



Global Challenges Lab

RWTH AACHEN
UNIVERSITY

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THE GREEN INVESTING (DIS)ILLUSION

Is the ESG Score a Sustainable Indicator
or just profitable Greenwashing?

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AGENDA



- 1 Introduction**
 - 1.1 General Introduction**
 - 1.2 Sustainable Investing**
 - 1.3 Environmental, Social & Governance Score**
 - 1.4 ESG Influence on the Company Performance**
- 2 Motivation Summary**
- 3 Our Methodology**
- 4 Results**
- 5 Conclusion & Outlook**

EARTH IN CRISIS

THE IMPACT OF CLIMATE CHANGE



CLIMATE CHANGE – A GLOBAL CRISIS

1.1

Introduction

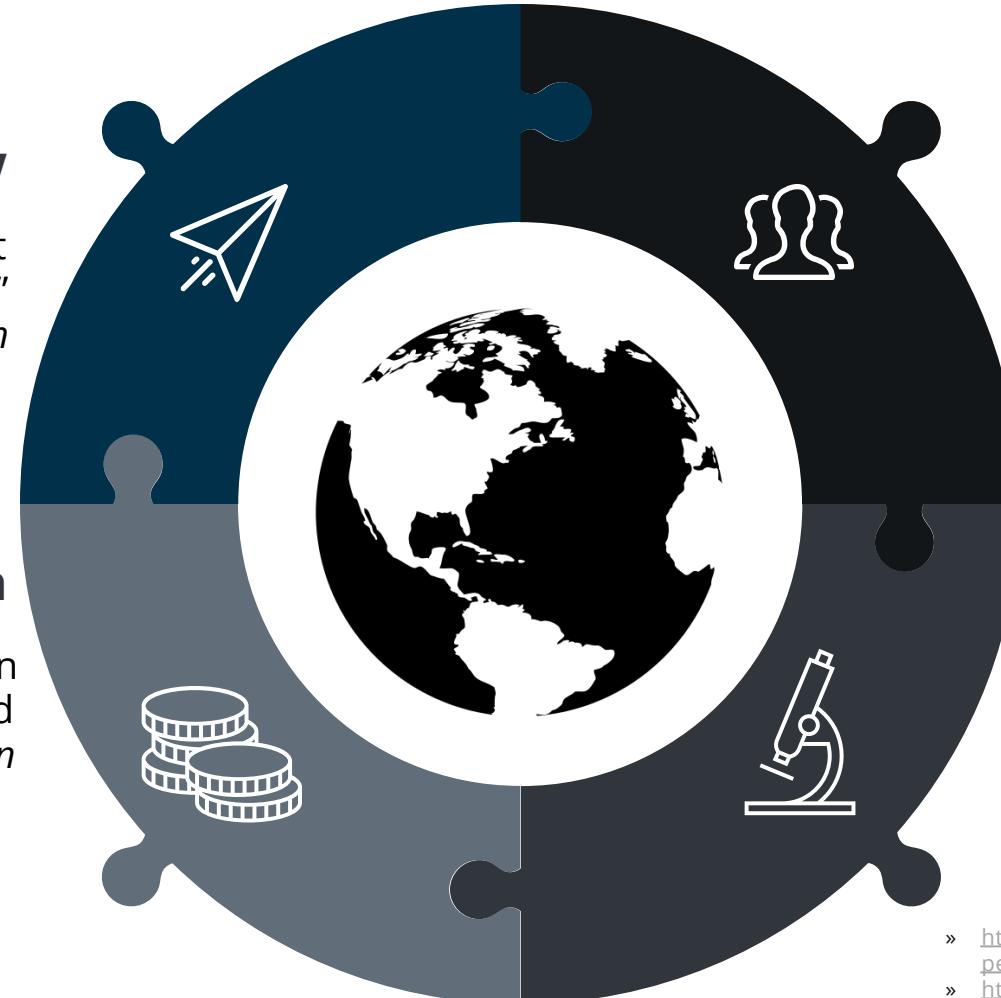
» The Facts and Figures of Climate Change: A Call to Action.

The Urgency of Now

"To avoid the worst impacts, we must cut global emissions in half by 2030."
- UN Environment Program

The Cost of Inaction

"Climate change cause \$600 trillion in damages to the global economy by the end of the century." - The Guardian



The Human Impact

"Climate change is causing millions to flee their homes due to rising sea levels and extreme weather events." - UN Commissioner for Refugees

The Science Behind

"There is a 97% consensus among climate scientists that humans are causing global warming." NASA

- » <https://www.unep.org/news-and-stories/press-release/global-emissions-must-peak-2020-reduce-climate-risk>
- » <https://www.theguardian.com/environment/2017/nov/14/global-insurance-plan-aims-to-defuse-potential-climate-damage-bombshell>
- » <https://www.un.org/en/un-chronicle/climate-change-disasters-and-their-mitigation>



URGENT ACTION

HOW HUMANITY IS ADDRESSING THE CLIMATE CRISIS

THE 4 PILLARS OF CLIMATE ACTION

1.1

Introduction

The key areas where humanity is taking action to address the climate crisis.

Policy

- » Clear and coordinated approach to reduce global emissions.
 - Global efforts to reduce carbon emissions.
 - *Paris Agreement*
 - Implementation of carbon pricing mechanisms.
 - *World Bank*



Technology

- » Enables us to meet our energy needs while reducing emissions.
 - Better battery technology for the integration of renewable energy into grid.
 - *Renewable Energy Agency*
 - Development of carbon capture technologies to reduce emissions.
 - *Carbon Solutions*



Lifestyle

- » Sustainable lifestyles can help to reduce emissions on an individual level.
 - Implementation of energy efficiency measures in buildings and appliances.
 - *E. McArthur Foundation*
 - Reduced meat consumption / adoption of plant-based diets.
 - *Science Targets Initiative*



Business

- » Reduce carbon footprint of firms while saving money and improving reputation.
 - Implementation of green SCM practices.
 - *GreenBiz*
 - Incorporation of circular economy principles to reduce waste/emissions.
 - *E. McArthur Foundation*



THE 4 PILLARS OF CLIMATE ACTION

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FOCUS

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THE RISE OF GREEN INVESTING

INVEST IN SUSTAINABLE DEVELOPMENT

Investing in a Sustainable Future: growth and possibility of Green Finance

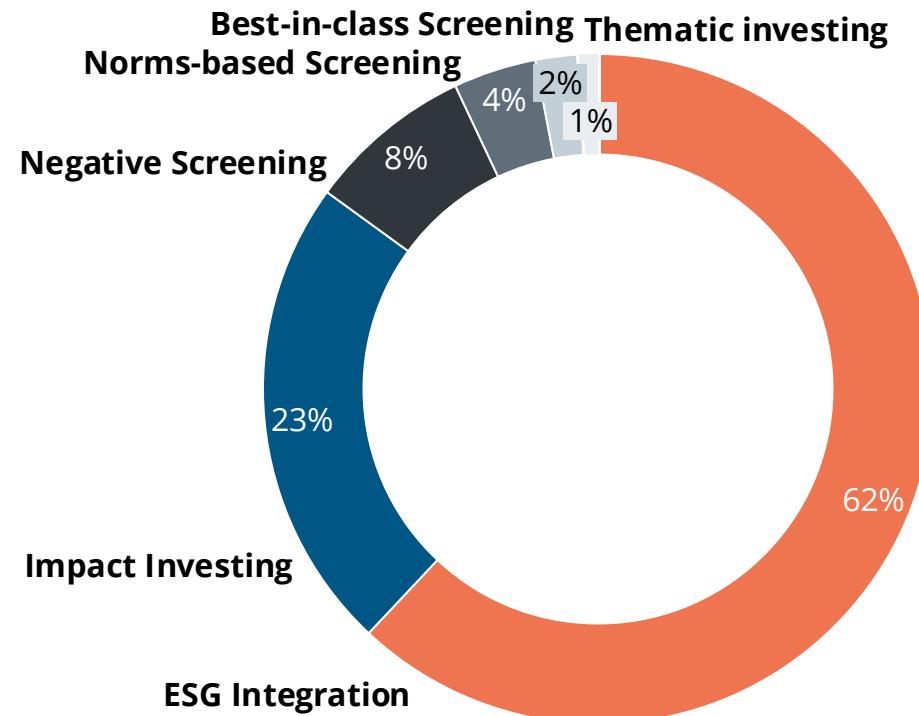
GLOBAL SUSTAINABLE INVESTING ALLIANCE¹

- » Sustainable investing assets grew 15% in two years to reach \$35 trillion in 2020.
- » Europe continues to lead sustainable investments
- » US market grew significantly in 2020.
- » COVID-19 pandemic has increased investor focus on ESG issues.

SUSTAINABLE INVESTMENT²

- » ESG integration is the most popular sustainable investment strategy, accounting for 62% of assets under management
- » Impact investing is the second most popular strategy, accounting for 23% of assets under management
- » Negative screening and norms-based screening are also commonly used strategies

BREAKDOWN OF SUSTAINABLE INVESTMENT STRATEGIES²



¹ Global Sustainable Investment Alliance (GSIA) Report 2020
² Bloomberg NEF (2021). Sustainable Investment Outlook 2021

SUSTAINABLE INVESTING

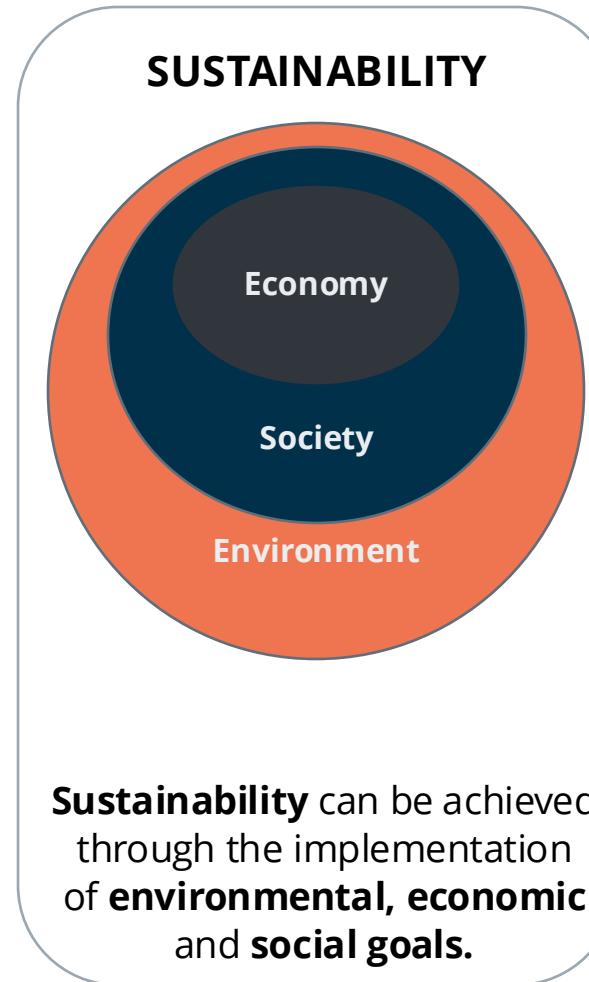
1.2

Sustainable Investing

"Sustainability meets the needs of the present without compromising future generation needs."

BRUNDTLAND REPORT – "Our Common Future"¹

- » It defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- » The report emphasized the interdependence between economic development, social development, and environmental protection.
- » It called for the integration of sustainable development principles into all aspects of decision-making, from local to global levels.



Exploring the rise of sustainable investing²

- » Idea: it is important to evaluate a company's sustainability and ethical impact
- » Measures a company's performance on various non-financial factors
- » to provide investors with a more comprehensive picture of a company's performance and risk profile



EVOLUTION OF SUSTAINABLE INVESTING

GREEN = SUSTAINABLE INVESTING?

STRONG VS. WEAK SUSTAINABILITY

A Comparison of Sustainability Approaches

WEAK SUSTAINABILITY¹

"Assumes that natural capital is substitutable by other forms of capital, such as human-made or social capital, and that economic growth can continue indefinitely without degrading the natural environment."

Weak sustainability practices:

- » Technological innovation,
- » Resource efficiency,
- » Market-based mechanisms (such as carbon or emissions taxes).

STRONG SUSTAINABILITY¹

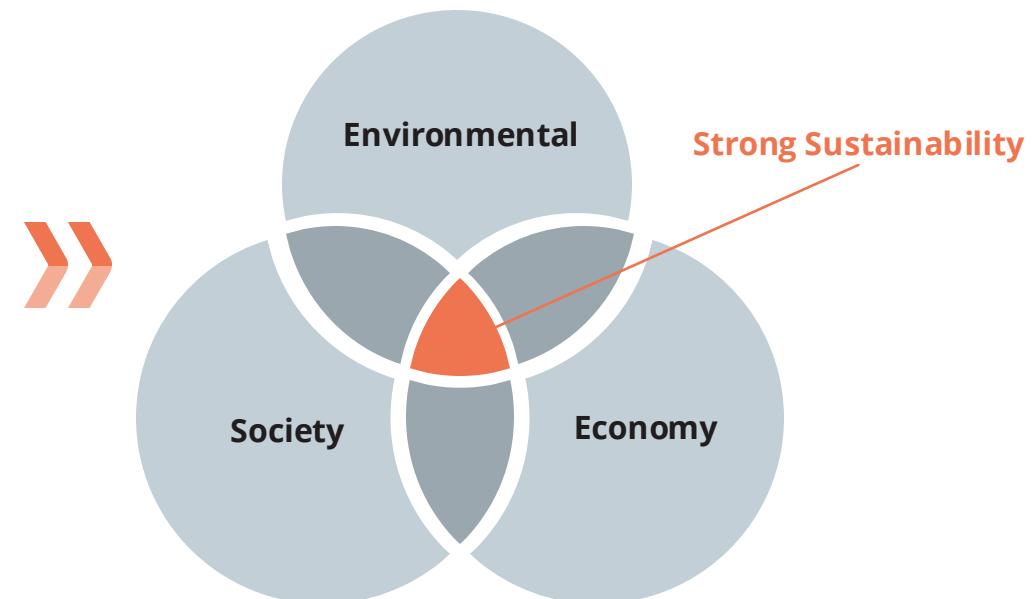
"Recognizes that natural capital is not substitutable by other forms of capital and that economic growth must be limited by ecological constraints to ensure the well-being of current & future generations."

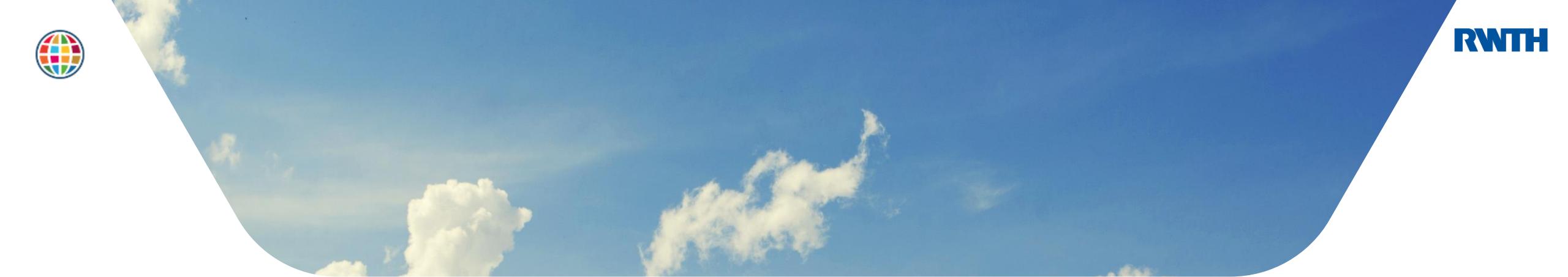
Strong sustainability practices:

- » Circular economy,
- » Ecosystem restoration,
- » Promotion of renewable energy,
- » Development of sustainable agriculture and forestry systems,
- » Biodiversity conservations.

COMPARISON

- » Both prioritize economic growth & environmental protection.
- » Weak sustainability approaches may prioritize economic indicators as profitability, shareholder value & market share.
- » Strong sustainability tend to prioritize ESG factors as social justice, biodiversity conservation, and ecosystem health.
- » Strong sustainability can be challenging due to conflicting stakeholder interests & economic-environmental trade-offs.





ENVIRONMENTAL - SOCIAL - GOVERNANCE

HOW ESG FACTORS CAN DRIVE POSITIVE CHANGES



THE POWER OF ESG INDICES AND SCORES

1.3

ESG

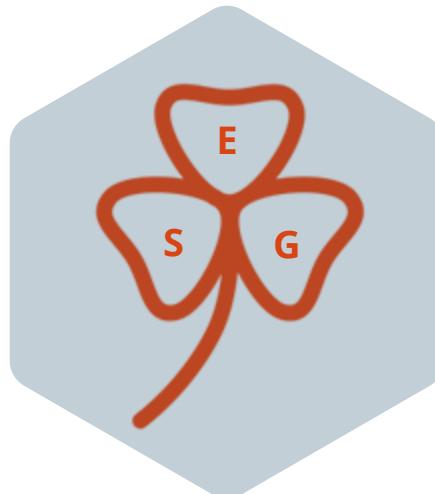
How to Identify Companies that Align with Your Values and Deliver Strong Returns.

DEFINITION

- » ESG stands for Environmental, Social, Governance.
- » To evaluate the sustainability and ethical impact of a company's operations.
- » to help investors evaluate companies based on their sustainability and ethical impact.

IMPORTANCE

- » Calculated based on a range of factors falling under three categories.
- » MSCI, Sustainalytics, and Bloomberg are leading providers of ESG ratings and data.
- » increasingly important to investors, with many institutional investors now including ESG considerations in their investments.



EXPLANATION

- » Companies with strong ESG scores more likely to perform well over long term.
- » ESG scores can vary widely across companies and industries
- » Increased interest in ESG investing strategies to generate financial returns and have positive impact.

EXAMPLES OF ESG FACTORS

- » Carbon emissions and climate change risks.
- » Labour practices and human rights.
- » Executive compensation and board diversity.
- » Data privacy and cybersecurity.

