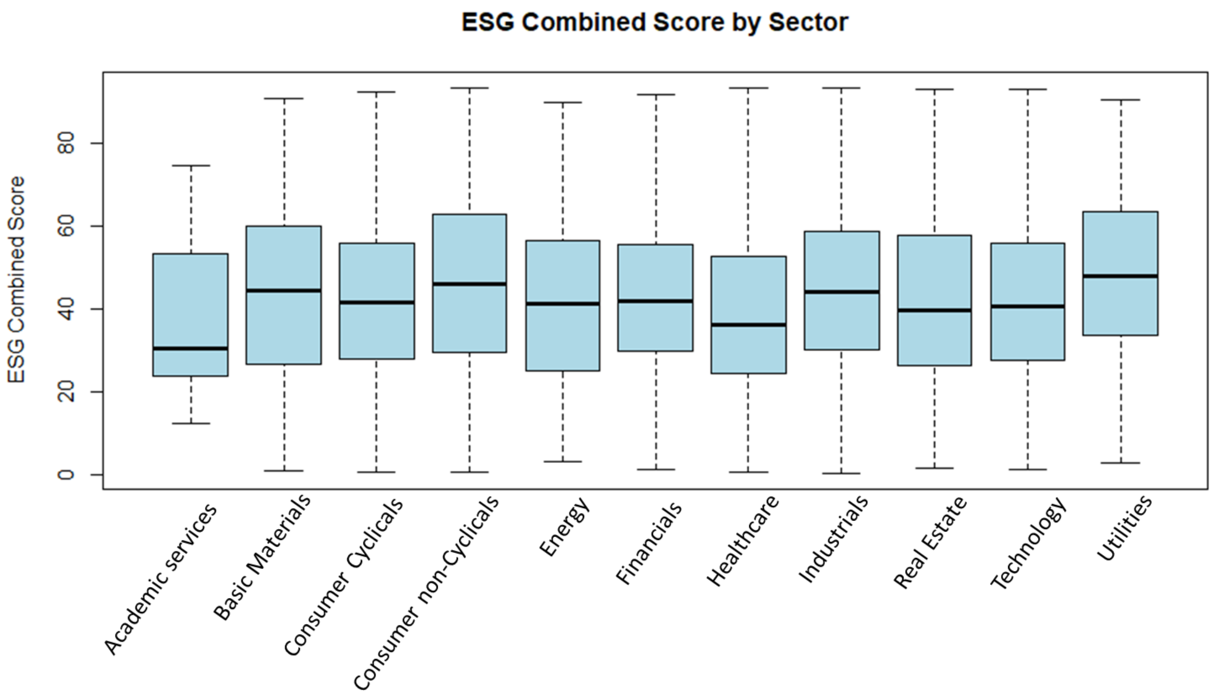


Figure 24 – Boxplot: ESG Combined Score by Sector; Developed Countries

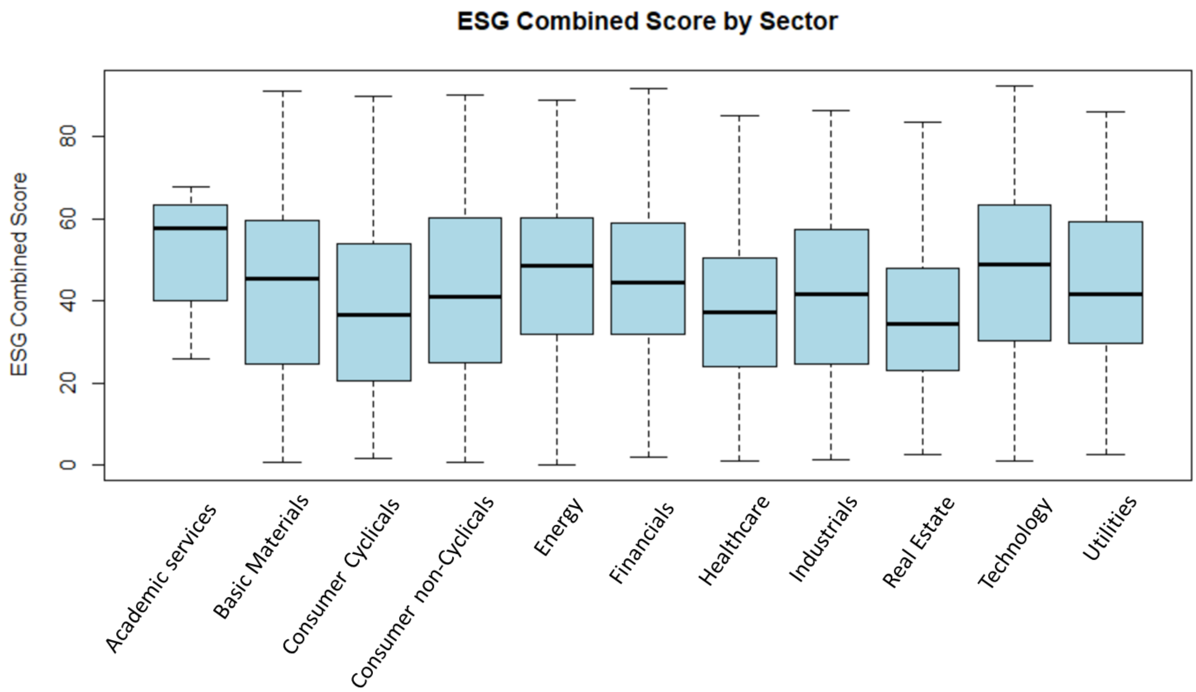


Figure 25 – Boxplot: ESG Combined Score by Sector; Emerging Countries

Finally, consistently with the increase in investors' focus over ESG issues, as *Table 22* shows, the number of firms with an ESG rating steadily increases over time. Therefore, the sample is an unbalanced panel, with a higher number of observations concentrated in the final years of the period.

	2010	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***	***2020***
Developed Countries	2142	2249	2310	2379	2455	2780	3436	3843	4195	4660	5027
Emerging Countries	465	770	864	906	967	1025	1093	1165	1290	1456	1612
Total	2607	3019	3174	3216	3422	3805	4529	5008	5485	6116	6639

Table 22 – Number of firms per year

5.2 Research Question 1

The purpose of the first research question is to test whether a relationship exists between a firm's overall sustainability performance and its cost of equity capital. The relationship is tested trough the equation (43), introduced in section "*4.3 Empirical Models*" and reported again hereinafter for the sake of convenience and clarity:

$$(Returns - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA + \beta_6 * ESGC_{score} + \varepsilon \qquad (43)$$

The model test whether a firm's realized returns in excess of the risk-free rate are linearly correlated with the ESG performance of the firm, controlling also for the correlation with the Fama and French five factors.

The datasets on which the relation is tested are partitions of the overall dataset and represent respectively developed and emerging countries. Descriptive statistics of those datasets are shown in the section "*5.1 Descriptive Statistics*".

Results of the empirical models are provided and then discussed hereinafter.

Developed Countries

Regarding the developed countries dataset, *Table 23* presents the multivariate regressions results.

A first analysis suggests that the p-value associated to the F-test is lower than $2.2e^{-16}$, therefore the model results statistically significant. Furthermore, R^2 is 0.2177, meaning that approximately 22% of the realized returns variability is accounted by the variables in the model. This consideration is sustained also by the adjusted R^2 value, equal to 0.2176. This last measure indicates that 22% of the variability of exit valuation is explained by the equation even after taking into account the number of predictor variables in the model.

Moving to the results of the regression model, the relationship between realized excess returns – proxy of the cost of capital – and the ESG combined score is negative and statistically significant, with a significance close to 100% (p-value $2.2e^{-16}$).

However, taken in absolute terms, the economic significance of the relationship is low. In fact, if a firm increases (decreases) its ESG score by one standard deviation (equal to 19.3 for the sample), its cost of equity capital would decrease (increase) by just 0.26%.

This result confirms the intuition derived from the theoretical framework underlying the research questions, prescribing a negative relation between a firm's cost of equity and its sustainability performance. Also, results are consistent with the findings of the majority of the studies on the subject in a multi-country setting (Feng et al., 2015; Gupta, 2015; El Ghoul et al., 2018).

Coefficients	**Estimate**	**t-value**	
Mkt	1.1465	289.21	***
SMB	0.5673	48.57	***
HML	0.2524	21.26	***
RMW	0.0562	3.19	**
CMA	– 0.2885	– 14.37	***
$\mathbf{ESGC_{score}}$	– 0.0135	– 16.13	***
Observations	419'918		
R^2	21.77%		
Adj. R^2	21.76%		
F-test	19'474.3		
p-value	$< 2.2e^{-16}$		

* p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 23 – Developed Countries Regression Results.

As a further consideration, think of a firm moving from an average sustainability performance – the ESG combined score being 43.3, falling in the C+ category – to being an "ESG leader" – ESGC score comprised between A- and A+, thus between 75 and 100. Such performance improvement could lead a company to decrease its cost of equity by a value between 0.43 and 0.77%.

Considering the low-interest rate environment we are currently living in, such a decrease could be not negligible, as the median cost of equity for US companies for instance is 5.55% (source: Damodaran). Under this light, the previous decrease of 0.43% to 0.77% would mean that the median company would be able to decrease its cost of capital by 8% to 14% by moving from "average" to ESG "leader".

Regarding control variables, consistently with expectations, the market factor's beta is higher than zero and, in particular, it is higher than one, meaning that the asset is riskier than the average market and thus its price fluctuations are amplified relative to the market portfolio. Also, the size factor's – SMB – beta is higher than zero.
These peculiarities are probably due to the prevalence of small firms in the sample (the median market capitalization being $5.5 billion), that causes the sample to be highly sensitive to the overall market portfolio movements – small stocks are riskier than the average firm – and therefore to behave like small stocks.

In fact, by running the same regression model on the same panel, however filtered in order to include just firms with a market capitalization higher than $10 billion, the market factor's beta drops very close to 1 (precisely *1.02*), and SMB's beta drops to *0.15*.
Even from this regression, the ESG combined score results to be negatively and significantly correlated with the cost of equity capital. Finally, it is worth noting that all the factors considered are strongly statistically significant.

Moving to the correlations among factors, it has been checked through the correlation matrix method, reported hereinafter in *Table 24*. Also, *Figure 26* provides a more graphical representation of the correlation matrix. The larger the bubble, the higher the correlation coefficient among the variables.

From the matrix, it is possible to conclude that multicollinearity is probably not an issue in this statistical regression. Indeed, as the correlation matrix reported in *Table 24* shows, all the coefficients result lower than the threshold set at *0.7*. However, correlations among the HML factor and both the RMW and CMA factors are quite high – *0.60* and *0.68* respectively. Nevertheless, this issue has been already anticipated by Fama and French (2014), who state that "with the addition of profitability and investment factors, the value factor of the FF three-factor model becomes redundant for describing average returns".

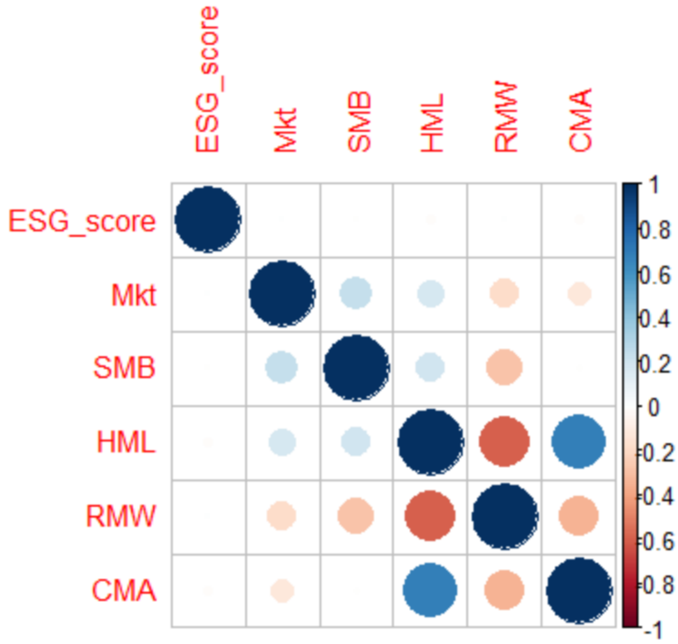


Figure 26 – Correlations among control variables.

Variable	1.	2.	3.	4.	5.
1. ESG_score					
2. Mkt	0.00				
3. SMB	– 0.00	0.24 (**)			
4. HML	– 0.02 (**)	0.17 (**)	0.19 (**)		
5. RMW	0.00	– 0.19 (**)	– 0.29 (**)	– 0.60 (**)	
6. CMA	– 0.02 (**)	– 0.13 (**)	– 0.01 (**)	0.68 (**)	– 0.35 (**)

* indicates $p < 0.05$; ** indicates $p < 0.01$.

Table 24 – Correlation matrix, developed countries dataset.

For the sake of completeness and given the high correlation between HML and the RMW and CMA factors, the relationship is tested also excluding the HML in the regression model. Results show that ESG score is still significant, its *beta* is stronger and the R^2 of the regression is lower. Results are reported in the *Appendix* (section "*D. Results*", subsection "*Regression Results for Developed Countries with Six-, Five- without HML, and Three-factor model*").

Finally, as further tests, the relationship has been run also employing (a) just the Three-factor model – thus including the market, SMB and HML factors – and (b) adding the momentum factor. The former regression is run to avoid problems related to the overfitting of control variables, while the latter has been run to further increase the explanatory power of the model. The regression results suggest that the relation is negative and significant also employing these alternative models. Again, regression tables are provided in the *Appendix*.

Emerging Countries

Regarding the emerging countries dataset, *Table 25* presents the multivariate regressions results.

A first analysis suggests that the p-value associated to the F-test is lower than $2.2e^{-16}$, therefore the model results statistically significant. Furthermore, R^2 is 0.2369, meaning that approximately 24% of the realized returns variability is accounted by the variables in the model. This consideration is sustained also by the adjusted R^2 value, equal to 0.2366. This last measure indicates that 24% of the variability of exit valuation is explained by the equation even after taking into account the number of predictor variables in the model.

Moving to the results of the regression model, as for the case of developed countries, the cost of equity capital is negatively related to the ESG score. However, the relation is not statistically significant (p-value = 0.1394 > 0.1). Therefore, a firm's ESG score does not explain expected returns and, consequently, an improvement in the ESG performance should not influence a firm's cost of equity capital.

The result is consistent with Feng et al., (2015) findings, who find a negative relation between the cost of equity capital and ESG performance for North America and Europe but no effect in Asia.

On the contrary, other studies take developed and emerging countries as a unique sample and find a negative relation (Gupta, 2015; El Ghoul et al., 2018). However negative overall, it is difficult to unbundle the separate effect of ESG performance on the cost of equity for developed and emerging countries from the aforementioned studies. In fact, it should be noted that taking a unique sample comprising developed and emerging countries creates a panel strongly unbalanced towards developed countries firms. For instance, in the context of this dissertation, the sample would have been made of 75% developed and 25% emerging countries firms, with the former clearly driving the results of the study.
It is worth noting though that the results of the present study may be influenced by the already cited "currency issue", which impact in a substantial way the calculation of realized returns. In fact, since realized returns are calculated "in dollar terms", they depend both on the actual performance in the emerging country's currency and on the exchange rate. It could happen in fact that a company posts a positive performance in its reporting currency but, because of a change in the exchange rates, the performance "in dollar terms" becomes negative.

Coefficients	**Estimate**	**t-value**	
Mkt	1.089	156.98	***
SMB	0.2525	12.93	***
HML	0.0996	4.45	***
RMW	– 0.1526	– 5.58	***
CMA	0.4295	16.71	***
$\mathbf{ESGC_{score}}$	– 0.0021	– 1.48	
Observations	135'797		
$\boldsymbol{R^2}$	23.69%		
Adj. $\boldsymbol{R^2}$	23.66%		
F-test	7'024.6		
p-value	$< 2.2e^{-16}$		

* p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 25 – Emerging Countries Regression Results.

Moving to the correlations among explanatory variables, the correlation matrix is reported hereinafter in *Table 26*. Again, the correlation among the HML factor and the RMW and CMA factors is quite high. Therefore, the same regression is run by removing the HML factor from the model.

Results – reported in the *Appendix*, section "*D. Results*", subsection "*Regression Results for Emerging Countries with Six-, Five- without HML, and Three-factor model*"). – confirms the previously obtained findings, with the relation being not statistically significant, negative, and of very low economic significance.

Variable	1.	2.	3.	4.	5.
1. ESG_score					
2. Mkt	0.01 (**)				
3. SMB	– 0.02 (**)	– 0.13 (**)			
4. HML	– 0.01 (**)	0.40 (**)	– 0.05 (**)		
5. RMW	– 0.02 (**)	– 0.33 (**)	– 0.14 (**)	– 0.51 (**)	
6. CMA	– 0.04 (**)	– 0.13 (**)	– 0.02 (**)	0.60 (**)	– 0.23 (**)

* indicates $p < 0.05$; ** indicates $p < 0.01$.

Table 26 – Correlation matrix, emerging countries dataset.

Finally, as further tests, the relationship has been run also employing (a) just the Three-factor model – thus including only the market, size (SMB) and value (HML) factors – and (b) adding the momentum factor. The regression results obtained by employing these alternative models confirm the results of the main model, reinforcing the finding that the relation is negative and not significant. Again, regression tables are provided in the *Appendix*.

5.3 Research Question 2

The second research question of the thesis aims at diving deeper in the results obtained in the previous paragraph, by focusing on specific countries.

In particular, the focus will be among the world's main economic centres, being the United States of America, Europe and China.