LEADING PROVIDERS OF ESG SCORES

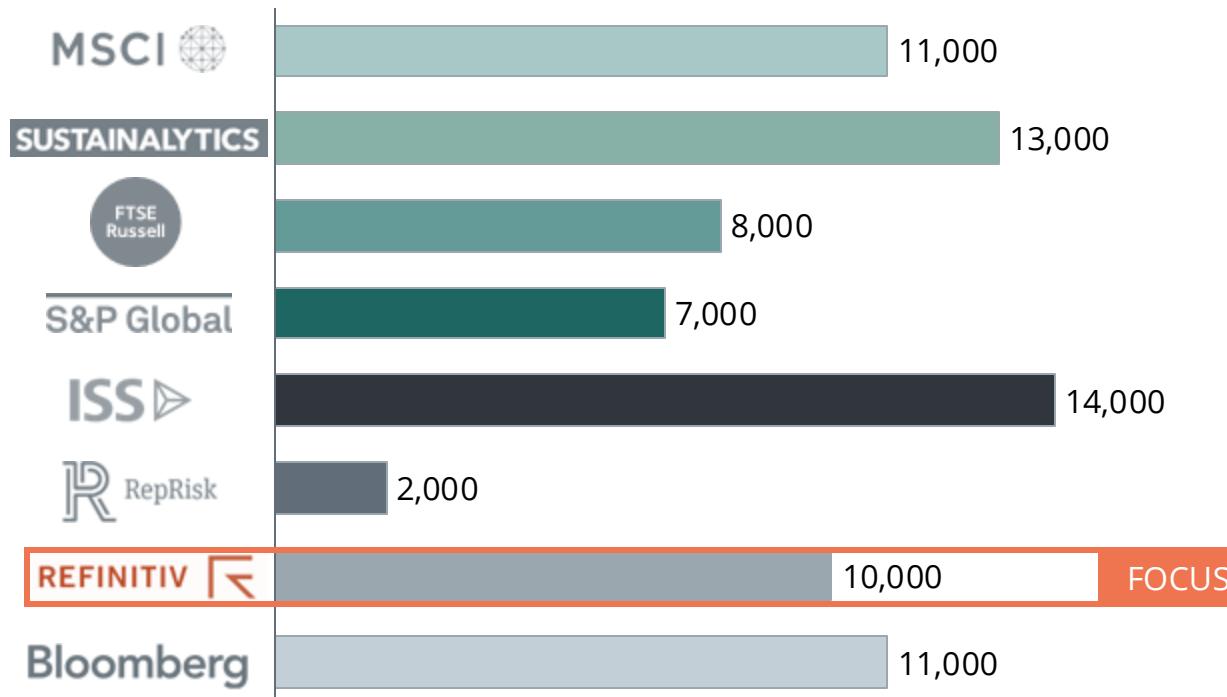
The Refinitiv ESG Score from Thomson Reuters

1.3

ESG



The figure shows for how many companies the leading providers supply ESG scores.



ESG SCORE PROVIDERS

REFINITIV

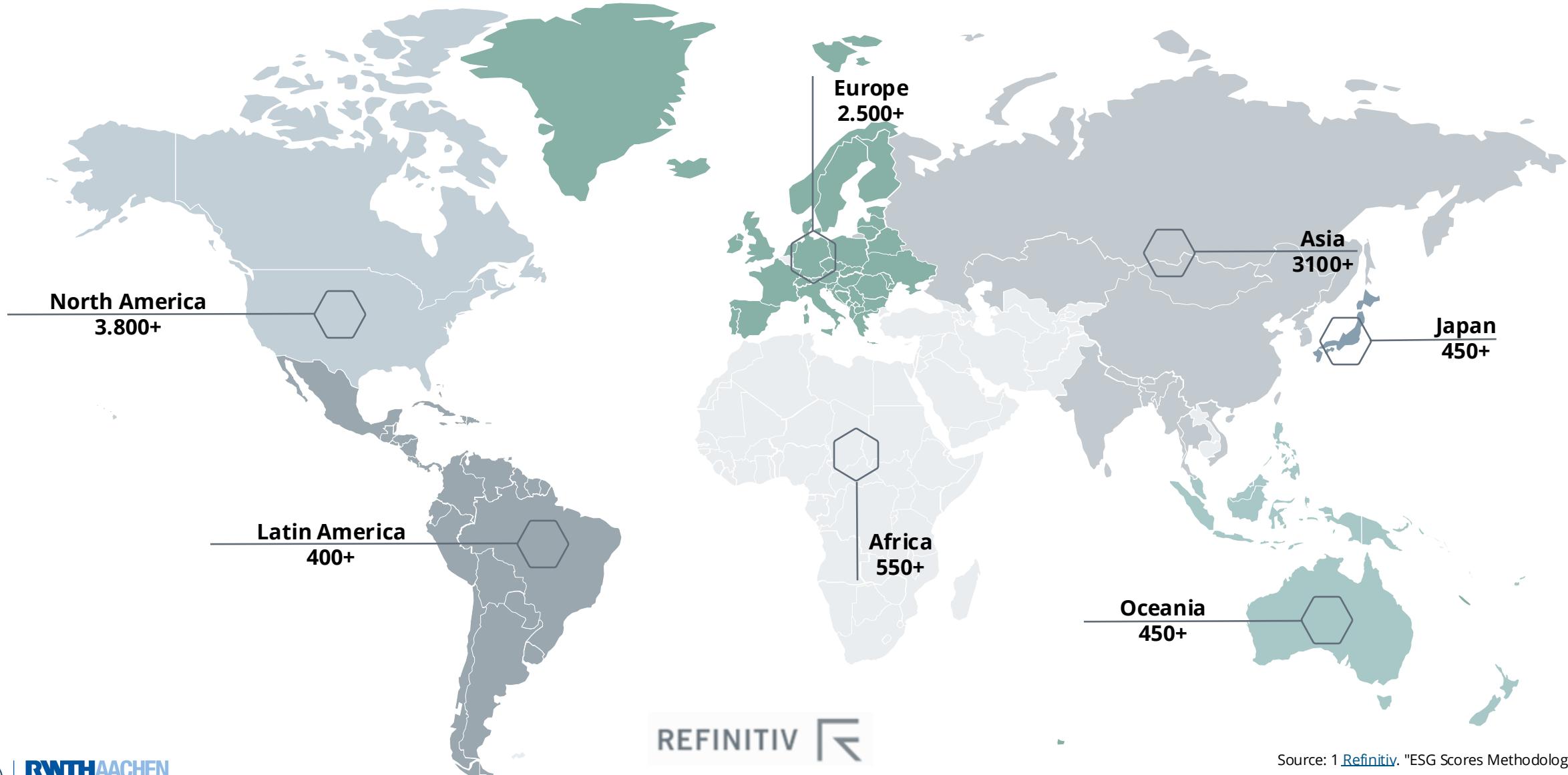
- » Refinitiv had a market share of 10% in 2020, making them one of the largest provider of ESG data.
- » Refinitiv's ESG scores are based on more than 450 data points, which are collected from over 10,000 companies worldwide.
- » Refinitiv's ESG data is used by a wide range of investors, including asset managers, hedge funds, and private equity firms, to inform their investment decisions.
- » Data model to aggregate data from over 10,000 sources, including company disclosures, news articles, and NGO reports, to generate its ESG scores.

REFINITIV ESG SCORE

1.3

ESG

Geographical distribution of companies in the Refinitiv ESG Score

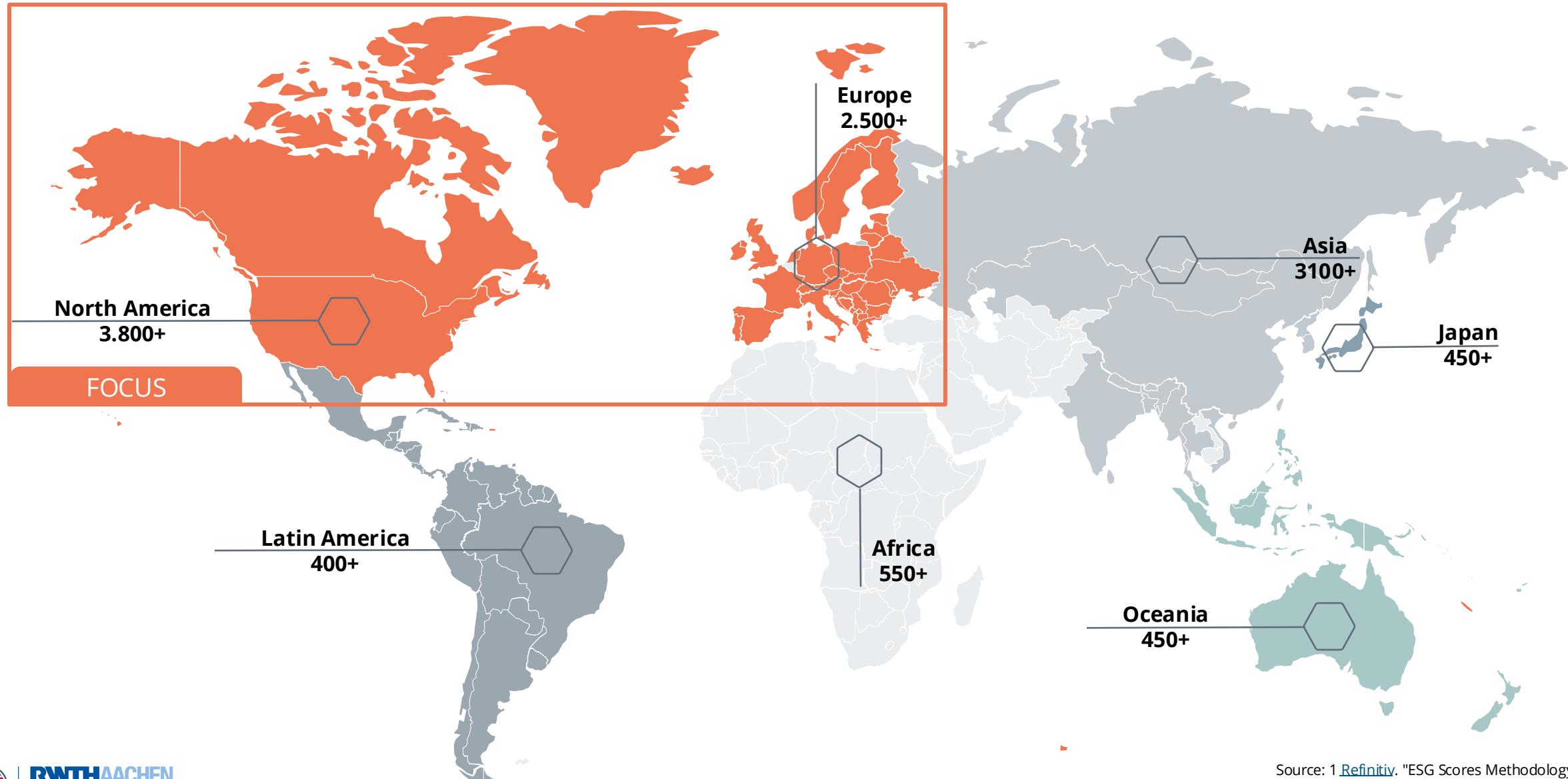


REFINITIV ESG SCORE

1.3

ESG

Geographical distribution of companies in the Refinitiv ESG Score



Source: 1 [Refinitiv](#). "ESG Scores Methodology."

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BREAKING DOWN THE ESG SCORE

A CLOSER LOOK AT THE REFINITIV ESG ATTRIBUTES

E S G

Environmental Social Governance

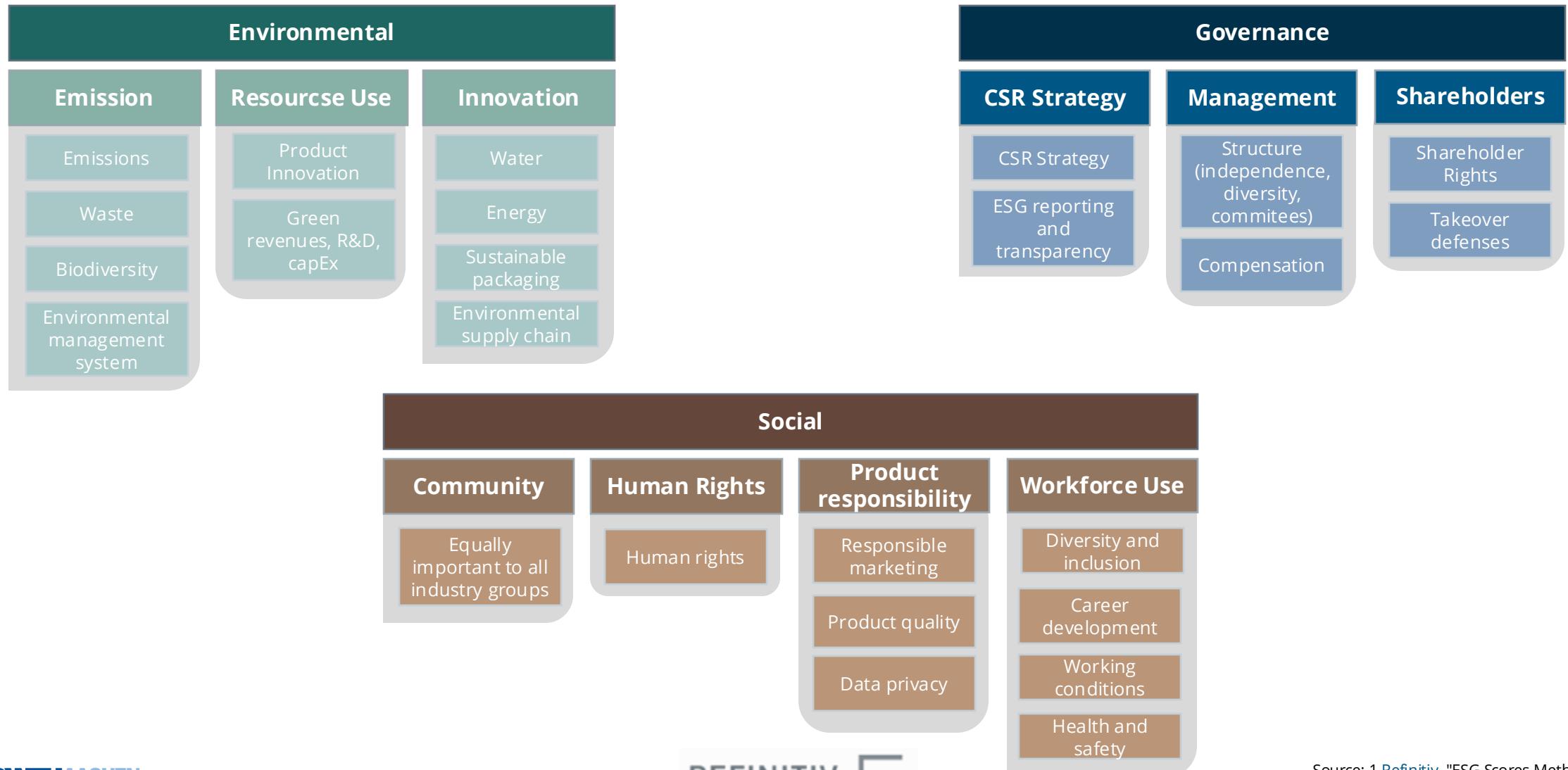


ENVIRONMENTAL, SOCIAL & GOVERNANCE ATTRIBUTES

1.3

ESG

Assessing Companies' Environmental Performance through the ESG SCORE



Source: 1 [Refinitiv](#). "ESG Scores Methodology."

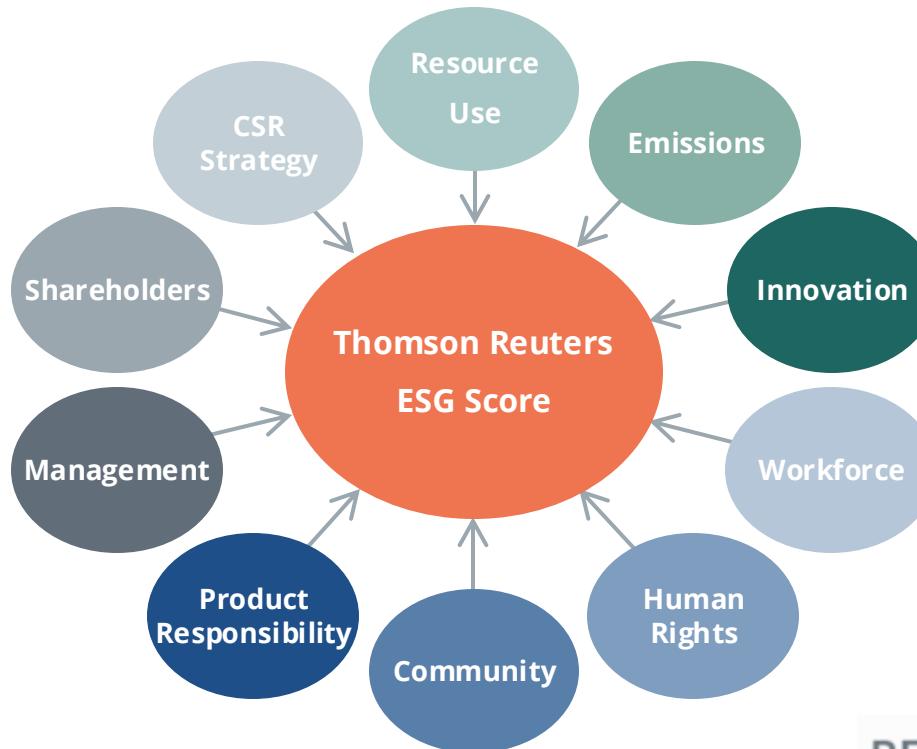
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REFINITIV ESG SCORE

1.3

ESG

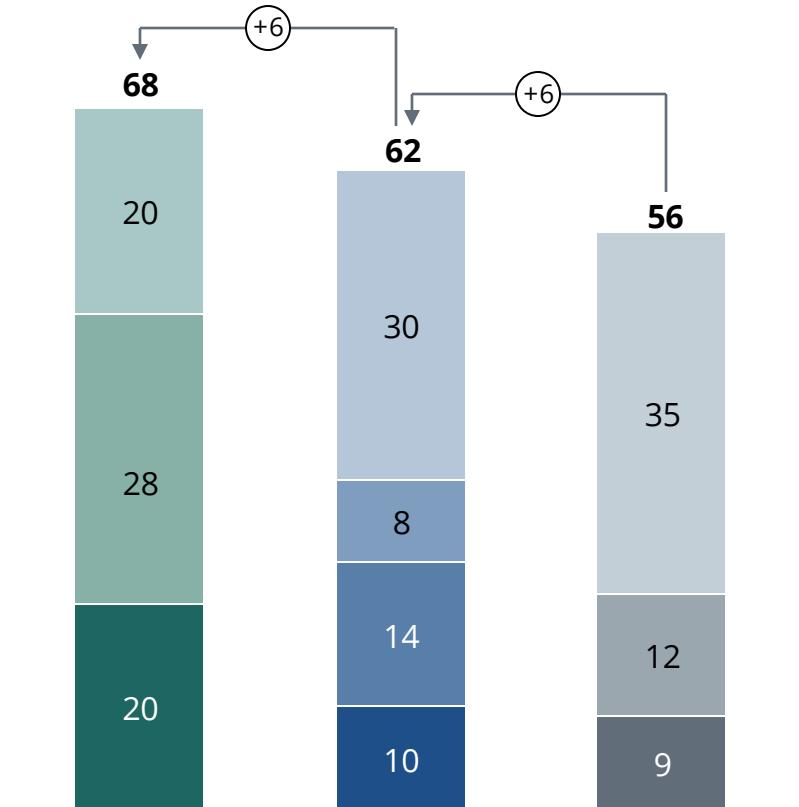
The Refinitiv ESG Score from Thomson Reuters



REFINITIV



- More than **630 measures** are collected and calculated
- ESG uses a subset of **186 metrics** according to the 3 pillars.