The relationship to test is reported hereinafter for the reader's convenience:

$$(Returns - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA + \beta_6 * ESGC_{score} + \varepsilon \quad (44)$$

The geographical sample used to test the three relationships are obtained from the developed and emerging countries datasets and filtered for the desired countries. The dataset are made, respectively, by 172'359, 116'027 and 20'764 firm-month observations. Note that, for the case of the US and Europe, the Fama and French factors employed are specific for the geographic area and no more the developed countries factors. This could result in slightly different outcomes in respect to the previously obtained results. Descriptive statistics for the US and EU factors are reported in the *Appendix* (section "*C. Data and Methodology*").

Regarding China instead, since country-specific factors were not available, the factors employed were again the emerging countries one.

Regression Results

Table 27 at the end of the subsection reports the multivariate regressions results for the three geographical samples.

Regarding the United States of America, the relationship between ESG performance and the cost of equity is negative and statistically significant. Furthermore, the relation is stronger if compared to the case of "developed countries" – respectively of –0.0206 against –0.0135. Operationally, an increase (decrease) of a firm's ESG performance by one standard deviation (equal to 17.5 for the sample) results in a decrease (increase) in its cost of equity of 0.36%.

The result is in accordance with the existing literature, that finds mainly a negative relation between sustainability and CoE for the United States (Sharfman and Fernando, 2008; Dhaliwal et al., 2011; El Ghoul et al., 2011; Cajias et al., 2014; Ng and Razaee, 2015; Weber, 2018; Hmaittane et al., 2019).

Regarding Europe, the relation is again negative and statistically significant. However, the correlation is weaker and of very low economic significance. In fact, the *beta* is just –0.006, meaning that an increase (decrease) of a firm's ESG performance by one standard deviation (equal to 18.4 for the sample) translates in a decrease (increase) in its cost of equity of just 0.11%.

The results is quite surprising, especially after providing some context. In fact, Europe has led the global landscape in terms of sustainable investing assets[4] and has been surpassed only recently by the US. Furthermore, as per the *Global Sustainable Investment Review 2020* report, Europe is home of 35% of the global total sustainable investing assets, and the proportion of sustainable investing assets has reached 42% of the total assets.

This being said, the expectations were to observe a strong relation between sustainability performance and the cost of equity in Europe. Also, many studies find a negative relation between sustainability and CoE regarding Europe (Reverte, 2012; Feng et al., 2015; Sassen et al., 2016; Michaels and Gruning, 2017), which in the end is confirmed by the results of this dissertation. However, the weakness of the economic relevance of the relation leads to the conclusion that firms in Europe does not really enjoy benefits by improving their sustainability performance. Note that this result is in accordance with Humphrey et al. (2012) findings, who find that UK firms are able to implement ESG business strategy without incurring in neither benefits nor costs in terms of risk and return.

Finally, regarding China, the relationship is again negative and statistically significant, however contrary to the case of emerging countries. Also, it is worth highlighting that the impact of the ESG factor is higher than both developed countries taken as a group and Europe, however being lower than in the US.

[4] Sustainable investment is an investment approach that considers environmental, social, and governance (ESG) factors in portfolio selection and management (*Global Sustainable Investment Review 2020*)

Operationally, an increase (decrease) of the firm's ESG performance by one standard deviation (equal to 16.3 for the sample) translates in a decrease (increase) of the cost of equity of just 0.25%.

Last, it is necessary to highlight some possible limitations of the findings regarding China, which can be imputed to three factors, being:

a) the use of emerging countries factors and not factors specific for China;
b) fewer observations were available for Chinese companies relative to American and European one, hence results may be less robust;
c) some peculiarities caused by the sample itself. In fact, results show how Chinese firms behaved a lot like value firms – HML factor higher than zero – and had a very low *Beta* – intended here as the CAPM Beta.

Finally, Feng et al. (2015) find that CSR disclosure decrease the firm's CoE in North America and Europe yet with no effect in Asia. The authors argue that the concept of CSR has advanced in the USA and Europe, where it has been perceived positively by the public and managers; whereas, in Asia, CoE rises when ESG scores of firms increase. Efforts to improve CSR performance are not valued by the managers as they are perceived to be costly and gather less favorable response from the market. Although it may be true for Asia, results of the present study disregard this last hypothesis as regards China, where ESG seems to have become a factor that impacts firms' cost of equity capital.

Overall, this dissertation's findings are consistent with existing literature, which mostly finds a negative relation between sustainability and CoE for each of the selected countries. The United States experience the strongest relationship between sustainability performance and CoE, followed by China (interestingly the relation here is statistically significant and stronger if compared with emerging countries). Finally, although statistically significant, the relationship is very weak for Europe and not economically-significant.

	Unites States of America			Europe			China		
Coefficients	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.0709	152.06	***	1.1112	172.42	***	0.9274	50.01	***
SMB	0.5975	47.01	***	0.4360	27.99	***	– 0.0451	– 0.86	
HML	0.1202	10.07	***	0.2414	11.92	***	0.4965	8.25	***
RMW	0.0276	1.45		0.1049	3.91	***	0.1382	1.87	.
CMA	– 0.1100	– 5.45	***	– 0.2718	– 9.22	***	– 0.9125	– 13.23	***
$ESGC_{score}$	– 0.0206	– 12.84	***	– 0.0061	– 4.29	***	– 0.0153	– 3.01	**
Observations	172’359			116’027			20’764		
R^2	21.70%			33.39%			20.28%		
Adj. R^2	21.67%			33.36%			20.09%		
F-test	7’959.1			9’689.5			878.2		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 27 – Regression results: US, Europe, and China

5.4 Research Question 3

After investigating whether the overall ESG performance of a firm is related to its cost of equity capital, the third research question aims at exploring the individual effect of the disaggregated ESG performance on the cost of equity capital.

To test this, two regression models have been employed. The first model aims at capturing the contribution of each pillar separately, while the second aims at capturing the mutually exclusive effect of the individual E, S, and G pillars.

The first regression takes the following form:

$$(Return - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA + \beta_6 * \boldsymbol{Pillar_{score}} + \varepsilon \quad (45)$$

The second regression takes the following form:

$$(Return - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \beta_5 * CMA + \beta_6 * \boldsymbol{E_{score}} + \beta_7 * \boldsymbol{S_{score}} + \beta_8 * \boldsymbol{G_{score}} + \varepsilon \quad (46)$$

The models are tested on the "developed countries" dataset only, given that a relationship between sustainability and CoE has been found to exist only for this geographical sample.

For the sake of clarity and convenience, results of the three different regression employing the first model are reported in the *Appendix* (section "*D. Results*", subsection "*Regression Results E, S, and G*"), while *Table 28* reports the *betas* relative to each pillar and their respective t-value.

Coefficients	**Estimate**	**t-value**	
$\mathbf{E_{score}}$	– 0.0100	– 18.05	***
$\mathbf{S_{score}}$	– 0.0095	– 13.75	***
$\mathbf{G_{score}}$	– 0.0078	– 10.75	***

Table 28 – Regression Results of E, S, and G pillars; Developed Countries.

The results show how each of the three pillars taken individually – E, S, and G – is statistically significant and negatively related with the cost of equity capital. The Environmental Pillar has the highest *beta* (–0.010), followed by the Social Pillar (–0.0095) and the Governance Pillar (–0.0078).
Given the already high and still increasing attention especially towards climate risk among the general public, corporates, and governments (think about the Paris Agreement or the recent position taken by BlackRock, which announced that it would integrate climate risk in investment decisions), it comes to no surprise the E score has the highest impact on CoE.

However, before concluding that each of the pillar actually contributes to decreasing a firm's cost of equity capital, it is fundamental to understand whether those effect are mutually exclusive. To test this, the second regression model has been run on the same dataset.
The regression results, reported hereinafter in *Table 29*, show how the previously obtain effects were not mutually exclusive. As a matter of fact, the Environmental and Governance sustainability performances are both negatively related to CoE and statistically significant, with the former having the highest *beta* (–0.0095 for the E pillar, relative to –0.0032 for the G pillar). Conversely, the Social sustainability performance showed a slightly positive correlation with CoE and, above all, the relationship is not statistically significant.

These results are consistent with most of the academic literature exploring the individual contribution of each ESG pillar to the cost of equity, with Environmental and Governance sustainability mostly found to be negatively related to CoE, whereas mixed results were found about Social sustainability. In particular, Ng and Rezaee (2015) provide evidence that only Environmental and Governance sustainability performance reduce the cost of equity, while Social sustainability is not significantly related to the cost of equity capital. The authors argue that the result is probably explained by the more direct relationship of these dimensions on risk reduction and financial performance.
Indeed, coherently with the previously developed theoretical framework, by either (a) reducing environmental liabilities in the case of environmental initiatives or (b) enhancing the effectiveness of corporate governance measures in the case of governance sustainability performance, those dimensions directly decrease a firm's risk exposure.
Conversely, Social sustainability performance may require additional resources but does not directly create shareholder value, and thus is not directly related to the cost of equity.