Environmental	Social	Governance
Resource Use	Community	Community
Emissions	Product Responsibility	Product Responsibility
Innovation	Management	Management
Workforce	Shareholders	Shareholders
Human Rights	CSR Strategy	CSR Strategy

Source: 1 [Refinitiv](#). "ESG Scores Methodology."

ASSESSMENT OF ESG THEME IMPORTANCE

1.3

ESG

Refinitiv ESG Materiality Assessment Methodology



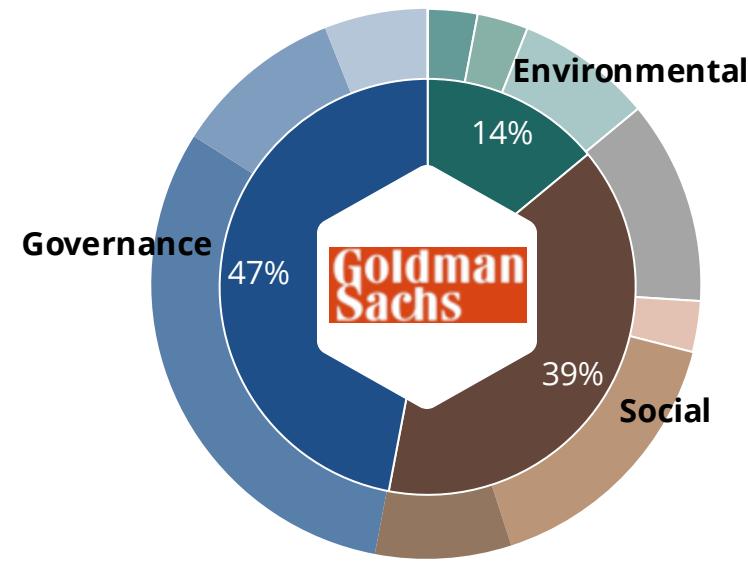
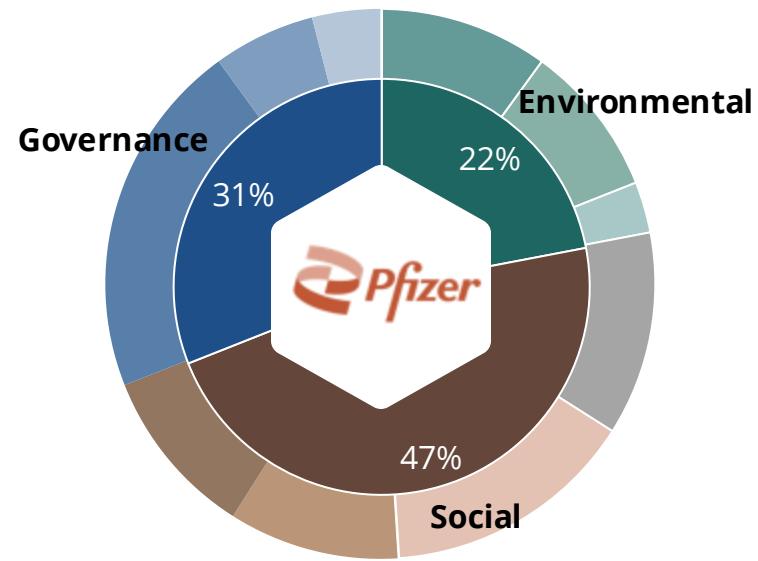
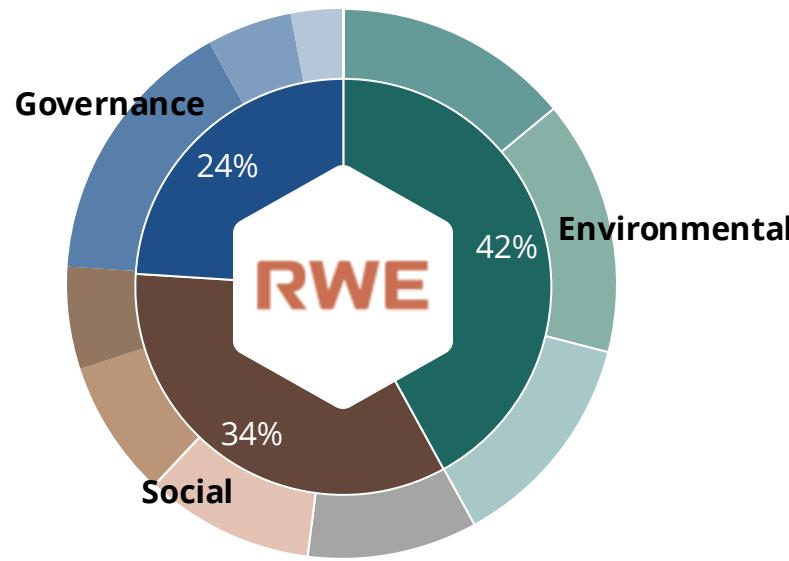
MATERIALITY DEFINITION

- » Refinitiv ESG defines materiality through category weights.
- » Relative importance of themes determined for each industry.
- » Data points with sufficient disclosure used as proxies for industry size.



DATA POINTS

- » *Numeric*: Determined by the relative median value for a company in that industry group.
- » *Boolean*: Determined based on the disclosure of relative level in that industry group.
- » Some themes excluded due to insufficient disclosure.



Resource Use	Env. Innovation	Human Rights	Product Responsibility	Shareholders
Emission	Workforce	Community	Management	CSR Strategy

1 Refinitiv. "ESG Scores Methodology.", 2 MSCI. (2021).
ESG Investing: Understanding Materiality, 3 SABR. (2021).
Materiality Map

ALIGNING PROFIT WITH PURPOSE

HOW ESG FACTORS BECOME CRITICAL IN FINANCIAL DECISION MAKING



THE IMPORTANCE OF ESG AND ITS ECONOMIC INFLUENCE

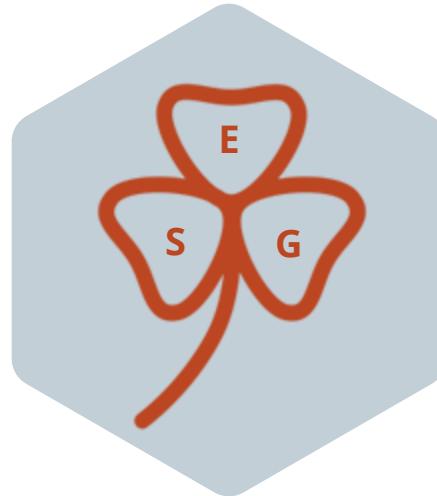
1.4

ESG Influence

Exploring the Economic Benefits and Risks of Integrating ESG Factors in Investment Decisions

Impact of ESG performance and firm value¹

- » ESG score has a positive and highly significant relationship with the firm value
- » SOC, GOV: highly significant positive relationship with the firm value
- » ENV: no relationship with firm value, reasons: taking longer time before outcome, high invest cost



ESG and financial performance²

- » Roughly 90% of studies find a nonnegative ESG-CFP relation
- » Large majority of studies reports positive findings
- » Positive ESG impact on CFP appears stable over time

The impact of social responsibility and CFP³

- » ESG directly impacts a company's financial performance
- » no consensus in the literature on this relationship, but more articles refer to a direct positive relationship and a bidirectional positive relationship

ESG and enterprises stock market performance⁴

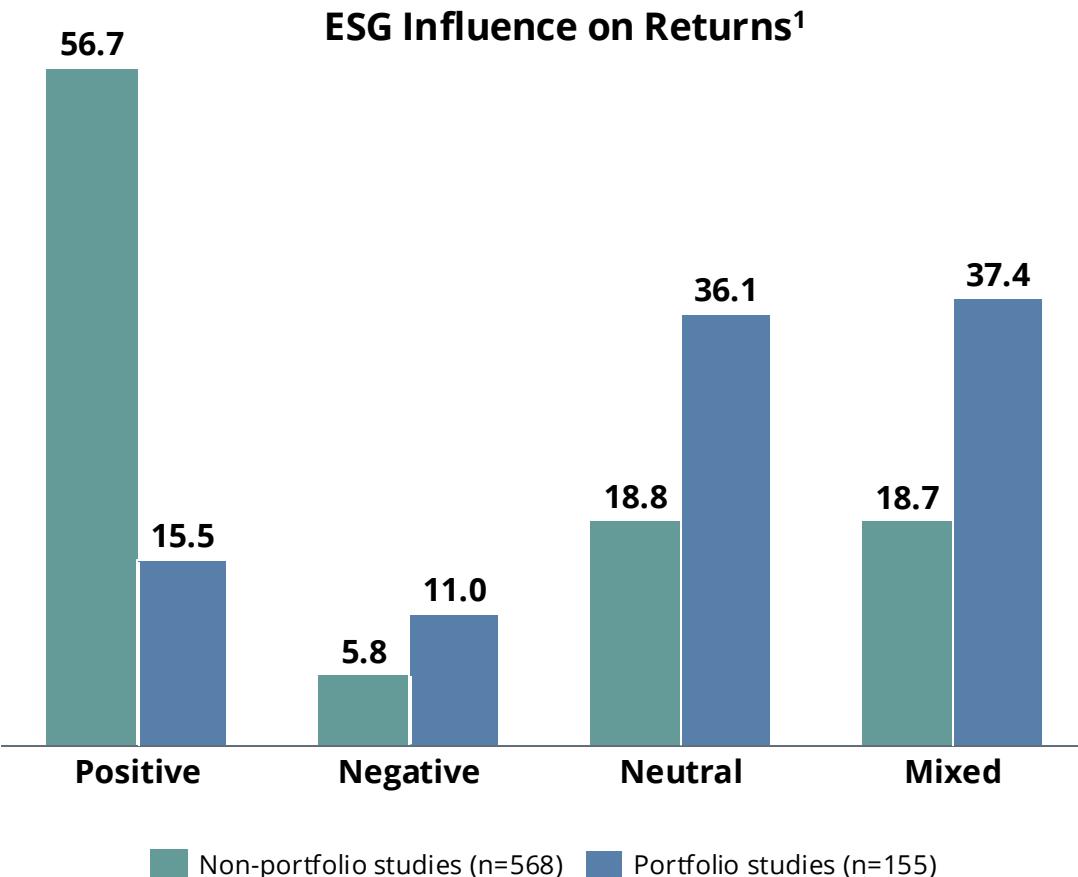
- » there is a positive correlation between enterprise's ESG indices and its stock market performance
- » non-state-owned enterprises is greater than that on state-owned enterprises, and the stock market performance of the secondary industry is much more affected by ESG indices than that of the tertiary industry

THE IMPORTANCE OF ESG IN FINANCIAL PERFORMANCE

1.4

ESG Influence

Making Sustainable Investing Decisions



ESG ON FINANCIAL PERFORMANCE



- » Evidence from +2000 empirical studies shows in approx. 90% of the individual studies, a non-negative correlation between ESG and financial performance was found.
- » Positive results were found for the benefit to investors, but they were less clear.¹
- » In a sample of 644 studies governance-related aspects have the highest percentage of negative correlations with 9.2%.
- » Environmental studies offer the most favorable relation with a 58-4.3% positive to negative ratio.
- » Social studies show the weakest relation with 55.1% positive and 5.1% negative outcomes.¹



- High discrepancy of available ESG data sources
- Limitation of the studies: lengthy academic publication period

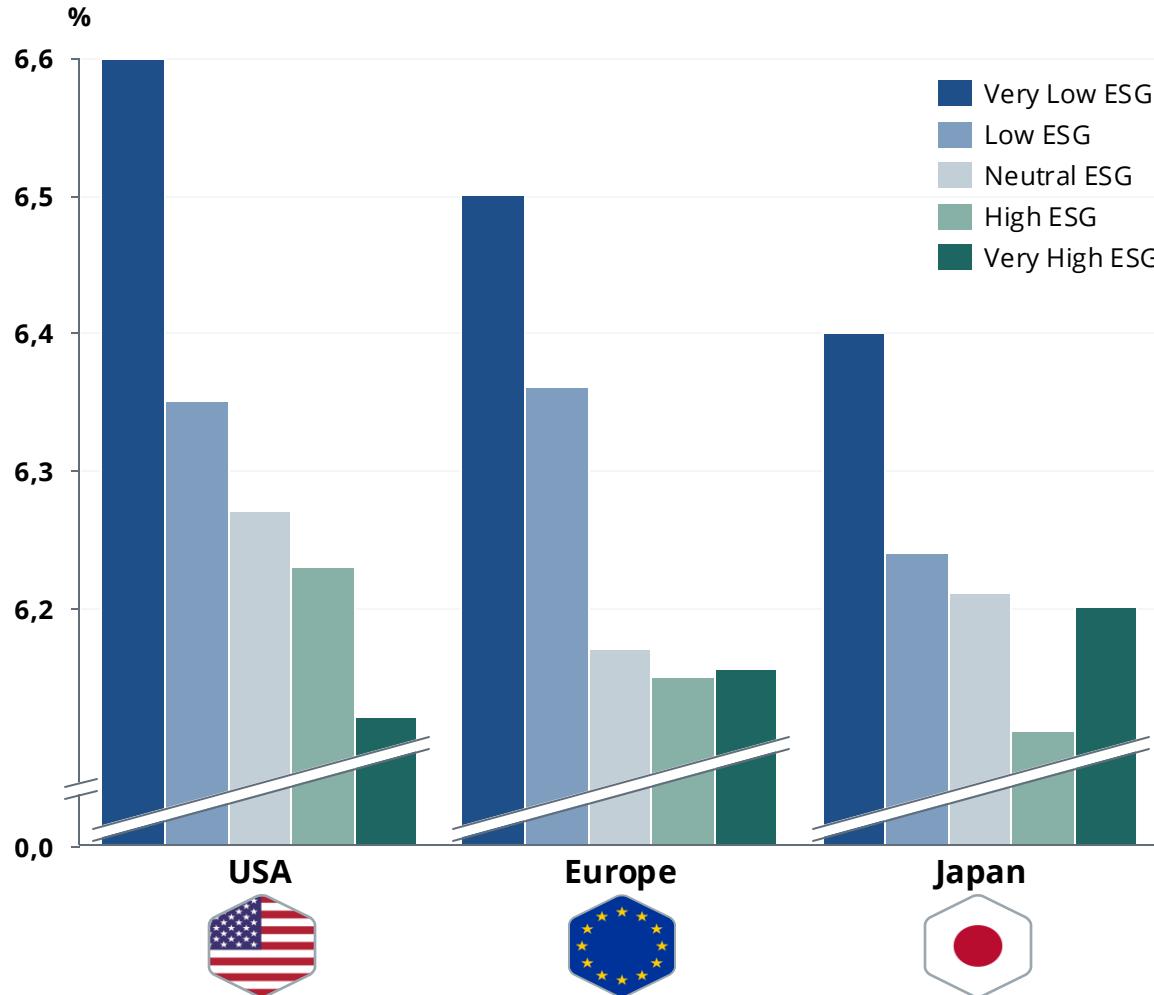
¹ Friede, Busch, Bassen

ESG SCORES AND COST OF CAPITAL

1.4

ESG Influence

Reducing the Cost of Capital through Strong ESG Performance



KEY TAKEAWAYS

- » Companies with high ESG scores experienced lower costs of capital than companies with poor ESG scores in both developed and emerging markets
- » Companies with lower ESG scores exhibited a stronger relationship to the cost of capital than those with higher scores
- » Regional differences were present, with the relationship between ESG scores and cost of capital being strongest in the U.S..

ENVIRONMENTAL SCORE: INFLUENCE ON FIRM PERFORMANCE

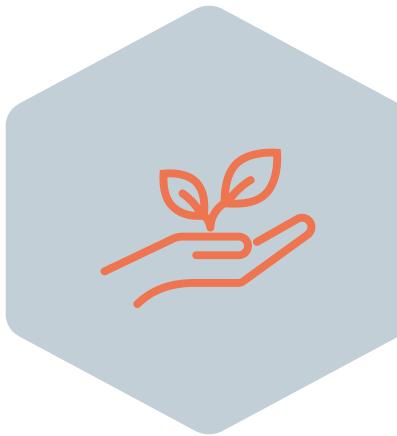
1.4

ESG Influence

Understanding the Influence of Emissions, Innovation and Resource Use

Emissions and firm performance¹

- » Carbon emissions reduce financial and market-based performance of emerging market firms
- » Firms with high carbon emissions have lower return on equity, Tobin's Q, and credit rating.



The management of greenhouse gas emissions and its effect on firm performance²

- » Adoption of an Environmental Management System and a control of emissions lead to profits through an *increase in demand & productivity*

The whole relationship between environmental variables and firm performance³

- » Positive relationship between environmental protection and financial performance
- » *competitive advantages*
- » The effect of environmental protection on firm performance varies across different sectors.

Dynamics of environmental and financial performance⁴

- » relationship between environmental and financial performance depends on time horizon
- » Short-term financial evaluation may underestimate the benefits of reducing emissions.
- » *investors "want" proactive environmental strategies*

ENVIRONMENTAL ACTIVITIES CAN HAVE A POSITIVE INFLUENCE

SOCIAL SCORE: INFLUENCE ON FIRM PERFORMANCE

1.4

ESG Influence

Impact of Corporate Social Responsibility on Financial Performance



Corporate Social and Financial Performance¹

- » Corporate social performance *is positively linked* to corporate financial performance
- » the effect is small.
- » The relationship between CSP and CFP is complex
- » can vary based on industry, location, and other factors.