Coefficients	Estimate	t-value	
Mkt	1.1467	289.27	***
SMB	0.5683	48.66	***
HML	0.2524	21.27	***
RMW	0.0586	3.33	***
CMA	– 0.2839	– 14.14	***
$\boldsymbol{E}_{\mathbf{score}}$	– 0.0095	– 11.16	***
$\boldsymbol{S}_{\mathbf{score}}$	0.0007	0.67	
$\boldsymbol{G}_{\mathbf{score}}$	– 0.0032	– 3.96	***
Observations	419’918		
$\boldsymbol{R}^{\mathbf{2}}$	21.79%		
Adj. $\boldsymbol{R}^{\mathbf{2}}$	21.77%		
F-test	14’618.7		
p-value	$< 2.2e^{-16}$		

* p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 29 – E, S and G Regression Results; Developed Countries.

As a final remark, note that the different contributions of the E, S and G pillars cannot be summed up to obtain the ESG combined score’s *beta*. Indeed, by doing the weighted average of the E, S, and G pillar contributions, one obtains the ESG score’s effect on CoE. It should though be reminded that the ESG combined score accounts also for recent controversies and may therefore be different from the “simple” ESG score.

5.5 Research Question 4

Finally, the last research questions aims to focus on the thirteen sectors part of the TRBC industry classification, in order to investigate whether there is a different relationship between CoE and sustainability performance among sectors. The fixed-effect regression model employed is reported hereinafter:

$$(Returns - RF) = \alpha + \beta_1 * Mkt + \beta_2 * SMB + \beta_3 * HML + \beta_4 * RMW + \\ + \beta_5 * CMA + \beta_6 * ESGC_{score} + \varepsilon \quad (47)$$

The dataset on which the regression model is tested is the "developed countries" geographical sample, given that a relationship between CoE and sustainability performance has been found only for this sample.

Operationally, instead of adding to the regression model a categorical variable representing sectors, a separate regression for each sector is run. By doing so, the results take into account that different sectors have an inherently different cost of equity – e.g., the CoE of a *Technology* firm is on average higher than the CoE of a *Consumer non-Cyclicals* firm. As such, the results will show the specific contribution of the ESG performance to the cost of equity capital for each sector.

Among the thirteen sectors, only ten comprehend enough firms to run a separate regression model (see *Table 18* and *19* in section "*5.1 Descriptive Statistics*"). Thus, (a) *Academics Services*, (b) *Government Activity,* and (c) *Institutions, Associations and Organizations* are excluded from the sample.

For the sake of clarity and convenience, *Table 30* reports just the *betas* of the ESG score for the different regressions and their level of significance. Complete regression results are reported in the *Appendix* (section "*D. Results*", subsection "*Regression Results by Sector*")

Interestingly, according to the results, the relationship between a firm's ESG performance and it cost of equity is negative and statistically significant for each of the sectors considered, with the *Utilities* sector where the relationship is significant at the 90% level, the sectors *Basic Materials* and *Energy* where the relationship is significant at the 99% level, and the remaining ones where the relationship is significant at the 99.9% level.

The magnitude of the correlation, however, varies significantly among sectors, ranging from the maximum value of –0.0312 for the *beta* relative to the *Healthcare* sector, to the minimum value of –0.0046 for the *beta* relative to the *Utilities* sector.
Also, contrary to the findings of Reverte (2012), the effect of sustainability on CoE do not seem to be higher in environmentally-sensitive sectors like *Energy* and *Utilities*.

The models are all significant and the R^2 are quite satisfying considering asset-pricing models, with the values of R^2 ranging from a maximum of 30.7% for *Industrials* to a minimum of 13.2% for *Consumer non-Cyclicals*. Also, no problems of multicollinearity among the independent variables have been observed.

Sector	**ESGC *Beta***	
Basic Materials	– 0.0077	**
Consumer Cyclicals	– 0.0147	***
Consumer non-Cyclicals	– 0.0154	***
Energy	– 0.0132	**
Financials	– 0.0094	***
Healthcare	– 0.0312	***
Industrials	– 0.0097	***
Real Estate	– 0.0067	***
Technology	– 0.0187	***
Utilities	– 0.0046	.

. p-value < 0.1, ** p-value < 0.01, *** p-value < 0.001

Table 30 – ESG combined score's beta by sector; Developed countries.

At this point, the thesis aims at providing a possible qualitative explanation for the divergences in the *betas* across sectors. In particular, this dissertation wants to investigate whether those divergences are related to structural differences among sectors, linked to the "ESG maturity" of the sector.

ESG mature sectors can be defined as those sectors where most of the firms have already integrated ESG practices in corporate strategy. Such maturity can be proxied with the variability of the ESG combined score. Two types of variability can be identified: (a) stability over time of the ESG score at the firm level and (b) the sectors' concentration of the ESG scores.

"Stability over time" follows a time-series approach and is calculated at the firm level trough the following two-step procedure:

1. For each firm, calculate the standard deviation of the ESG combined score over time.
2. Calculate the average of the previously obtained standard deviations.

"Concentration" of the ESG combined score follows a cross-sectional approach and is calculated within each sector trough the following two-step procedure:

1. For each year, calculate the standard deviation of the ESG combined score across the companies that are part of the sector.
2. Calculate the average of the previously obtained standard deviations.

Results are provided in *Table 33,* provided in the *Appendix* (section "*D. Results*", subsection "*Three dimensional matrix, values*"). Also, results are mapped on a three-dimensional matrix *– Figure 27*.

The three dimensions of the matrix are:

- on the *x-axis*, the average of firms' standard deviations of the ESG combined score over time (i.e., stability over time);
- on the *y-axis*, the average of firms' standard deviations of the ESG combined score each year (concentration);
- the bubble's size represents the ESG combined score's *beta*.

Note that the higher the standard deviation (SD) over time at the firm level – proxy of "stability over time", the less stable the ESG score is over time. Accordingly, low SD means high stability.

Also, the higher the standard deviation at the sector level – proxy of "concentration", the less concentrated the ESG score is across the sector. Accordingly, low SD means high concentration.

The matrix reported in *Figure 27* is obtained by zooming the *x-axis* between 6 and 8.5 and the *y-axis* between 17.5 and 21.

The breakpoints used to draw the quadrants are the average values of the *x-* and *y-axis* values, thus *7.1* for "stability over time" – standard deviation at the firm level – and *19.3* for "concentration" – standard deviation at the sector level. Through these values, it is possible to obtain four quadrants.

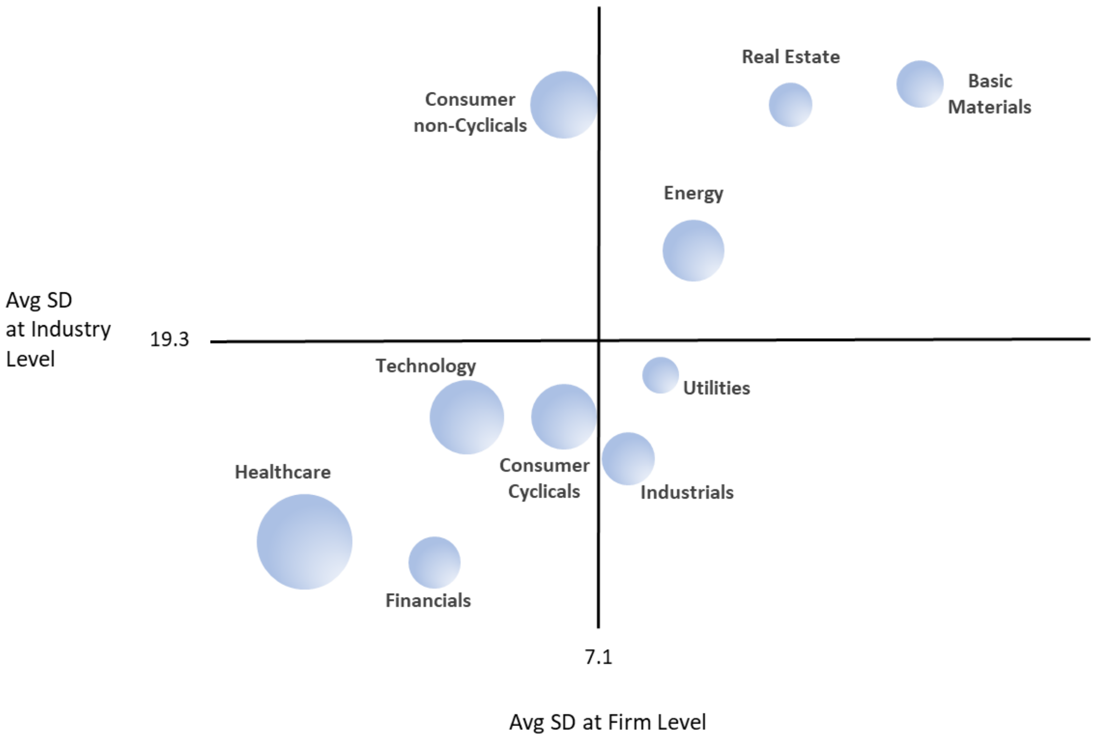


Figure 27 – Three-dimensional matrix: ESG combined score's beta by Sector, Firm's score SD, and Sector's score SD.

By focusing on the top-right – low stability over time and concentration – and bottom-left (ESG mature) – high stability over time and concentration – quadrants, the results are quite interesting. On average the effect of sustainability performance on the cost of equity is larger for those sectors in the bottom-left quadrant relative to the sectors in the top-right quadrant.

This result has also some important managerial implications.

First, the research finds that the impact of sustainability performance on the cost of equity varies considerably across sectors, with some where the economic relevance of the relation has been found to be very weak (think of *Utilities* and *Real Estate*), while others experience a highly significant correlation (think of *Healthcare* and *Technology*).

A possible explanation could be found in the fact that, in environmentally-sensitive sectors like *Energy* and *Utilities*, sustainability is already deeply integrated in firms' corporate strategy and, as such, investors already expect those companies to achieve high sustainability standards and do not reward them with a lower cost of capital. Managers thus are able to implement ESG strategy with nor costs nor benefits in terms of CoE (Humphrey et al., 2012). On the other side, managers of companies in sectors like *Healthcare* and *Technology* could reduce the firm's cost of equity capital by improving their sustainability performance and, in turn, create shareholders value.

Finally, the contribution of this research, in the limit of such a qualitative analysis, provides a possible explanation on why the correlation may vary across sectors which, to the best of my knowledge, has not been yet proposed in the academic literature.
Concentration across sectors and stability over time of the ESG score seem to impact the correlation between sustainability performance and CoE, as on average the effect is larger for sectors in the bottom-left quadrant relative to sectors in the top-right one. This dissertation leaves as a further development to investigate whether this interesting result is confirmed by a quantitative analysis.

6. CONCLUSIONS

More than 35% of the world's total assets under management are sustainable investments, with the overall amount exceeding the gigantic figure of $ 35 trillion[5]. This figure increased at a compounded annual growth rate of 11.5% in the last four years, and has grown even faster in the US, where the CAGR settled at 17%. As those data show, the relevance of business sustainability in the financial world has been thriving in recent years, with many professional advocating for an inclusion of ESG performance in investment decisions, as it should foster, in their view, long-term value creation. However, this assertion has not been far from criticism, as many others argue that there is not a link between sustainability and shareholder value (Cornell and Damodaran, 2020).

In this context, this study explores whether ESG performance has an impact on shareholders' value and, specifically, whether it is correlated to a firm's cost of equity capital. In particular, the thesis aims at determining whether the relationship exists in different geographical settings, analyzing both developed and emerging countries as a group as well as focusing on the world's main economic centres: United States, Europe, and China.
Furthermore, the research explores the disaggregated ESG performance – the E, S, and G pillars, and test whether the magnitude and significance of the individual E, S and G factors correlate with the cost of equity capital. Finally, the relationship is tested across sectors, to explore whether there are significant differences among them.

The findings of this dissertation show how ESG got out of the realm of pure philosophy and should rather become a primary point of interest in the corporate strategy agenda. In fact, sustainability creates real shareholder value since, besides the already well documented effects on the cost of debt, firms are rewarded for their sustainability performance with a lower cost of equity capital and, therefore, a negative relationship between sustainability performance and cost of equity capital exists for what regards developed countries taken as a group. Specifically, by increasing (decreasing) sustainability performance by one standard

[5] Global Sustainable Investment Review 2020

deviation, a firm would decrease (increase) its cost of equity financing by 0.26%. Also, taken from another perspective, if a firm is able to move from an average sustainability performance to being an "ESG leader"[6], such performance improvement could lead a company to decrease its cost of equity by approximately 0.55%. Although this effect might not seem to be economically significant, it should be contextualized in the low-interest rate environment we are currently living in. In such a case in fact, the abovementioned benefit means that a firm might be able to reduce its cost of equity capital by approximately 10%[7].

Then, by disaggregating the overall ESG performance in its pillars, the present study found that the environmental pillar is the main driver of the negative relation between ESG performance and cost of equity. In fact, the relationship is stronger (meaning more negative) for the E pillar, followed by the governance pillar. On the contrary, the relationship between the social pillar and CoE has been found to be not statistically significant.
This result can be explained by the fact that the E and G pillars are more directly related to risk reduction and financial performance if compared to the S pillar (Ng and Rezaee, 2015). Indeed, coherently with the theoretical framework, by either (a) reducing environmental liabilities in the case of environmental initiatives or (b) enhancing the effectiveness of corporate governance measures in the case of governance sustainability performance, those dimensions directly decrease a firm's risk exposure. On the other hand, Social sustainability performance may require additional resources but does not directly create shareholder value, and thus is not directly related to the cost of equity.

Among developed countries however, differences emerged when focusing on United States and Europe individually. Regarding the US, the relationship has been found to be stronger (again, meaning more negative) relative to developed countries. On the other hand, as per European firms, although the relation has been found to be statistically significant, its economic significance has been found to be irrelevant. Overall, the findings are consistent with most of the studies examining the topic.

Practical implications for managers constitute in the necessity of including ESG criteria into corporate strategy, treating it as a potential source of competitive advantage. This is certainly

[6] The sample's median ESG combined score is equal to 43.3, falling in the C+ category, while the "ESG leader" category has been identified in the A category, comprising scores from 75 and 100.

[7] As per Damodaran, the median US-firm's cost of equity for the year 2020 was equal to 5.55%.

true for US-based firms, who would benefit also from a reduction in their cost of equity capital, as well as for EU-based firms, who can implement ESG business strategy without incurring in neither benefits nor costs in terms of risk and return (Humphrey et al., 2012). It should be noted that this research completes previously existing studies, as the sample comprehends also many small-cap firms. Hence, managerial implications are to be considered valid also for small firms.

Moving to emerging countries instead, the relationship has been found to be negative although not statistically significant and, as such, sustainability performance does not affect a firm's expected returns and, in turn, its cost of equity capital.
A possible explanation is that the concept of CSR has advanced in developed countries (in particular in USA and Europe), where it has been perceived positively by the public and managers; whereas, in emerging countries, efforts to improve CSR performance are not valued by the managers as they are perceived to be costly and gather less favorable response from the market (Feng et al., 2015). Although this explanation has been proven valid for emerging countries taken as a group, the findings of the present study disregard this last hypothesis as regards China, where the relationship has been found to be both negative and statistically significant, suggesting that Chinese companies might benefit from improving their sustainability performance in a similar vein as developed countries.

Finally, diving deeper in the existing relationship between sustainability performance and cost of equity for developed countries, the research finds that the magnitude of the correlation varies considerably across sectors, with some where the economic significance of the relation has been found to be very weak (think of *Utilities* and *Real Estate*), while others experience a highly significant correlation (think of *Healthcare* and *Technology*).

A possible explanation could be found in the fact that, in environmentally-sensitive sectors like *Energy* and *Utilities*, sustainability is already deeply integrated in firms' corporate strategy and, as such, investors already expect those companies to achieve high sustainability standards and do not reward them with a lower cost of capital. Managers thus are able to implement ESG strategy with nor costs nor benefits in terms of CoE (Humphrey et al., 2012). On the other side, managers of companies in sectors like *Healthcare* and *Technology* could reduce the firm's cost of equity capital by improving their sustainability performance and, in turn, create shareholders value.

Finally, the contribution of this research, provides a possible intuition on why the correlation may vary across sectors which, to the best of the author's knowledge, has not been yet investigated in the academic literature. Indeed, concentration of the ESG scores across the sector and stability over time of a firm's ESG score seem to impact the correlation between sustainability performance and CoE, as on average the effect is larger for sectors characterized by high concentration and stability relative to sectors characterized by low concentration and stability.

A limitation this study potentially suffers is related to the reliance on the Refinitiv Eikon ESG score used as a proxy of a firm's business sustainability performance. Indeed, as per Berg et al. (2019), ESG scores differ for (a) the scope, i.e., the difference in the factors considered, (b) the weight of factors and (c) the measurement divergence, i.e., when different agencies measure the same factor differently. This lack of standardization causes the findings of this research to be intrinsically linked to the ESG score and, as such, it would be worthwhile to challenge the reliability of the present findings by employing other datasets.
However, this database has been widely used in prior research as well as for investment purposes by major investment houses (Ioannou and Serafeim 2012; Mackenzie et al. 2013; Cheng et al. 2014; Eccles et al. 2014; Feng et al., 2015; Gupta, 2015; Sassen et al., 2016; Giudici, 2018). Also, Thomson Reuters states that the database is created by 100 experienced analysts and that "every data point goes through a verification process, including a series of data entry checks, automated quality rules and historical comparisons", which provides further evidence of the quality of the database.