Job satisfaction and firm performance²

- » Job satisfaction is positively linked to firm performance
- » measured by return on assets and return on equity.
- » The relationship takes time to manifest



CSR influence on CFP³

- » The relationship between CSR and CFP is mixed
- » Some studies have found a positive link between CSR and CFP
- » others have found no significant relationship or even a negative relationship.



Board diversity on firm performance⁴

- » significant negative association between gender and age diversity on firm performance
- » measured by Tobin's Q.
- » negative relationship may only apply to SMEs
- » larger firms may benefit from greater diversity



SOCIAL ACTIVITIES MAY HAVE A POSITIVE INFLUENCE, BUT ITS NOT CLEAR

GOVERNANCE SCORE IMPACT ON FIRM PERFORMANCE

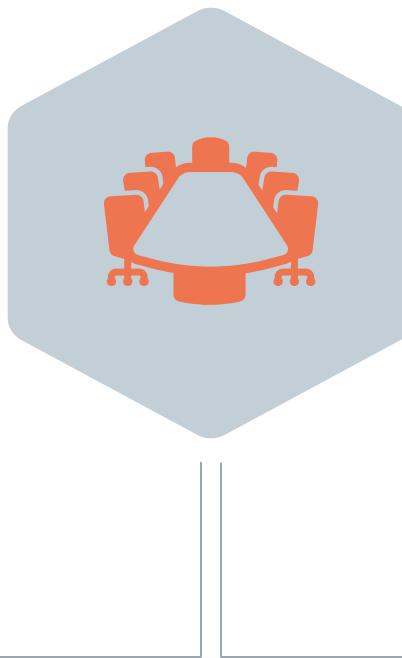
1.4

ESG Influence

Exploring the Relationship with the Governance Score

Xie: Do environmental, social and governance activities improve CFP?¹

- » *Board independence* has a significantly positive relationship with market value.
- » CEO duality has a weakly positive relationship with ROA.
- » Percentage of women on the board has a very strong positive linkage with ROA and market value.



Kyere, Ausloos: Corporate governance and firms' financial performance in UK²

- » Companies improve their financial market performance by adopting the *right corporate governance mechanisms*.
- » Insider shareholding has no influence on financial performance.
- » Strong independent board improves financial performance.

Mishra: Effect of board characteristics on firm value³

- » Board size is positively and significantly related to Tobin's Q and ROA.
- » *Board independence* is affecting firm performance positively
- » market is not attaching much value to it

Özbuğday: Corporate social responsibility and market valuation⁴

- » CSR activities positively affect the stock market valuation of companies in the consumer goods industry, but not in the financial services or healthcare industries.
- » Companies without CSR activities may face *financial and reputational risks* as investors and stakeholders value them more

GOVERNANCE MEASURES MAY HAVE A POSITIVE INFLUENCE, BUT DIFFERENCE TO SOCIAL SCORE IS NOT CLEAR



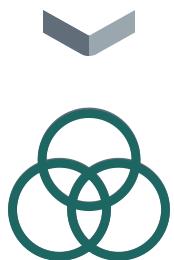
SUM UP MOTIVATION

UNCOVERING THE TRUTH BEHIND ESG INVESTING

IS SUSTAINABLE INVESTING POSSIBLE WITH ESG AS A CRITERIA?

MOTIVATION OF OUR WORK

Better understanding of sustainability and investing, the **ESG** and its rating system, Linking the definition of **sustainability** and ESG rating system, comprehension of the **causes** for a good ESG valuation and a good financial performance



Sustainability



ESG



Causality

OUR MOTIVATION FOR ANALYSIS

Is the ESG a Good Criteria for Sustainable Investing?

2

Motivation

Why are we conducting this analysis?

1

- Lack of clarity around the sustainability of ESG scores
- Companies with high ESG scores have been found to outperform their peers in terms of financial performance, including higher returns and lower volatility.
- Even though the evidence is not completely clear because the positive impact may vary depending on factors as industry, geography and company size.
- Positive correlation between ESG scores and financial performance does not necessarily imply causation.



Why does this analysis matter?

2

- » Investors need reliable information to make informed decisions about sustainable investing.
- » Investors could be misled into investing in companies which don't fit their sustainability criteria.
- » Understanding the reasons for the correlation help investors distinguish between sustainable and "greenwashing" companies.



IS THE ESG SCORE A RELIABLE INDICATOR OF SUSTAINABLE INVESTING OR JUST PROFITABLE GREENWASHING?



METHODOLIGY

GATHERING THE DATA AND FIND CONNECTIONS

COLLECT AND FORMATTING DATA

Choosing sources for data in relation to the reliability of the date, **filter** the markets for data abundance and **finding** a sufficient set of datapoints



Databases



Markets



Datapoints

DATABASES AND MARKETS

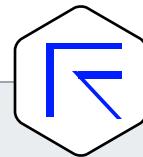
3.

Methodology

Two Sources of Data and two Markets

Refinitiv

- » All Data available
- » Access via Eikon
- » Python Api
- » Datastream(excel)
- » Workspace



- » Incomplete Data
- » Unreliable, incomprehensible
- » Unreliable, easy to use

Refinitiv Workspace was the best compromise

Yahoo Finance

- » Fast Access to financial data
- » Only Limited Data Available
- » No subscription needed

Additional difficulty:

- » Calculation methods for scores got changed.



Markets

- » Decision on Markets was relatively straight Forward
- » US and European Markets
 - » Long existing Companies
 - » Lots of historical ESG Scores
 - » Enough research to compare against



RELEVANT DATA

3.

Methodology

ESG Data and it's dependencies

ESG

- » Need for reliable data
 - ESG Scoring Scope >50% for the last 10 Years

Amount of Data

- 1 ESG Score
- 9 Pillar Scores
- 215 Individual Scores



**668 companies
that fulfill
these criteria**

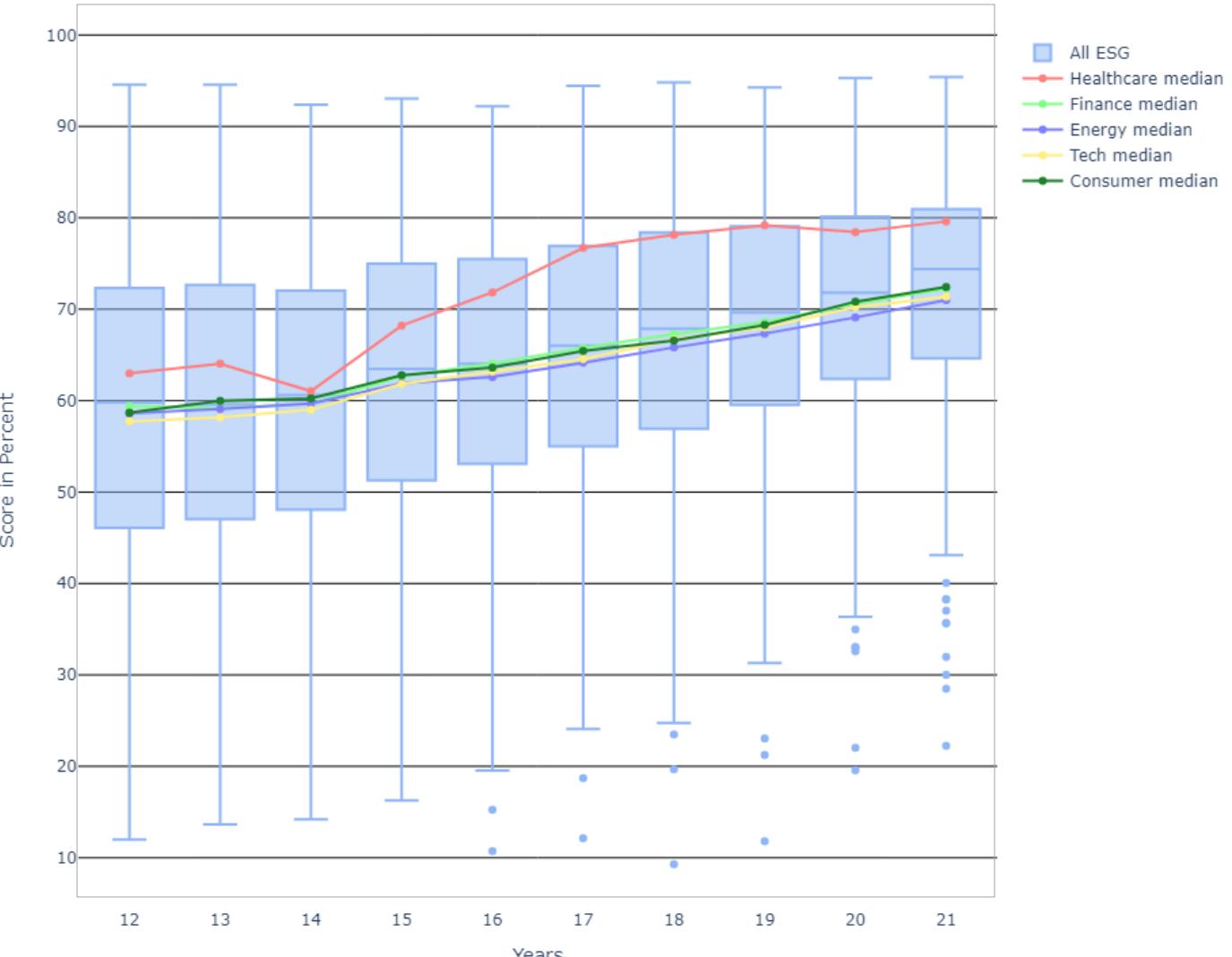


Industry Data

- » GICS Industry Name
 - 11 Sectors
 - 21 Industry Groups
 - 69 Industries

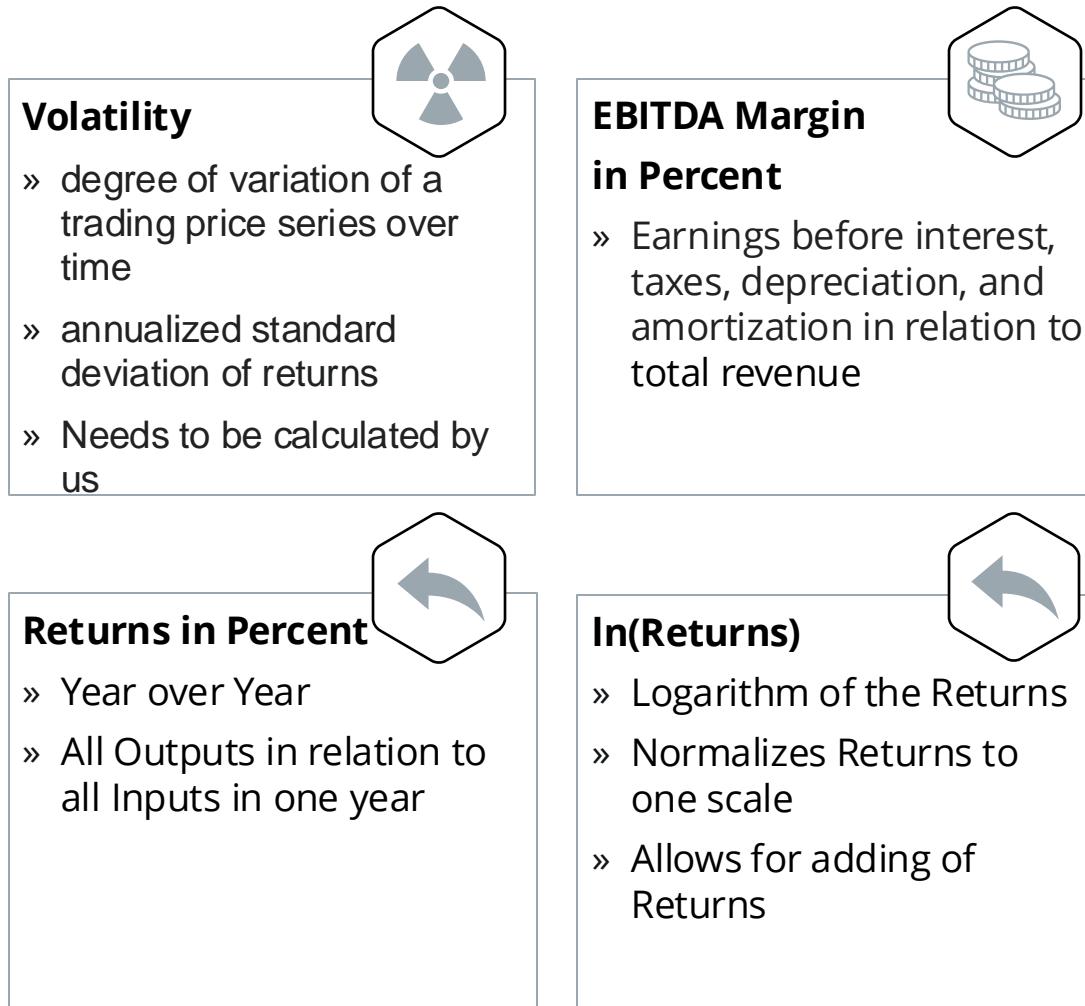


ESG Development by Industry

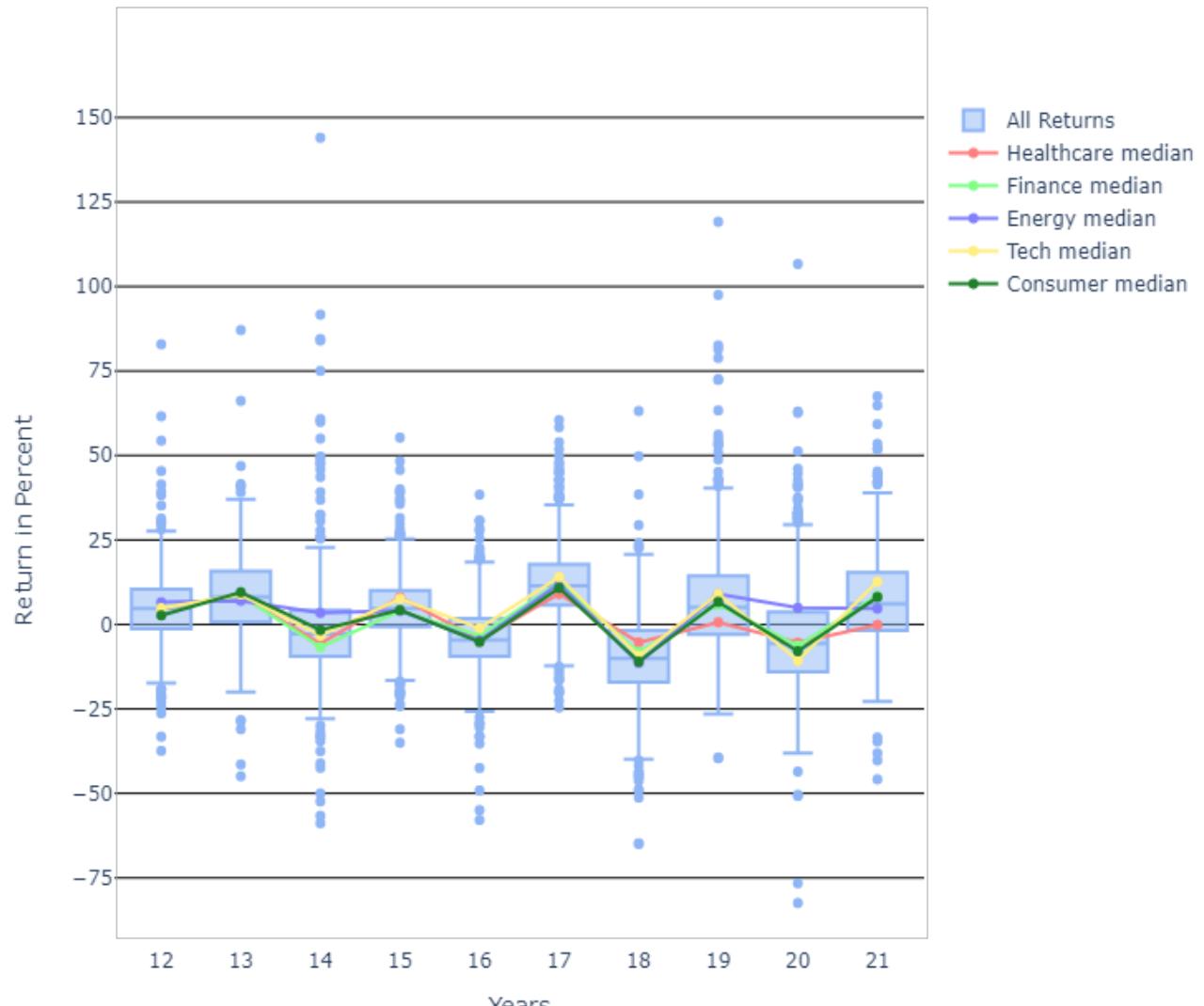


RELEVANT DATA

ESG Data and it's dependencies



Returns Development by Industry



DATA PREPARATION

Calculation of Data and Clusters



Volatility



Clustering

DATA PREPARATION

3.

Methodology

Methods to structure and understand our data

Volatility

- » Data of over 5000 previous trading days
- » Cleaning data of days outside of scope
- » Around 2500 days left
- » Divided into 10 years
- » Then calculation of volatility

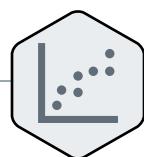


Formula

- » $Changey_{ct(x+1)} = \ln(Return_{ct(x+1)}) - \ln(Return_{ct(x)})$;
 $c = [\text{companys}], x = [0, -1, \dots]$
- » $Volatility = \sigma_a \sqrt{T}$;
 $a = [12, \dots, 21], T_a = [252, 248, \dots, 252]$

K means

- » Filter all nonnumeric values out of all the ESG data
- » Set the number of clusters
 - K means is then performed over all companies and years
 - Generates clusters that separate the data with minimal error

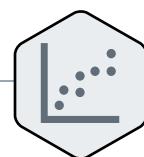


Formula

- » $\text{Min } J = \sum_{i=1}^k \sum_{x \in S_i} \|x_j - \mu_i\|^2$;
 μ_i is mean of set $S_i = [S_1, \dots, S_k]$, $x_j = [x_1, \dots, x_n]$

Principal component analysis (PCA)

- » Filter all nonnumeric values out of all the ESG data
- » Set number of components
- » PCA is an iterative procedure



First iteration

- Get the component with the highest influence (principal component), by maximizing the variance on the axis

Following iterations

- Subtract the principal component
- Get the new principal component
- Continue for n iterations



GICS Industries Categories are not necessarily the best way to divide our data into subsets.