Another limitation the present study may suffer is related to the choice of the score taken as a proxy for sustainability performance. The present research was conducted by employing the ESG combined score instead of the "simple" ESG score. For the reader's convenience, it should be reminded that the former score discounts the "simple" ESG score by accounting for recent controversies. However, although such score results to be more volatile and, on average, lower because of the potential discount relative to ESG controversies, it accounts for relevant issues when considering the sustainability performance of a company, i.e. controversies. In fact, as the argument about the relation between sustainability and the cost of equity lies mainly on the perception shareholders have about the riskiness of the company and the ability of its management, controversies play a crucial role, as less investors will be willing to hold shares in companies involved in controversies. Nevertheless, it would be worthwhile to challenge the reliability of the present findings by using the Thomson Reuters' "simple" ESG score.

Furthermore, it would add value to the existing debate if an absolute ESG score would be used as a proxy of a firm's business sustainability performance. Indeed, the bulk of the research has been done by relying on the Refinitiv Eikon ESG score and the MSCI ESG score, which are both classified as relative scores. This causes some problems in the scoring methodology, as the absolute ESG score is normalized against a benchmark, which typically is the industry group. As such, there could be divergences in how the benchmark is defined, leading to a potential distortion in the final ESG score.

Finally, this research leaves as a further development the investigation of the determinants of the variability of the relationship between ESG performance and CoE across sectors. Although this dissertation offered a possible explanation of the aforementioned variability, further research is necessary to assess whether this interesting result is confirmed by a quantitative analysis.

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APPENDIX

A. Sustainability

Eni Scores

REFINITIV ESG COMPANY REPORT

Eni SpA (ENI.MI)

Document Date: 2021-06-30

REFINITIV
DATA IS JUST THE BEGINNING®

COMPANY OVERVIEW

Market Cap. (Mil USD)	**$44,447**
Revenue (Mil USD)	**$53,721**
No. of Employees	**31,495**
D&I Index Ranking	**83 / 3389**
TRBC Ind. Group	**Oil & Gas**
Countries/ Region	**Italy**
Fiscal Yr. End	**2019-12-31**
ESG Reporting Scope	**100%**

A ESG Score	D- ESG Controversies Score	C+ ESG Combined Score
B+ Environmental Pillar Score	A+ Social Pillar Score	A Governance Pillar Score

CONTROVERSIAL BUSINESS PRACTICES

Does the company engage in any controversial business activities? **No**

Did the company have any controversies in violation of the Ten Principles of the UN Global Compact? **Yes**

Recent Environmental Controversies	**3**
Business Ethics Controversies	**7**
Recent Business Ethics Controversies	**10**

Figure 28 – Refinitiv Eikon ESG score, Eni SpA

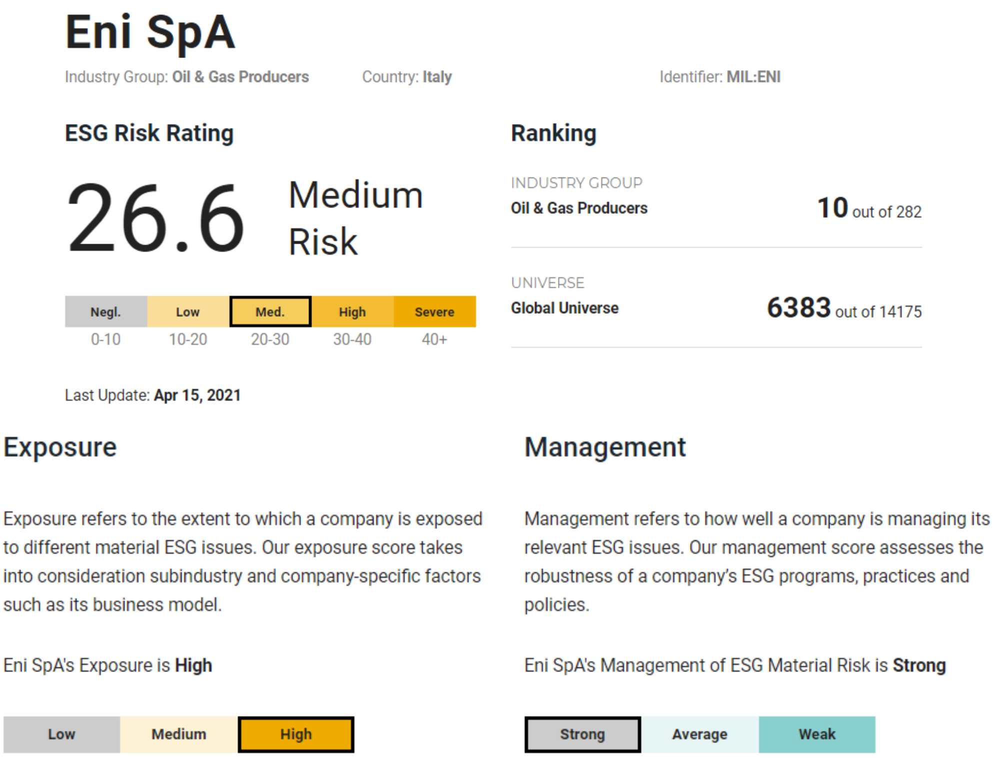


Figure 29 – Sustainalitics ESG score, Eni SpA

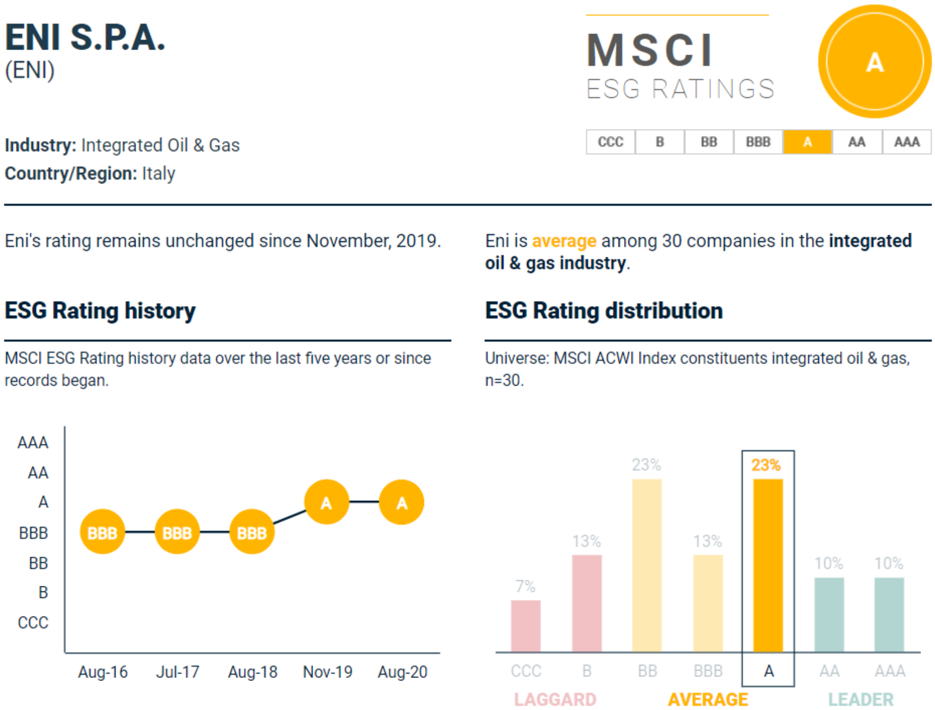


Figure 30 – MSCI ESG score, Eni SpA

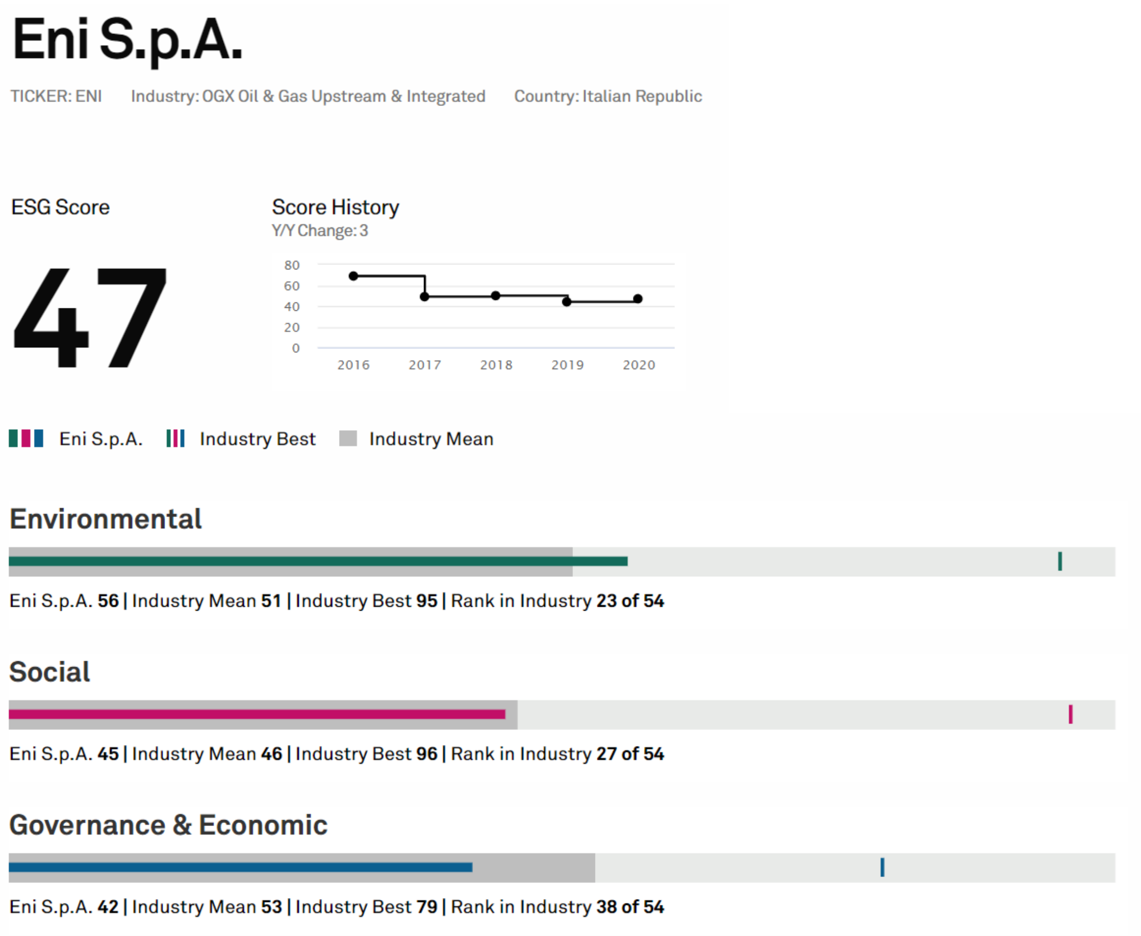


Figure 31 – S&P Global ESG score, Eni SpA

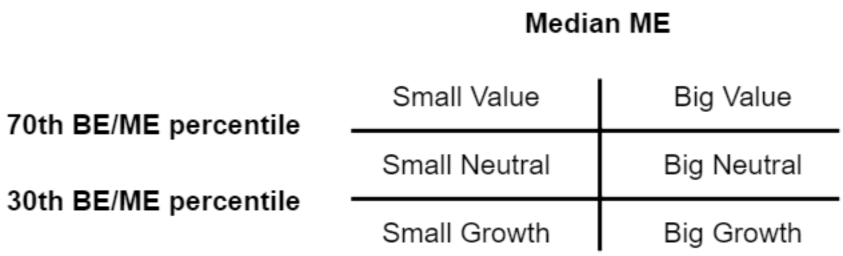
B. The Cost of Equity Capital

Fama and French Factors and Portfolios Construction

This section will present how the authors construct the factors starting from eighteen value-weighted portfolios. Note that the United States portfolios are constructed in a slightly different way than European, Developed and Emerging countries portfolios. Therefore, first the United States portfolios will be described, then a reference to the others will be done. Note that all returns are in U.S. dollars, include dividends and capital gains, and are not continuously compounded.

The eighteen vale-weighted portfolios are the following:

- Six portfolios formed on size and book-to-market ratio. The size breakpoint is the median market value of equity of firms included in the NYSE, while the value breakpoints are the 30th and 70th percentiles of the book-to-market ratio for the firms included in the NYSE.



  Firms with a low book-to-market ratio are the growth stocks, as most of the market value of equity comes from the present value of growth opportunities rather than from current operations. Conversely, firms with a high book-to-market ratio are the value stocks, as the market is pricing a negative present value of growth opportunities which in turn lowers the book value of the firm.

- Six portfolios formed on size and operating profitability. Operating profitability is measured as annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses divided by book equity for the previous fiscal year.

The breakpoint for size is the median market value of equity while the breakpoints for operating profitability are the 30th and 70th NYSE percentiles.
Firms with high operating profitability – above the 70th percentile – are said to have a Robust profitability, while firms with low operating profitability – below the 30th percentile – are said to have a Weak profitability.

	Median ME	
	Small Robust	Big Robust
70th OP percentile		
	Small Neutral	Big Neutral
30th OP percentile		
	Small Weak	Big Weak

- Six portfolios formed on size and investment. Investment is the change in total assets from the fiscal year t-2 to the fiscal year t-1, divided by t-2 total assets.
  The size breakpoint is the median market value of equity while the Inv breakpoints are the 30th and 70th NYSE percentiles.

	Median ME	
	Small Aggressive	Big Aggressive
70th INV percentile		
	Small Neutral	Big Neutral
30th INV percentile		
	Small Conservative	Big Conservative

Regarding all the other regions portfolios, big stocks are those in the top 90% of market cap for the region, and small stocks are those in the bottom 10%. The BE/ME, OP, and INV breakpoints for a region are the 30th and 70th percentiles of respective ratios for the big stocks of the region.

Having defined the portfolios, it is now time to report how factors are constructed.

- The size factor is calculated by taking the simple average of the returns on the nine small stocks portfolios minus the returns on the nine big stocks portfolios. Operationally it is as follows:

$$SMB_{BE/ME} = \frac{(Small\,Growth + Small\,Neutral + Small\,Value)}{3} - \frac{(Big\,Growth + Big\,Neutral + Big\,Value)}{3}$$

$$SMB_{OP} = \frac{(Small\,Robust + Small\,Neutral + Small\,Weak)}{3} - \frac{(Big\,Robust + Big\,Neutral + Big\,Weak)}{3}$$

$$SMB_{INV} = \frac{(Small\,Conserv + Small\,Neutral + Small\,Aggres)}{3} - \frac{(Big\,Conserv + Big\,Neutral + Big\,Aggres)}{3}$$

$$SMB = \frac{\left(SMB_{BE/ME} + SMB_{OP} + SMB_{INV}\right)}{3}$$

- The value factor is calculated as the average of the difference between the returns on value and growth stocks. It is obtained as follows:

$$HML = \frac{(Small\,Value - Small\,Growth) + (Big\,Value - Big\,Growth)}{2}$$

- The profitability factor is calculated as the average of the difference between the returns on stocks with robust and weak profitability. It is obtained as follows:

$$RMW = \frac{(Small\,Robust - Small\,Weak) + (Big\,Robust - Big\,Weak)}{2}$$

- The investment factor is calculated as the average of the difference between the returns on conservative and aggressive stocks. It is obtained as follows:

$$CMA = \frac{(Small\,Conservative - Small\,Aggressive) + (Big\,Conservative - Big\,Aggressive)}{2}$$

q-Factor Model, Factor and Portfolio Construction

Following the Fama and French portfolio approach, Hou et al. (2015) construct their factors starting from eighteen value-weighted portfolios, formed on market equity, investment-to-assets, and ROE. The breakpoint used for the market value of equity is the median NYSE market equity while the breakpoints for the other two factors are the 30th and 70th NYSE percentiles for stocks ranked on investment-to-asset and ROE respectively. Note that these factors are available only for the United States market.

The figure below shows how the 2 by 3 by 3 sorts portfolios are formed for small stocks. The same is done then for big stocks. In the figure below, H stands for "High" and L for "Low". For instance, "Small H/L" represents small stocks with high investments and low return on equity.

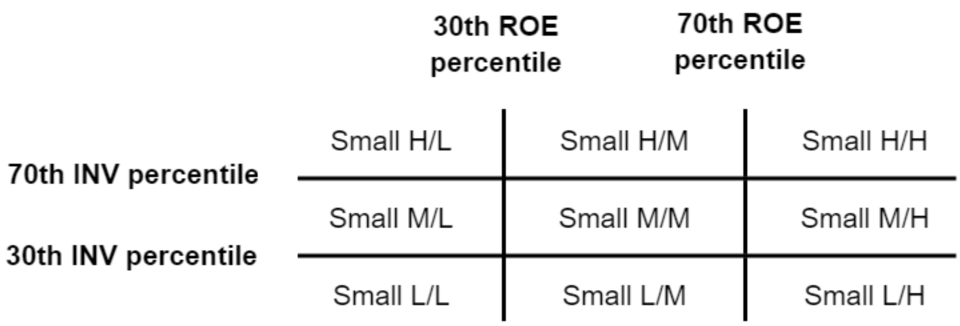


Figure 32 – 3 by 3 sorts portfolios for small stocks; q-Factor model

The expected growth factor – EG – is defined separately as the difference between the simple average of the returns on two high expected growth portfolios – measured as $E_t[\delta I/A]$ (i.e., expected change in investment-to-assets) – and the simple average of the returns on two low $E_t[\delta I/A]$ portfolios.