OBLIGATORY
FALSE CORRELATION:

NO. OF EMPLOYEES AT
CAMPSPACES CORRELATES
WITH 0.95 WITH THE
HARVEST QUANTITY OF
FIELD CUCUMBERS

HOW CAN WE MEASURE CAUSALITY?

- TLDR: We can't
- We are going to measure whether X Granger causes Y



Correlation



A/B Testing



Granger Causality

GRANGER CAUSALITY TEST

3.

Methodology

Can X help to predict Y ?

Regression

- » Train two Time Series Regression Models
 - Model 1 based only on Y
 - Model 2 based on X and Y
- » Calculate the Residuals
- » Does Model 2 deliver a better prediction than Model 1?

F-Test

- » Compare the residuals of both models
 - Are they significantly different
 - If yes, then X Granger causes Y
 - If not, then X does not Granger cause Y

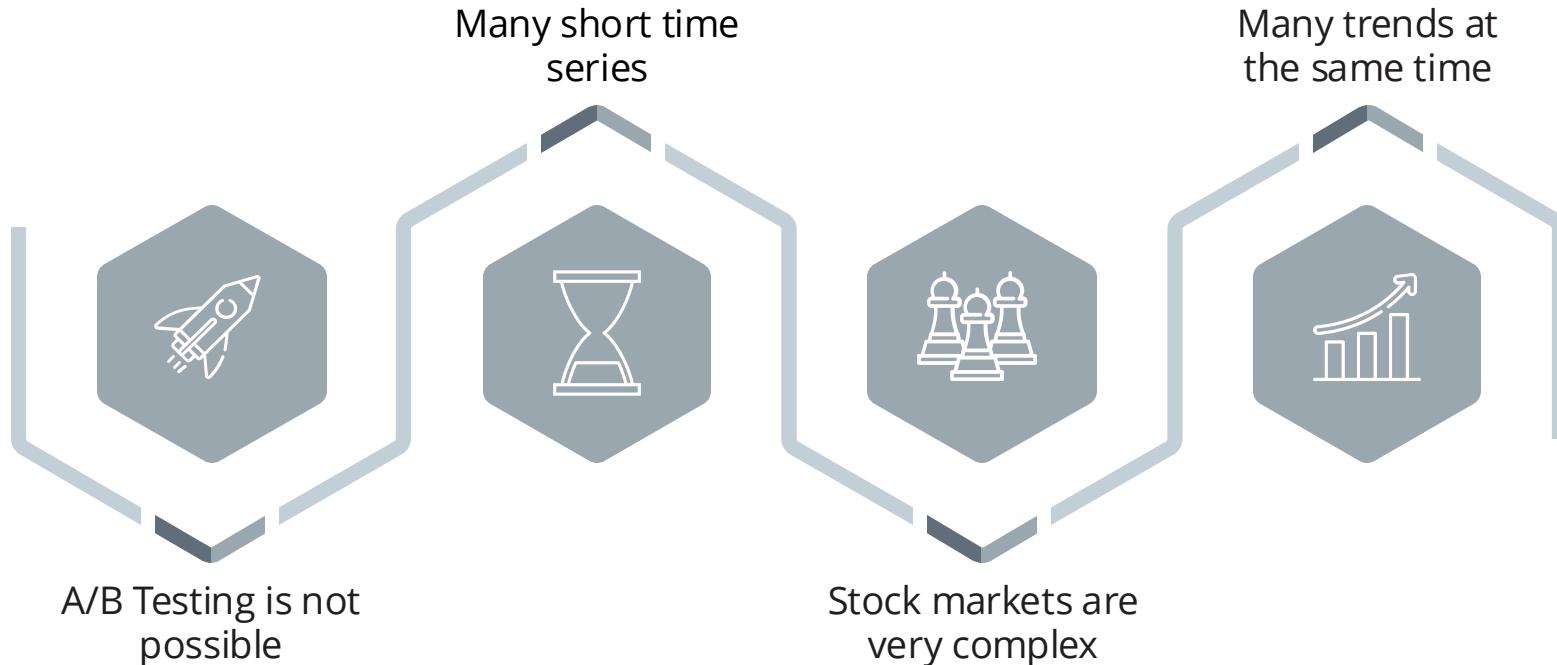
Assumptions

- » If one helps to predict based on past values, it may cause it
- » Does not solve the Problem if both are correlated to a third variable
- » It needs many time steps to get a significant result

FOR THE GRANGER TWO LONG TIME SERIES ARE REQUIRED

CHALLENGES

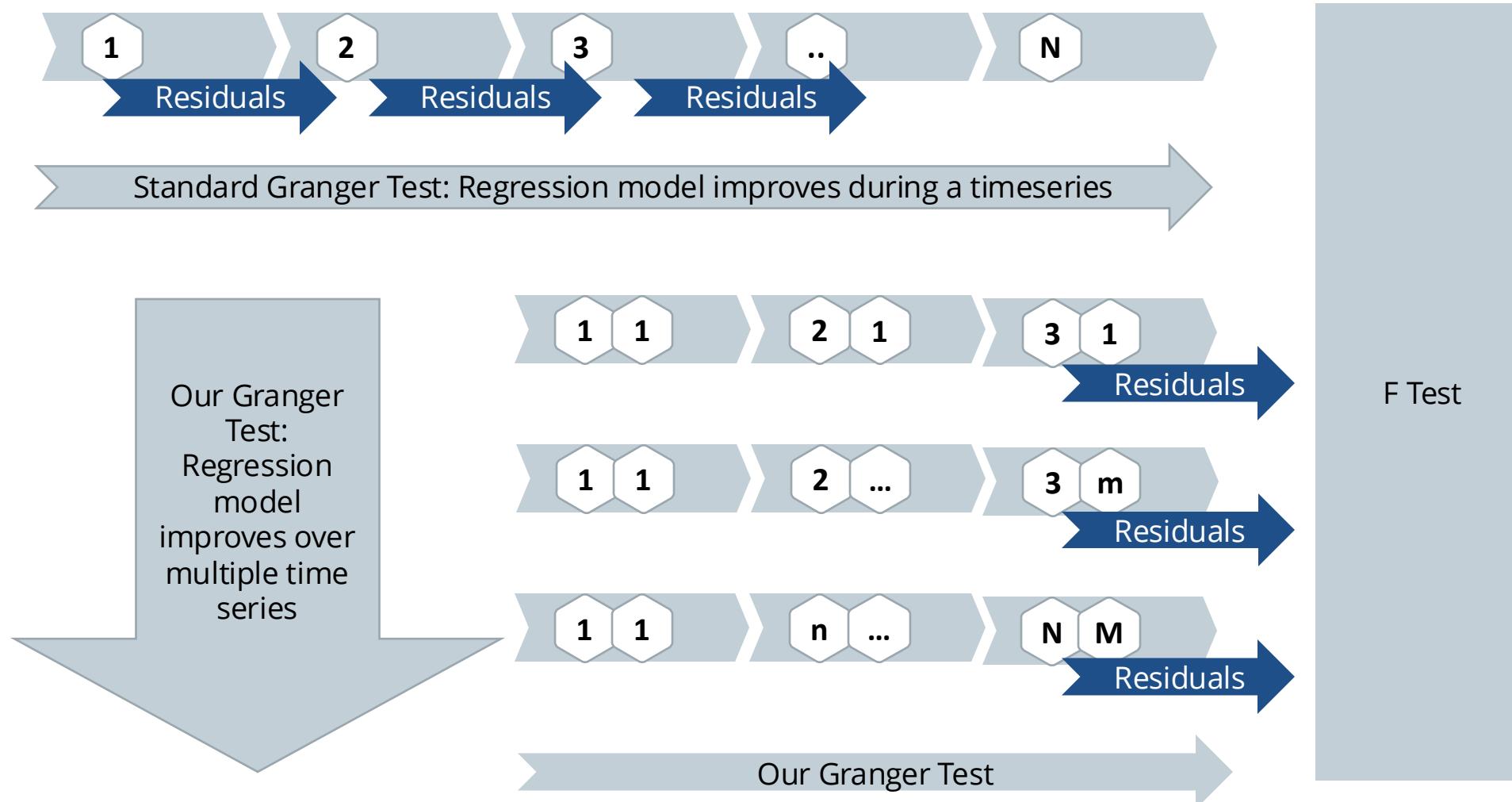
The Granger test won't give us an easy ride to the solution



THE NORMAL GRANGER TEST IS NOT SUFFICIENT
WE NEED A GRANGER TEST THAT CAN LEVERAGE MANY SHORT TIME SERIES

OUR GRANGER TEST

Leveraging the number instead of the length of the timeseries



Pros

- » Solves the Problem with short time series
- » Fits all Regression models
- » Minimizes the Information Loss

Important

- » Model which fits the data is required
- » Trade off between bias and variance of the models
- » The model must fit all aspects of the Granger Test

The Regression Part of the Granger test

Autoregression (AR)

- » Regression based on past values
- » Uses lagged values
- » For the timeseries Y

$$Y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + \text{error}_t = \sum_{\tau=1}^L A_\tau X_{(t-\tau)} + \epsilon_t$$

» For the Granger Test the previous data of x needs to be considered as well

*With L as the number of Lags,
A as the coefficient matrix,
X as the Matrix comming out of the
vectors of the variables,
b as the error term
with a and b as coefficents*

$$Y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + \text{error}_t$$
$$b_0 + b_1 x_{t-1} + b_2 x_{t-2} + \dots + b_m x_{t-m} + \epsilon_t$$

Vector Auto Regression (VAR)

- » For Multivariate Granger tests
- » Fundamentally the same principle as the AR
- » Does catch the dynamic interdependences as VAR

FINE TUNING OF THE REGRESSION MODEL

3.

Methodology

Methods to improve the Regression Model

Only Clustering and Lasso

- » Just use the data from the same industry/ cluster
- » Use Lasso to prevent overfit
- + Easy to understand
- + Simple implementation
- Huge Information Loss
- Overfitting still possible
- The same as step 2 or 3 without a starting guess
- Huge variance bias tradeoff

1



NOT A GOOD IDEA

Industry beta

- » Adding a beta and an intercept to the VAR model, to fine tune it on the industry
- » $y = \alpha * y_{pred} + b$
- + Prevent overfit due to lack of parameters
- + Can be used on large or small industries
- + Can be combined with Lasso, to exclude the risk of overfit
- May underfit the model/ still overfit the model

2



GOOD AND SIMPLE

Stepwise approach

- » Sort the Companies by cosine similarity
- » Start with the Coefficients from the VAR model
- » Optimize them stepwise
- + way more options to finetune
- More complex
- May Overfit the model
- Exploding/ vanishing gradients possible

3



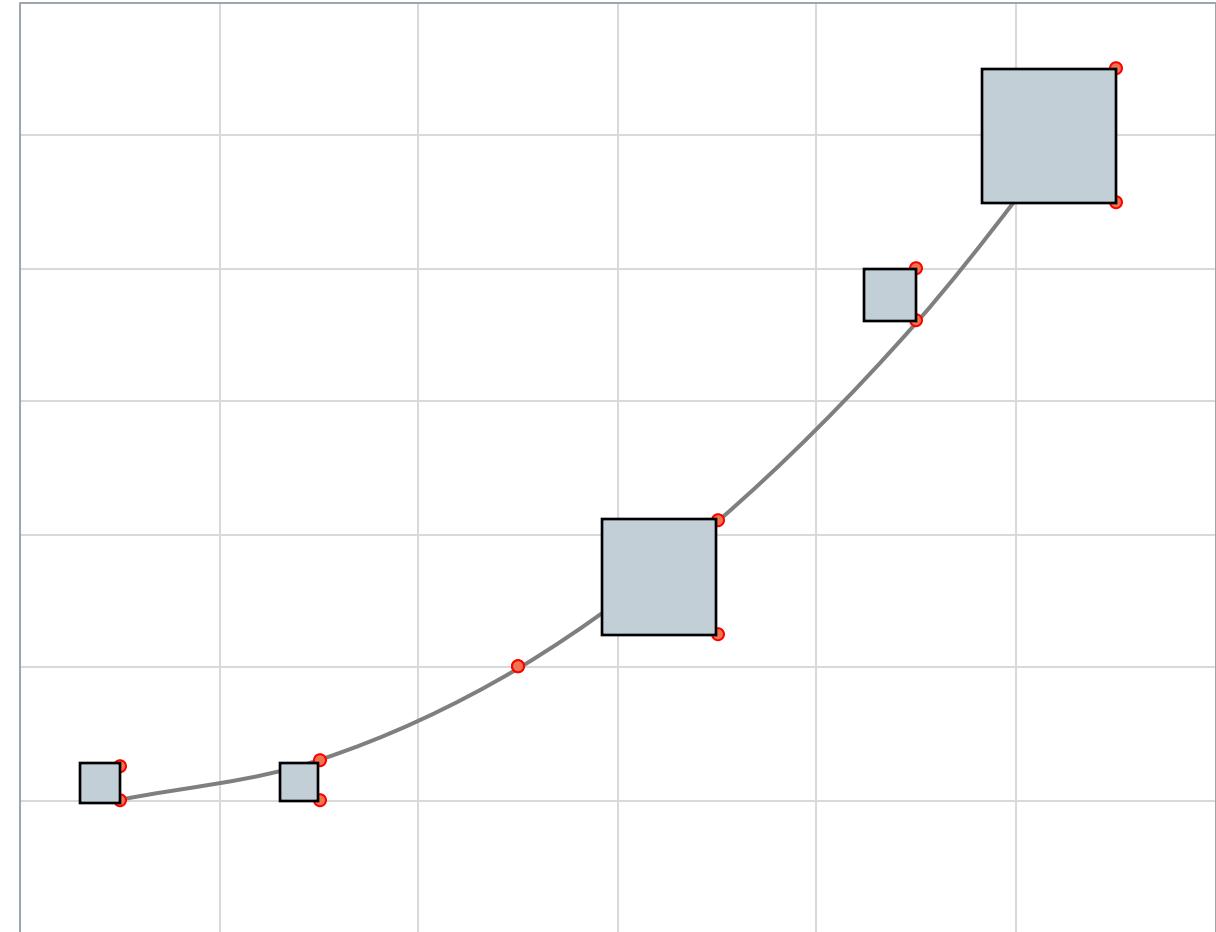
PROMISING BUT COMPLEX

The Regression Part of the Granger test

Least Squares

- » Approximates the solution of a system
- » Minimizes the overall Residuals of the difference between the observed value and the modeled value
- » Residuals get squared to ensure positivity
- » Larger Errors get punished more

$$\sum_{i=1}^n (f(x_i, \vec{a}) - y_i)^2 = \|\vec{f} - \vec{y}\|_2^2$$
$$\min_{\vec{a}} \|\vec{f} - \vec{y}\|_2^2$$
$$\vec{a} = [a_1, \dots, a_m], x = [\vec{f}(x_1, \vec{a}), \dots, \vec{f}(x_n, \vec{a})]$$



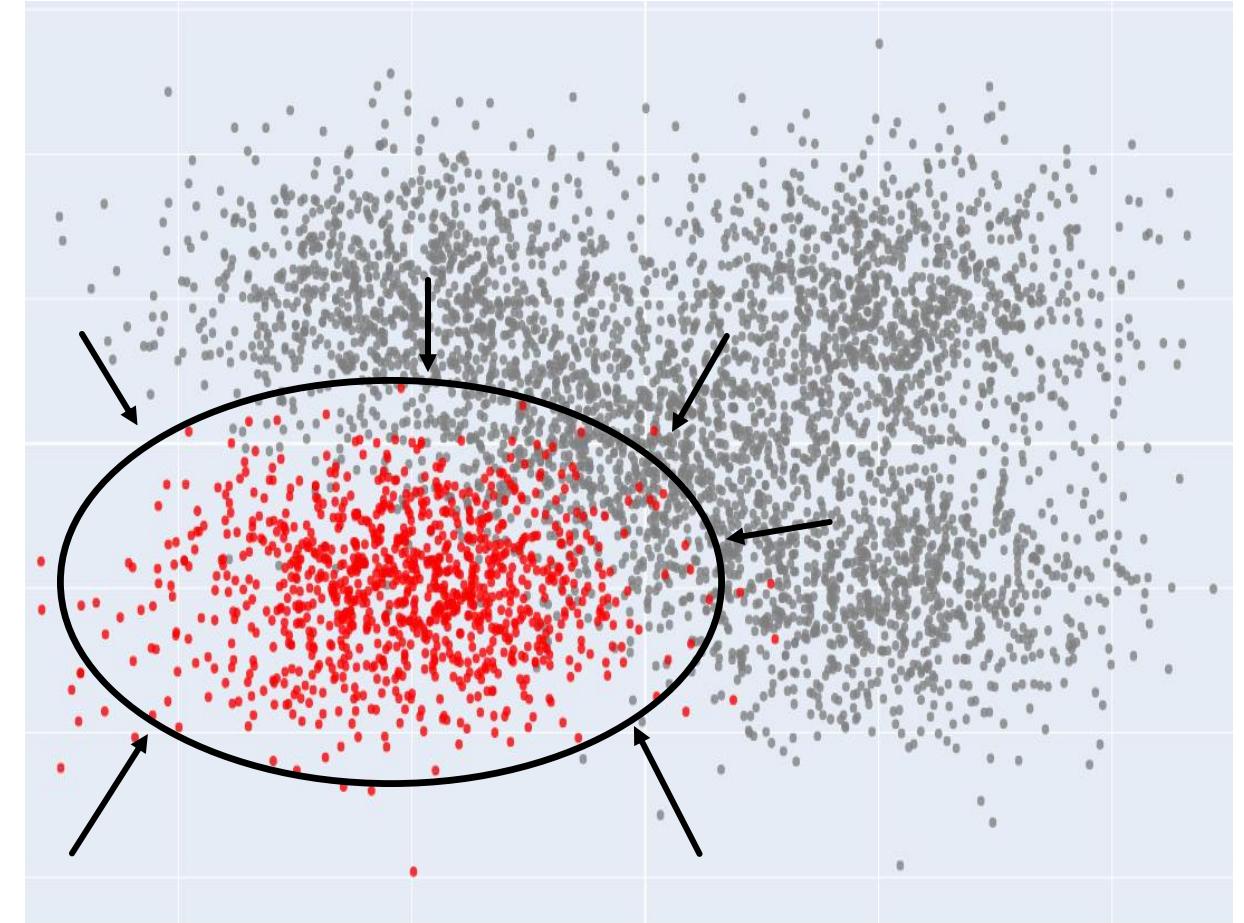
The Regression Part of the Granger test

Gradient Descent

- » For Multivariate Granger tests
- » Error gets minimized
- » Step size decreases with distance to optimum

$$X_t = \sum_{\tau}^L A_{\tau} X_{(t-\tau)} + \epsilon_t$$

with L as the number of Lags, A as the coefficient matrix, X as the Matrix build out of the vectors of the variables and ϵ as the error term



COMPARING THE RESULT

3.

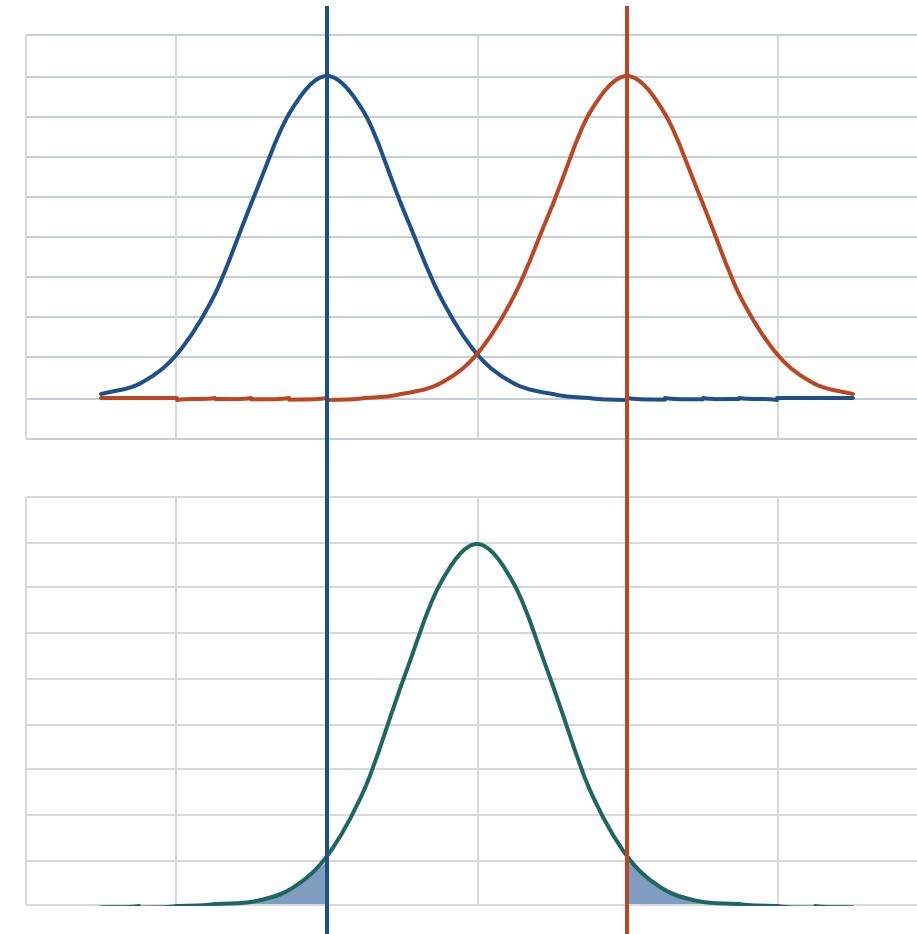
Methodology

The F-test for comparing the σ^2

F-test

- » Tests a hypothesis against the null hypotheses
 - Null hypotheses: Samples are from the same population
- » If there is a significant difference between samples, the null hypothesis gets rejected

$$F = \frac{S_2^2}{S_1^2} = \frac{\frac{1}{n_2 - 1} \sum_{i=1}^{n_2} (X_{2,i} - \bar{X}_2)^2}{\frac{1}{n_1 - 1} \sum_{i=1}^{n_2} (X_{2,i} - \bar{X}_2)^2}$$



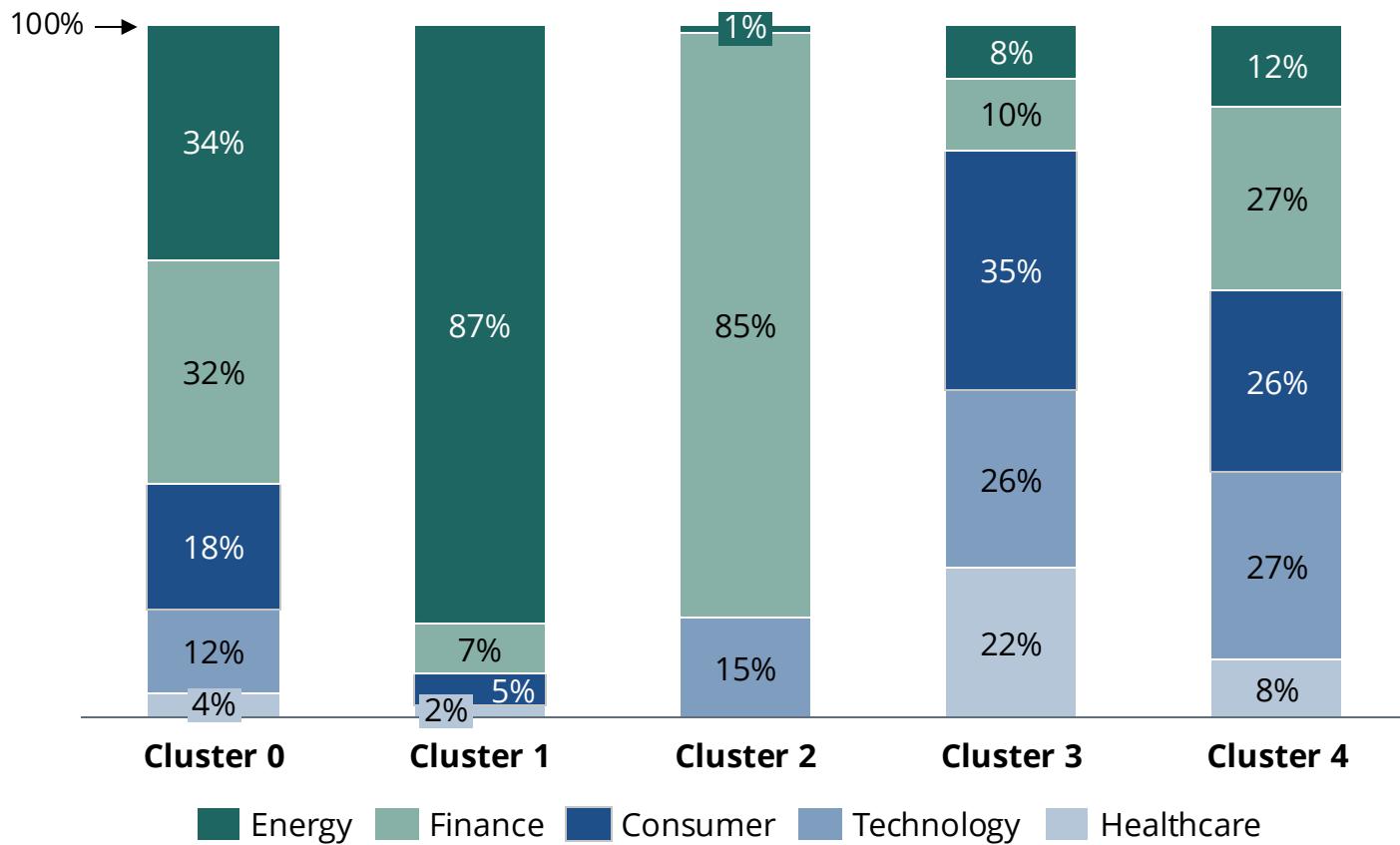
CLUSTERS

3.

Methodology

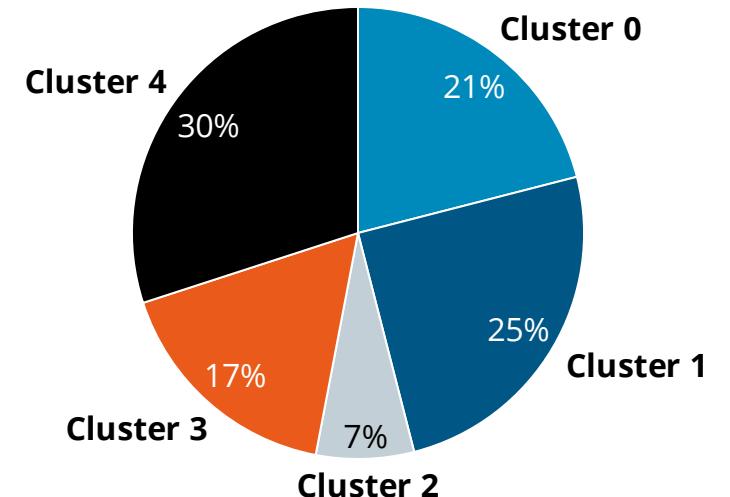
Companies clustered based on ESG data

COMPOSITION OF CLUSTERS BY INDUSTRY



COMMENTS

- » Clusters one consists of mainly the energy sector
- » Cluster two consists of mainly the finance sector
- » Therefore, Cluster one and two also consist of business-to-business markets
- » The other clusters have a more even distribution of their industries





RESULTS

DOES THE ESG SCORE GRANGER CAUSE INDUSTRY CHARACTERISTICS?



INFLUENCE ON RETURNS

4.

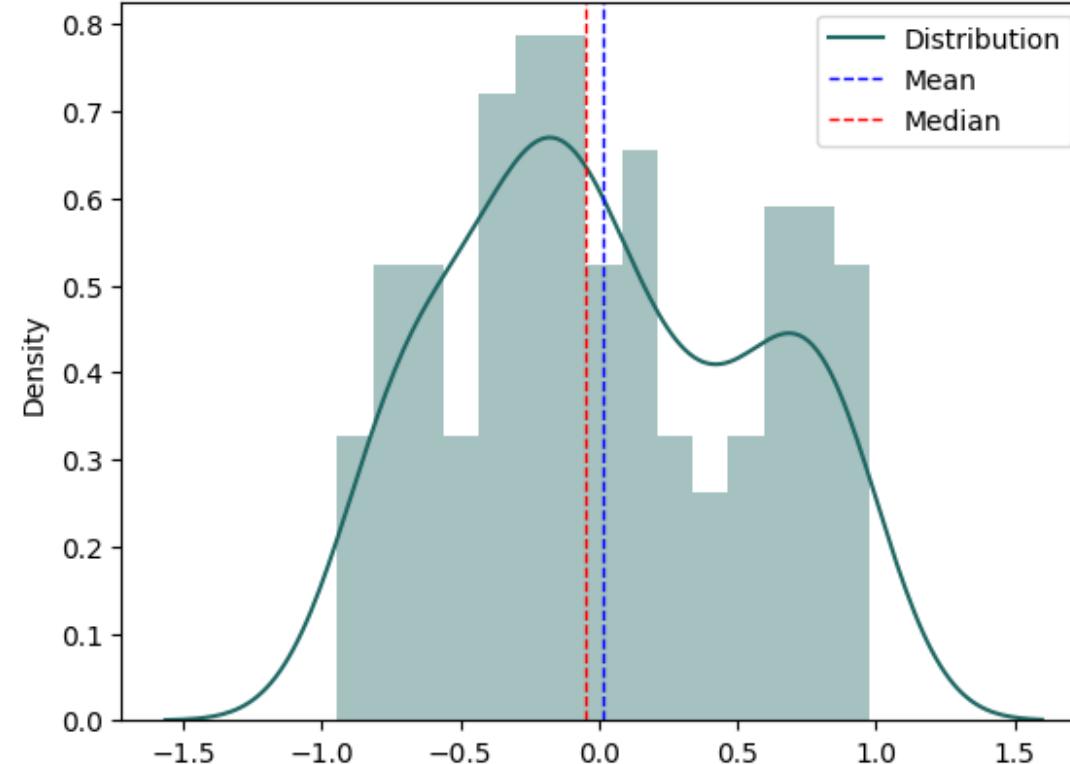
Results

Neither correlation nor Granger Causality between ESG and stock returns

Observations

- » There was neither a significant Granger causality between the Pillar Scores and the return nor the Individual Scores and the return
- » Approaches to construct a model to predict
 - Lagged Multi Linear Regression
 - Additional PCA Optimizing regressions with Industry Beta and Gradient Descent
 - Polynomial and Exponential modeling
 - Applied logarithmic transformation to make data stationary
 - The Data showed heteroscedasticity

Distribution of the correlation between the ESG Score and the lagged log return



WE DID NOT FIND A SIGNIFICANT GRANGER CAUSALITY BETWEEN ESG AND STOCK PERFORMANCE

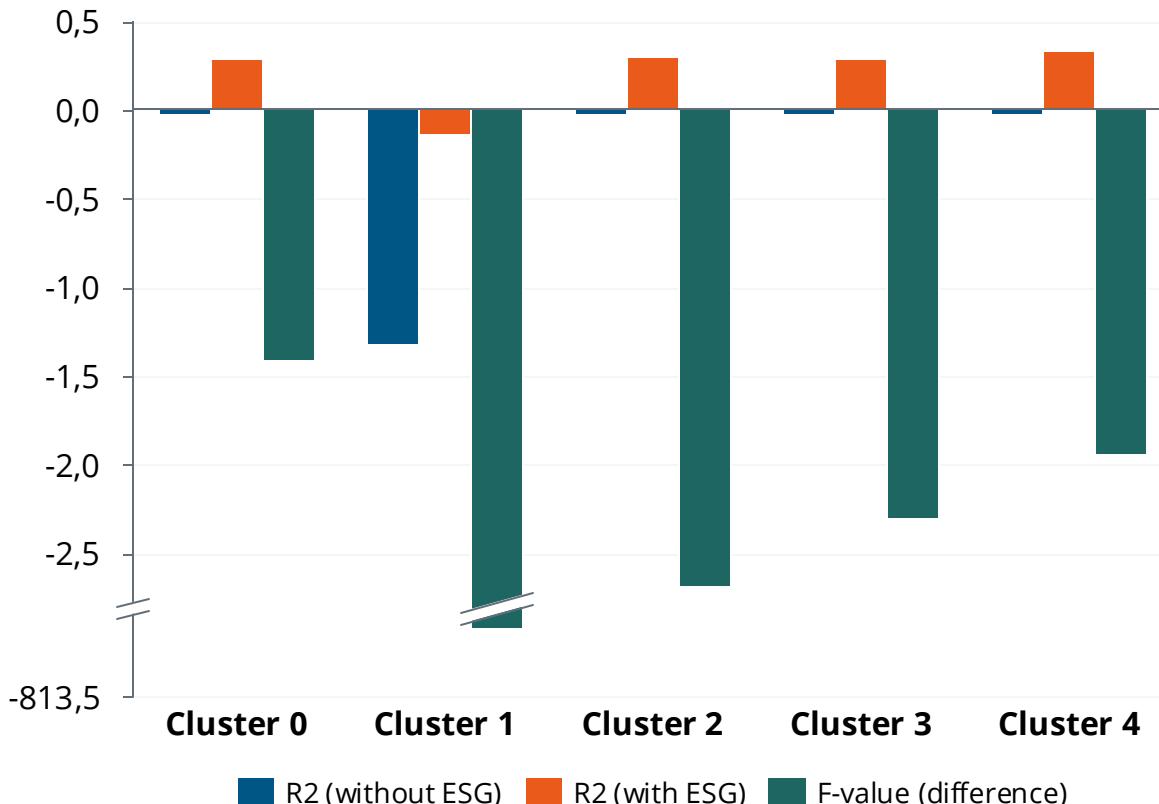
INFLUENCE ON EBITDA MARGIN

4.

Results

ESG Granger causes EBITDA in most clusters

GRANGER TEST ESG ON EBITDA



COMMENTS

- » Quality of predictions differ immensely
- » F-Test proved that there is significant difference between the residuals from the model with and without ESG data for all Clusters
- » Still, the R² for cluster one (Energy) is negative
 - » ESG is not a good indicator
- » All other other cluster improved from a negativ R² to almost 0,3
- » Not if it is a positive correlation

ESG Factors Granger cause EBITDA

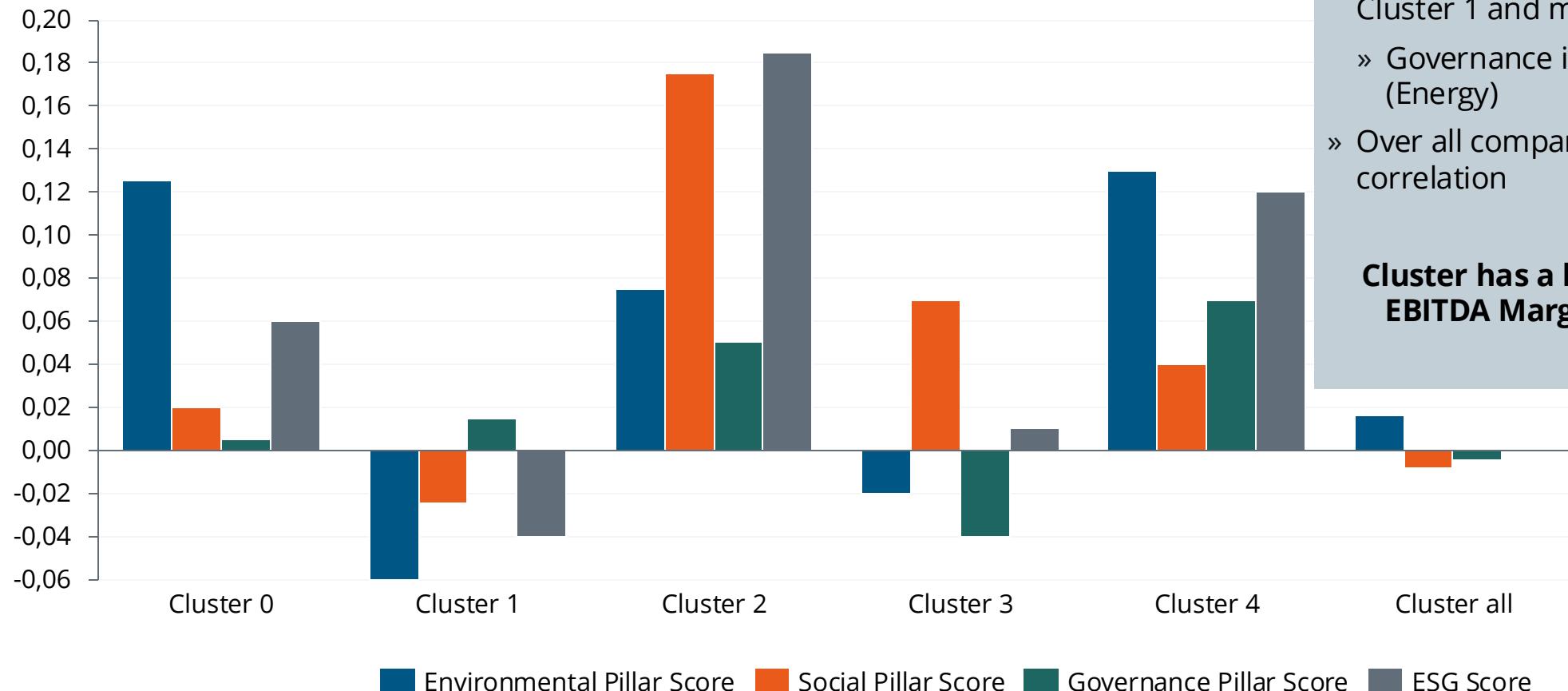
HOW DOES THE ESG INFLUENCE EBITDA MARGIN

4.