$$EG = \frac{(Small\ High + Big\ High)}{2} - \frac{(Small\ Low + Big\ Low)}{2}$$

	Median ME	
	Small High	Big High
70th Et[δI/A] percentile		
	Small Medium	Big Medium
30th Et[δI/A] percentile		
	Small Low	Big Low

Figure 33 – Expected Growth portfolios; q-Factor Model

C. Data and Methodology

United States Factors, Descriptive Statistics

	Average	***Median***	***SD***	***Max.***	***Min.***
Mkt	1.26	1.43	4.52	13.65	– 13.38
SMB	0.10	0.24	2.80	6.88	– 8.38
HML	– 0.65	– 0.79	2.97	8.22	– 13.96
RMW	0.03	0.09	1.56	4.27	– 3.93
CMA	– 0.11	– 0.08	1.62	4.68	– 3.35
RF	0.06	0.02	0.07	0.21	0

Table 31 – Descriptive Statistics; United States Factors

European Factors, Descriptive Statistics

	Average	***Median***	***SD***	***Max.***	***Min.***
Mkt	0.66	0.59	5.12	16.62	– 15.44
SMB	0.26	0.21	1.72	4.72	– 5.07
HML	– 0.49	– 0.58	2.80	10.76	– 11.30
RMW	0.36	0.56	1.53	3.52	– 3.85
CMA	– 0.31	– 0.22	1.33	2.96	– 4.39
RF	0.05	0.01	0.07	0.21	0

Table 32 – Descriptive Statistics; European Factors

D. Results

Regression Result for Developed Countries with Six-, Five- without HML, and Three-factor model

	Six-factor Model			Five-factor Model without HML			Three-factor Model		
Coefficients	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.1318	275.90	***	1.1669	285.73	***	1.1625	172.42	***
SMB	0.5802	49.52	***	0.5985	48.32	***	0.5911	27.99	***
HML	0.1549	11.24	***				0.1248	11.92	***
RMW	0.0661	3.75	***	– 0.1163	– 6.94	***			
CMA	– 0.2125	– 10.21	***	– 0.0056	– 0.35				
MOM	– 0.1057	– 13.90	***						
$ESGC_{score}$	– 0.0136	– 16.28	***	– 0.0146	– 16.34	***	– 0.0143	– 4.29	***
Observations	419’936			419’936			419’936		
R^2	21.81%			19.66%			19.69%		
Adj. R^2	21.79%			19.64%			19.68%		
F-test	16’727.5			20’543.1			25’741.8		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 33 – Regression Result for Developed Countries with Six-, Five- without HML, and Three-factor model

Regression Result for Emerging Countries with Six-, Five- without HML, and Three-factor model

	Six-factor Model			Five-factor Model without HML			Three-factor Model		
Coefficients	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.0760	153.01	***	1.1047	184.72	***	1.0381	174.45	***
SMB	0.2714	13.85	***	0.2466	12.65	***	0.2745	14.38	***
HML	0.0189	0.81					0.3918	26.61	***
RMW	– 0.1119	– 4.06	***	– 0.1942	– 7.55	***			
CMA	0.3932	15.19	***	0.5074	26.97	***			
MOM	– 0.1632	– 11.17	***						
$ESGC_{score}$	– 0.0021	– 1.51		– 0.0021	– 1.51		– 0.0025	– 1.79	.
Observations	135'797			135'797			135'797		
R^2	23.77%			23.68%			23.52%		
Adj. R^2	23.72%			23.64%			23.48%		
F-test	6044.4			8424.4			10'437.1		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 34 – Regression Result for Emerging Countries with Six-, Five- without HML, and Three-factor model

Regression Results E, S and G

	Environmental Pillar			Social Pillar			Governance Pillar		
Coefficients	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.1467	289.26	***	1.1465	289.18	***	1.1465	289.15	***
SMB	0.5684	48.67	***	0.5675	48.58	***	0.5675	48.57	***
HML	0.2524	21.27	***	0.2518	21.21	***	0.2543	21.42	***
RMW	0.0586	3.33	***	0.0554	3.15	**	0.0587	3.33	***
CMA	– 0.2838	– 14.14	***	– 0.2895	– 14.42	***	– 0.2867	– 14.28	***
$ESGC_{score}$	– 0.0100	– 18.05	***	– 0.0095	– 13.75	***	– 0.0078	– 10.75	***
Observations	419’918			419’918			419’918		
R^2	21.77%			21.76%			21.74%		
Adj. R^2	21.77%			21.75%			21.73%		
F-test	19’488.3			19’459.2			19’443.5		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 35 – Regression Result E, S and G pillars

Regression Results by Sector

Coefficients	Basic Materials			Consumer Cyclicals			Consumer non-Cyclicals		
	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.2667	88.64	***	1.3099	108.67	***	0.7778	60.51	***
SMB	0.9571	22.79	***	1.0097	28.43	***	0.1527	4.03	***
HML	0.2551	5.95	***	0.3942	10.92	***	– 0.1984	– 5.16	***
RMW	– 0.0172	– 0.28		0.6603	12.36	***	0.5298	9.30	***
CMA	– 0.3982	– 5.55	***	– 0.2342	– 3.85	***	0.5640	8.70	***
$ESGC_{score}$	– 0.0076	– 2.70	**	– 0.0174	– 6.81	***	– 0.0154	– 6.15	***
Observations	40'837			64'780			26'519		
R^2	21.98%			20.75%			13.20%		
Adj. R^2	21.96%			20.73%			13.16%		
F-test	1'917.4			2'826.8			671.7		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 36 – Regression Result by Sector (1/4)

	Energy			Financials			Healthcare		
Coefficients	Estimate	t-value		Estimate	t-value		Estimate	t-value	
Mkt	1.7218	74.09	***	1.1259	119.51	***	0.9880	61.75	***
SMB	1.2143	17.77	***	0.1665	6.01	***	0.7455	15.79	***
HML	1.1780	16.85	***	0.7099	25.17	***	– 0.4687	– 9.83	***
RMW	0.5220	5.08	***	– 0.5199	– 12.47	***	– 0.7371	– 10.11	***
CMA	– 0.4140	– 3.52	***	– 0.5623	– 11.88	***	– 0.6132	– 7.41	***
$ESGC_{score}$	– 0.0127	– 2.67	**	– 0.0111	– 5.28	***	– 0.0331	– 6.96	***
Observations	21’753			55’233			37’527		
R^2	28.61%			29.12%			14.35%		
Adj. R^2	28.57%			29.10%			14.33%		
F-test	1’452.1			3’780.7			1’044.2		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 37 – Regression Result by Sector (2/4)

	Industrials			Real Estate		
Coefficients	Estimate	t-value		Estimate	t-value	
Mkt	1.1919	150.90	***	1.0177	103.60	***
SMB	0.5383	23.13	***	0.3825	12.25	***
HML	0.3661	15.47	***	0.4898	16.75	***
RMW	0.0801	2.30	*	0.5810	13.28	***
CMA	– 0.2437	– 6.11	***	– 0.0272	– 0.55	
$\mathbf{ESGC_{score}}$	– 0.0097	– 5.74	***	– 0.0067	– 3.47	***
Observations	71’665			34’135		
$\boldsymbol{R^2}$	30.66%			30.68%		
Adj. $\boldsymbol{R^2}$	30.64%			30.66%		
F-test	5’279.3			2’517.3		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 38 – Regression Result by Sector (3/4)

	Technology			Utilities		
Coefficients	Estimate	t-value		Estimate	t-value	
Mkt	1.1305	91.38	***	0.6552	50.24	***
SMB	0.3800	10.44	***	– 0.0547	– 1,42	
HML	– 0.1516	– 4.10	***	0.0981	2.51	*
RMW	– 0.2523	– 4.56	***	0.5191	9.03	***
CMA	– 0.5618	– 8.92	***	0.3944	6.04	***
$\mathbf{ESGC_{score}}$	– 0.0195	– 7.26	***	– 0.0046	– 1.67	.
Observations	49’992			16’452		
R^2	18.60%			14.50%		
Adj. R^2	18.58%			14.45%		
F-test	1’903.6			464.7		
p-value	$< 2.2e^{-16}$			$< 2.2e^{-16}$		

. p-value < 0.1, * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001

Table 39 – Regression Result by Sector (4/4)

Three-dimensional matrix, values

Sector	**Avg. SD at the Firm level**	**Avg. SD at the Sector level**	**ESGC score's *Beta***
Basic Materials	8.1	20.5	– 0.0077
Consumer Cyclicals	7.0	18.9	– 0.0147
Consumer non-Cyclicals	7.0	20.4	– 0.0154
Energy	7.4	19.7	– 0.0132
Financials	6.6	18.2	– 0.0094
Healthcare	6.2	18.3	– 0.0312
Industrials	7.2	18.7	– 0.0097
Real Estate	7.7	20.4	– 0.0067
Technology	6.7	18.9	– 0.0187
Utilities	7.3	19.1	– 0.0046

Table 40 – ESG combined score's beta by Sector, Firm's score SD, and Sector's score SD.