Results

Is it positive or negative correlation

LAGGED CORRELATION TO EBITDA MARGIN



COMMENTS

- » Correlation ist strong and positiv **within** Clusters 0,2,4
- » Correlation is mostly negativ in Cluster 1 and mixed in Cluster 3
 - » Governance influences Cluster 1 (Energy)
- » Over all companys there is almost no correlation

Cluster has a higher influence on EBITDA Margin than ESG data

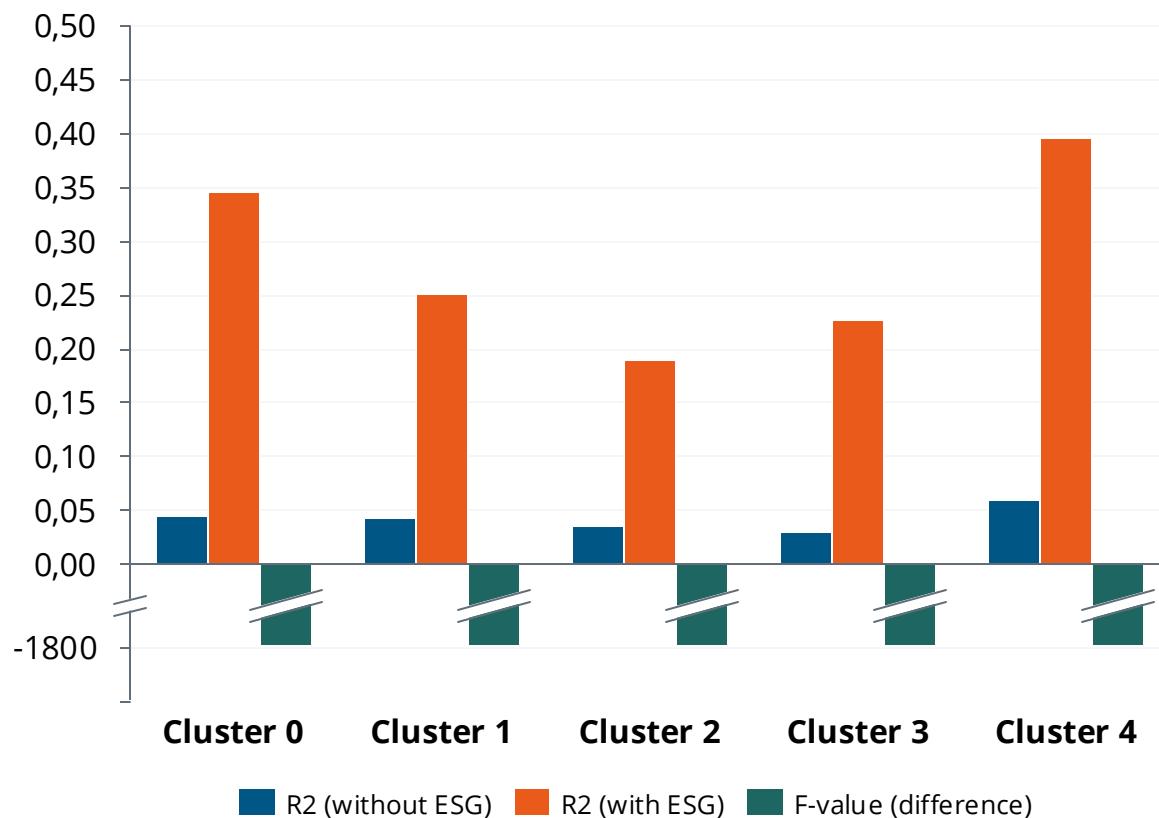
INFLUENCE ON VOLATILITY

4.

Results

ESG Granger causes volatility in all clusters

GRANGER TEST ESG ON VOLATILITY



COMMENTS

- » F-Test proved that there is significant difference between the residuals from the model with and without ESG data for all Clusters
- » R² without ESG is always positive but ESG data improves it a lot
- » Here ESG is a good indicator
- » Not if it is a positive correlation

ESG Granger causes volatility in all clusters

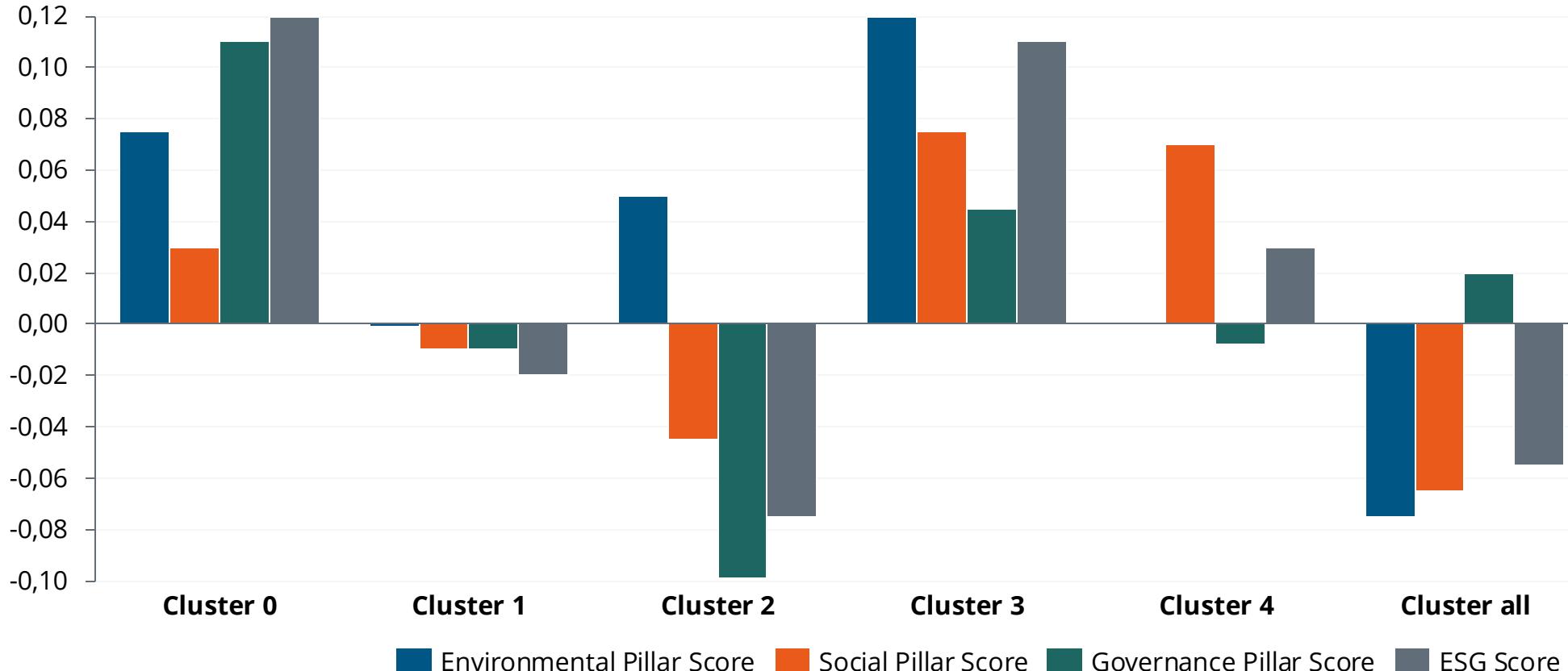
INFLUENCE ON THE VOLATILITY

4.

Results

Is it positive or negative correlation

LAGGED CORRELATION TO VOLATILITY



COMMENTS

- » Correlation ist strong and positiv **within** Clusters zero and three
- » Correlation is mostly negativ in Clusters 1,2,all
- » Governance influences Cluster 2 (Finance), reduces volatility
- » Environmental Pillar Grancer causes increased volatility within all clusters

ESG Score reduces volatility

HOW DOES THE ESG CHANGE THE VOLATILITY BETWEEN CLUSTERS

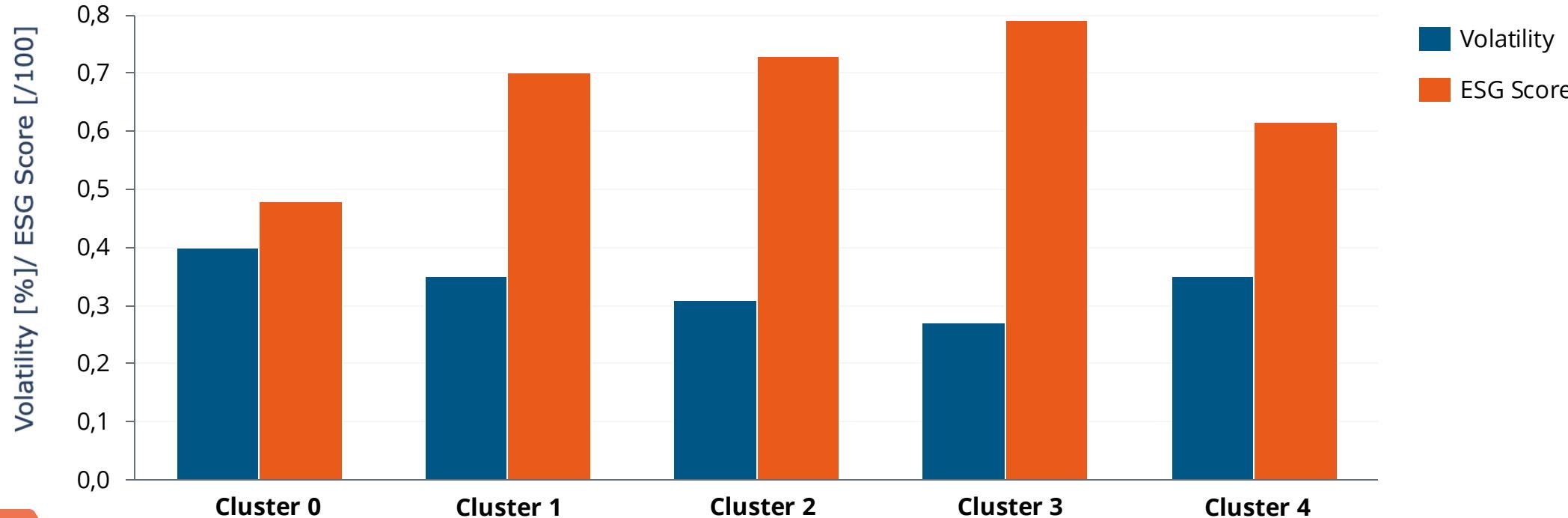
4.

Results

The better the mean of the ESG



**MEAN ESG SCORE AND MEAN VOLATILITY
Per Cluster**



Clusters with high ESG Scores tend to have lower Volatility
Clusters 1 (Energy) and Cluster 2 (Finance) have a high mean ESG Score

IMPLICATIONS

Three dimensions of sustainability



EBITDA Margin and Risk

- » ESG-friendly investing may cause higher more stable profits
- » The positive correlation to EBITDA Margin is probably not because of new digital business models since they are highly volatile
- » Good ESG Scores indicate good adaption to changing market circumstances because it indicate lower volatility
- » ESG-related investing can hedge against market volatility, like oil prices



Performance

- » Efficient market hypothesis
 - » If the ESG Score would have a strong influence on stock returns, this information would be used until it is useless
 - » Since the ESG Score is not a good indicator for stock returns but for EBITDA Margin and risk, investors maybe don't perceive the ESG data as valuable information



Facts

- » The Energy industry does not seem to be influenced by the ESG Score
- » The industries could be reverse engineered by the ESG factors
- » Governance Pillar has high influence on industries with high dependence on management like finance
- » It is surprising that the ESG Score does not have a higher influence on stock returns, since they have lower risk and should therefore be more attractive according to Efficient-Frontier-Theory



THE MARKET IS HIGHLY COMPLEX, IN CONTRAST TO BUSINESS MODELS
THE ESG MAY GIVE INFORMATION ABOUT MANAGEMENT SKILLS

Main findings

ESG and Sustainable Investing

- » Interest in sustainable investment and thus in ESG is on the rise
- » ESG is used as a criteria for sustainable investment
- » there are many studies that show that a high ESG rating is related to long-term company performance
- » there are few studies on the reasons
- » Difficulties in understanding the difference of the pillars

Data Analysis

- » ESG Score does not affect stock returns
- » High ESG Score positively influences EBITDA Margin and volatility
- » Influence of ESG Score is strongly related to the cluster
- » ESG helps to categorize companies
- » Results align with Efficient-Market -Theory but not with Efficient-Frontier-Theory

What have we learned? What is our opinion about the ESG as an indicator?

ESG Score as a sustainable indicator

- » ESG score assume that being less damaging than their direct competitor is good enough to be regarded as resource-sustainable
- » **BUT:** Natural resources are limited, and sustainability is only possible within those limited parameters
- » ESG score fails to measure sustainability

ESG Washing

- » Investors are misled through the ESG into investing in companies which don't fit their sustainability criteria.
- » The ESG licenses greenwashing and adds social and governance components

ESG Score as a performance indicator

- » Indicator for firm performance
- » Could be a good indicator for diversification

Transparency and database

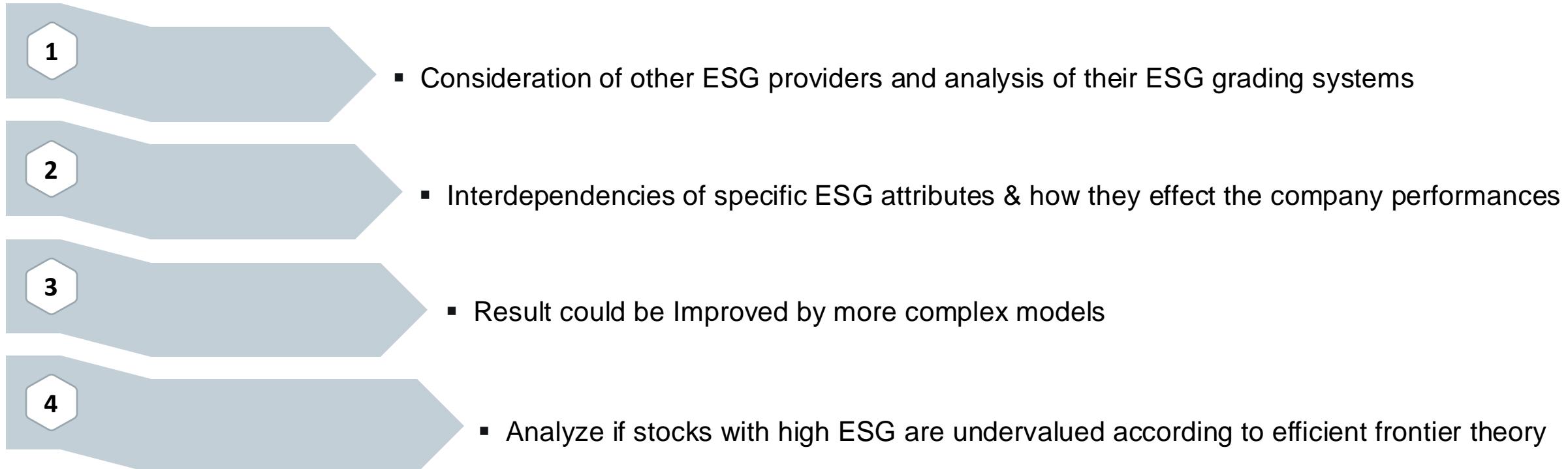
- » Not possible to find out which data point refers to which category → intransparent
- » Weighting depends on industry
- » Database: refinitiv values companies which pay for it
- » There is a need for a government financed and independent database

OUTLOOK

5.

Outlook

Further research is needed.

- 
- 1 ▪ Consideration of other ESG providers and analysis of their ESG grading systems
 - 2 ▪ Interdependencies of specific ESG attributes & how they effect the company performances
 - 3 ▪ Result could be Improved by more complex models
 - 4 ▪ Analyze if stocks with high ESG are undervalued according to efficient frontier theory

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THANK YOU FOR YOUR ATTENTION!

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Co-Author Thomas Lontzek

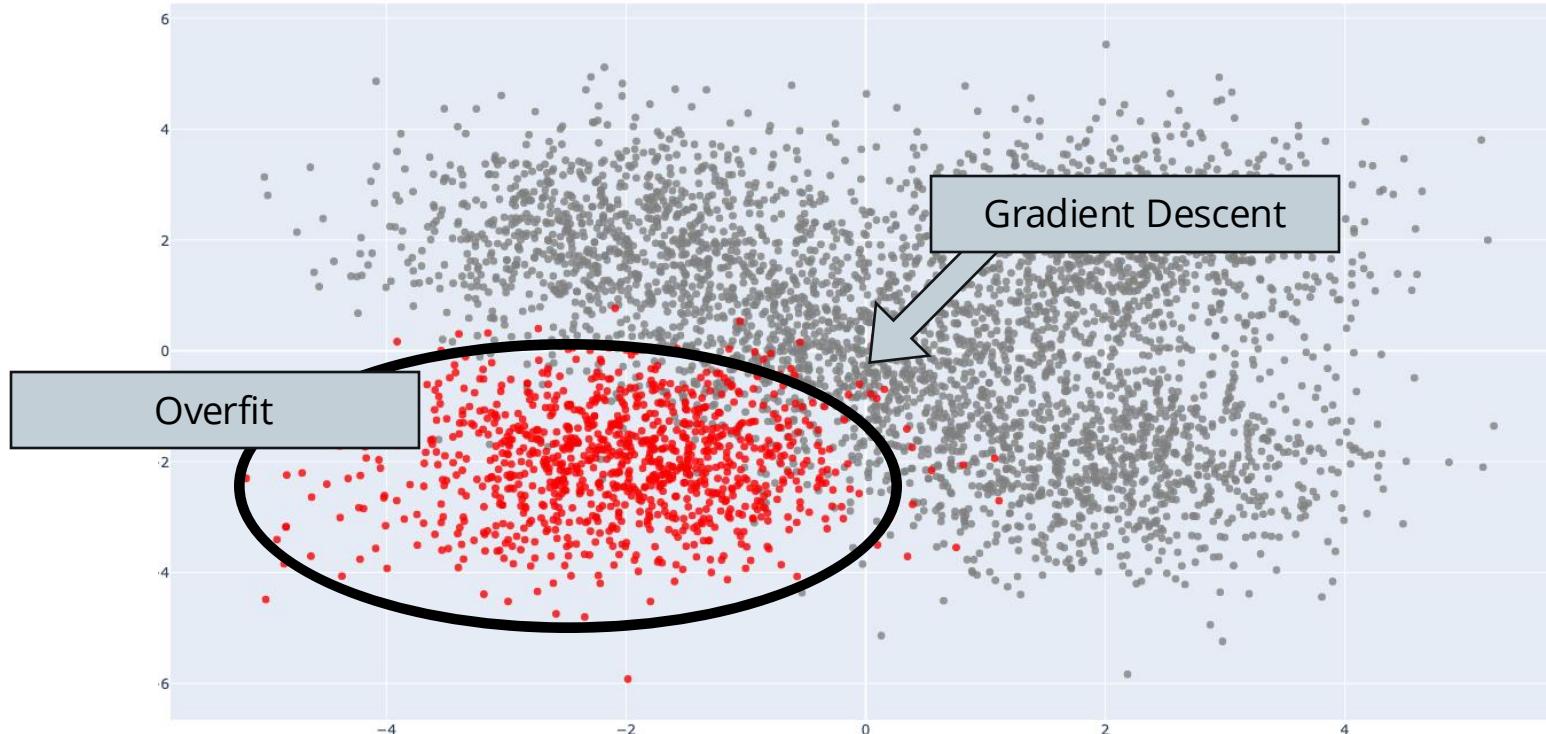


BACKUP

CLUSTERED GRADIENT DESCENT

3.

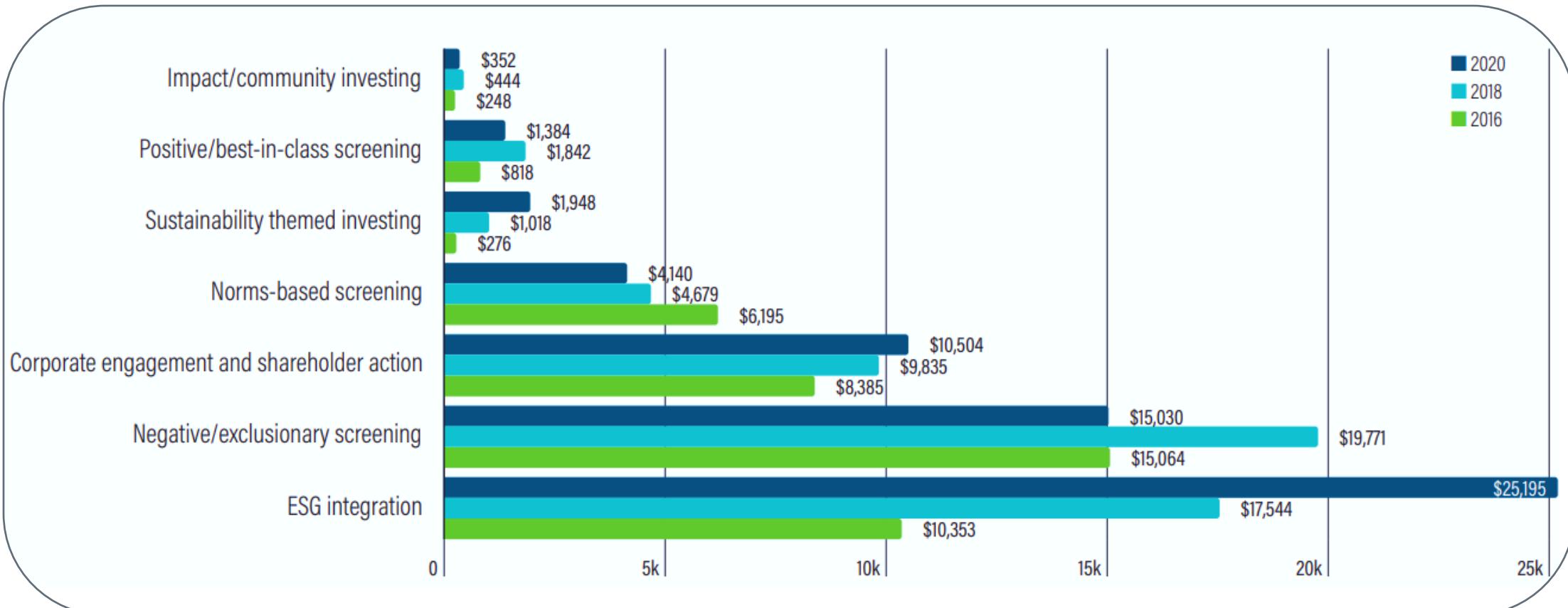
Methodology



THE RISE OF GREEN INVESTING

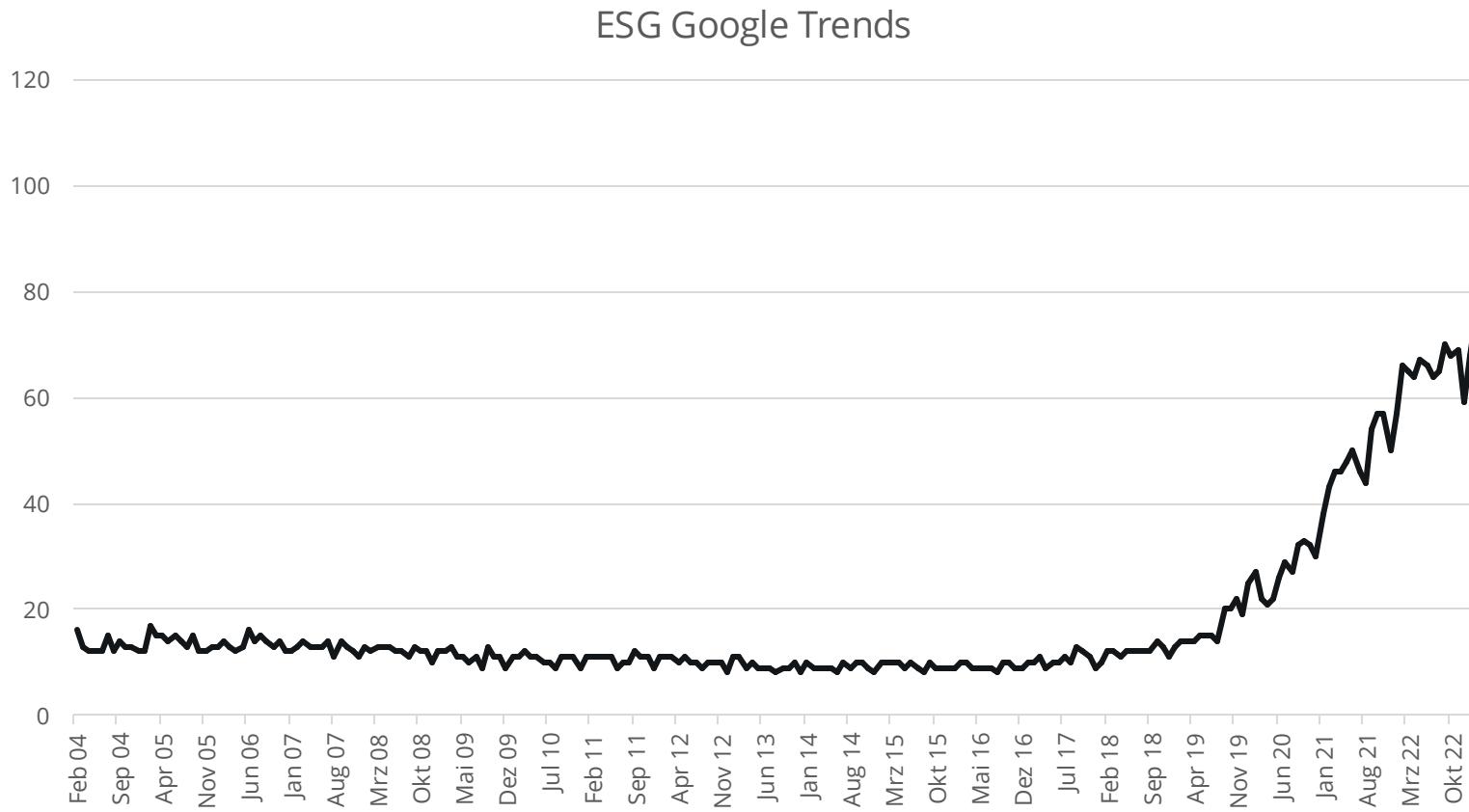
Carbon emissions from human activities are the main cause of climate change.

Global growth of sustainable investing strategies 2016-2020



Source: <http://www.gsi-alliance.org/wp-content/uploads/2021/08/GSIR-20201.pdf>

GOOGLE TRENDS OF ESG



- » Sustainable Finance Disclosure Regulation (SFDR) is an EU regulation that came into operation on March 10, 2021, and is designed to improve transparency and clarity in the area of sustainability of financial products and services
- » Financial institutions must disclose the methodologies and data sources they use to assess the ESG performance of companies
- » Decision: December 9, 2019

ASSESSMENT OF ESG THEME IMPORTANCE

Refinitiv ESG Materiality Assessment Methodology



MATERIALITY DEFINITION

- » Refinitiv ESG defines materiality through category weights.
- » Relative importance of themes determined for each industry.
- » Data points with sufficient disclosure used as proxies for industry magnitude.
- » One data point identified per theme.



DATA POINTS

- » *Numeric:* Determined by the relative median value for a company in that industry group.
- » *Boolean:* Determined based on the disclosure of relative level in that industry group.
- » Some themes excluded due to insufficient disclosure.

Industry median

- » Primarily used for numeric data points
- » Materiality weighting is to be based on the relative proportion that a particular sector contributes to the overall gross number in the full ESG universe
- » the relative weight, is determined by the relative median value for a company in that industry group
- » The relative median values for each industry group to which the data point is material are compared, and decile ranks are assigned
- » The decile rank determines the relative weights assigned to that data point in determining the industry weight (1-10)

Transparency weight

- » the relative weight of a data point, is based on the disclosure of its relative level within the relevant industry group
- » The disclosure percentage for each industry group, where the data point is considered material, is identified and assigned a decile rank
- » decile rank is used to determine the relative weight of that data point in calculating the industry weight, on a scale from 1 to 10.

UNDERSTANDING SUSTAINABILITY

Sustainable development was officially defined in the Brundtland report of UN in 1987

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

- » Economic development, social progress, and environmental protection are interdependent and mutually reinforcing goals.
- » Achieving sustainable development requires balancing these goals.
- » Major global challenges: poverty, population growth, and unsustainable production and consumption patterns.
- » Advocates for the use of market-based mechanisms and the integration of environmental considerations into decision-making processes.

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UNDERSTANDING SUSTAINABILITY

Three dimensions of sustainability

Economy

- » The economic system should efficiently satisfy individual and societal needs
- » The economic performance of a society and its productive, social and human capital must at least be maintained over time



Society

- » The existing performance of social security systems potential should at least be preserved for future generations
- » Social security systems can only grow in line with economic growth in line with the economic performance potential



Environment

- » The rate of depletion of renewable resources should not exceed the regeneration rate
- » The temporal capacity of the environment to respond and regenerate to anthropogenic inputs or and to regenerate itself, is to be considered



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UNDERSTANDING SUSTAINABILITY

Why is sustainable development important?

Study

- » Independent study conducted under the direction of Sir Nicholas Stern (namesake), published on October 30, 2006
- » investigates the economic impacts of climate change
- » examines the costs and benefits of taking action to mitigate its effects.



Results

- » Climate change is a serious global problem with severe and potentially irreversible impacts on human societies and the natural world.
- » The costs of taking action to reduce greenhouse gas emissions and address climate change are far outweighed by the costs of inaction, which include economic, social, and environmental costs.
- » Delaying action on climate change will only make the problem more difficult and costly to solve in the future
- » The poorest and most vulnerable populations will be most affected by climate change, and action to address the problem must take into account the need for social equity and poverty reduction

ANALYSIS OF ESG SCORES

2 ESG Scores

The specific process for creating an ESG score for a company may vary depending on the rating agency or research firm, but generally involves the following steps:

- Data collection: The first step in creating an ESG score is to collect relevant data on the company. This data may come from a variety of sources, including financial statements, regulatory filings, news articles, and proprietary surveys.
- Data analysis: Once the data has been collected, it is typically analyzed using a set of defined criteria and weightings. Different rating agencies or research firms may use different criteria and weightings, so it is important to compare scores from multiple sources in order to get a comprehensive view of a company's ESG performance.
- Score calculation: Based on the data analysis, an ESG score is calculated for the company. This score is usually expressed as a numerical rating, with higher scores indicating a better performance on ESG issues.
- Score publication: Once the ESG score has been calculated, it is typically published by the rating agency or research firm.

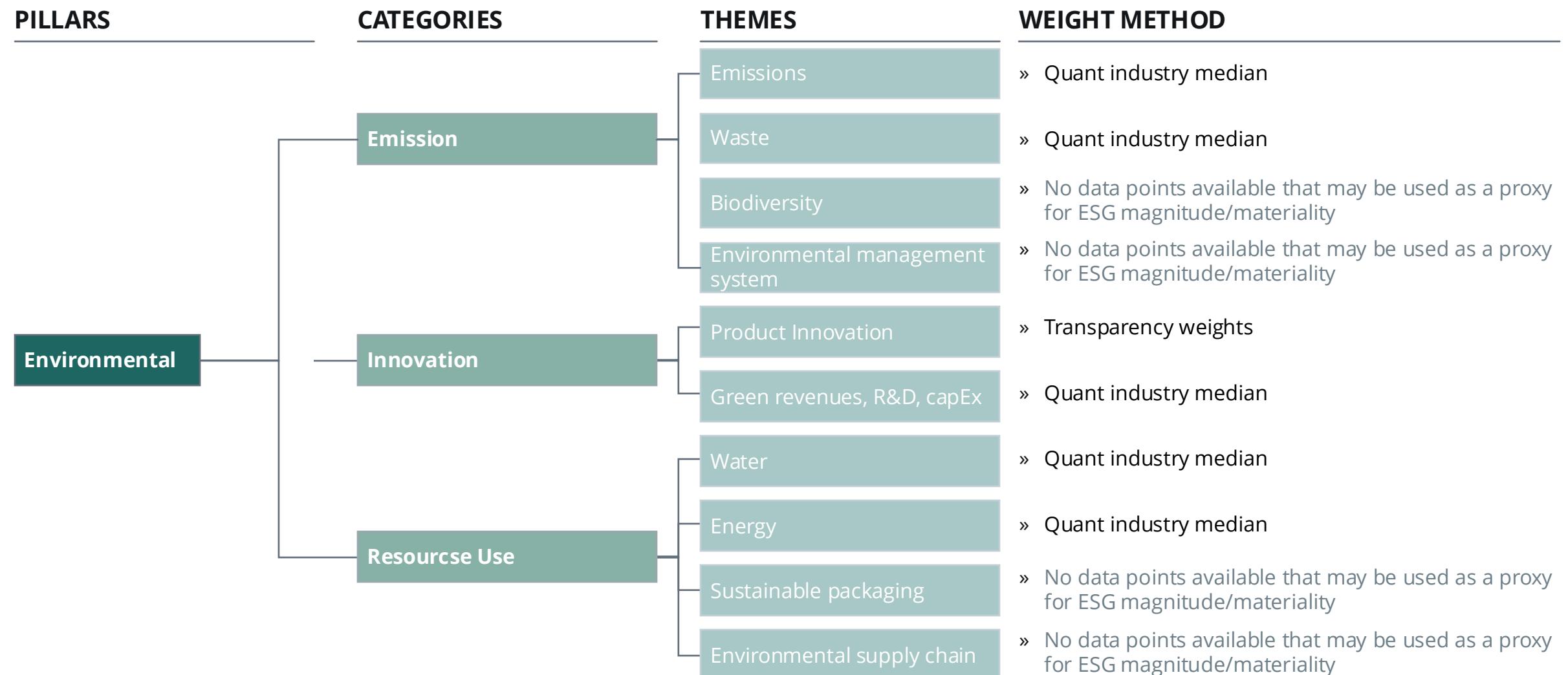
ESG scores are usually expressed as a numerical rating, with higher scores indicating a better performance on ESG issues. Different rating agencies may use different scoring methods and criteria, so it is important to compare scores from multiple sources in order to get a comprehensive view of a company's ESG performance.

ANALYSIS

TRESG Score	Definition
Resource Use Score (E)	The Resource Use Score reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management
Emissions Score (E)	The Emission Reduction Score measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes.
Innovation Score (E)	The Innovation Score reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.
Workforce Score (S)	The Workforce Score measures a company's effectiveness towards job satisfaction, a healthy and safe workplace, maintaining diversity and equal opportunities, and development opportunities for its workforce
Human Rights Score (S)	The Human rights category score measures a company's effectiveness towards respecting the fundamental human rights conventions
Community Score (S)	The Community Score measures the company's commitment towards being a good citizen, protecting public health and respecting business ethics.
Product Responsibility Score (S)	The Product Responsibility Score reflects a company's capacity to produce quality goods and services integrating the customer's health and safety, integrity and data privacy.
Management Score (G)	The Management Score measures a company's commitment and effectiveness towards following best practice corporate governance principles.
Shareholders Score (G)	The Shareholders Score measures a company's effectiveness towards equal treatment of shareholders and the use of anti-takeover devices.
CSR Strategy Score (G)	The CSR Strategy Score reflects a company's practices to communicate that it integrates the economic (financial), social and environmental dimensions into its day-to-day decision-making processes.

ENVIRONMENTAL ATTRIBUTE

Assessing Companies' Environmental Performance through the ESG SCORE



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SOCIAL ATTRIBUTE

Examining Companies' Social Impact through the ESG Score

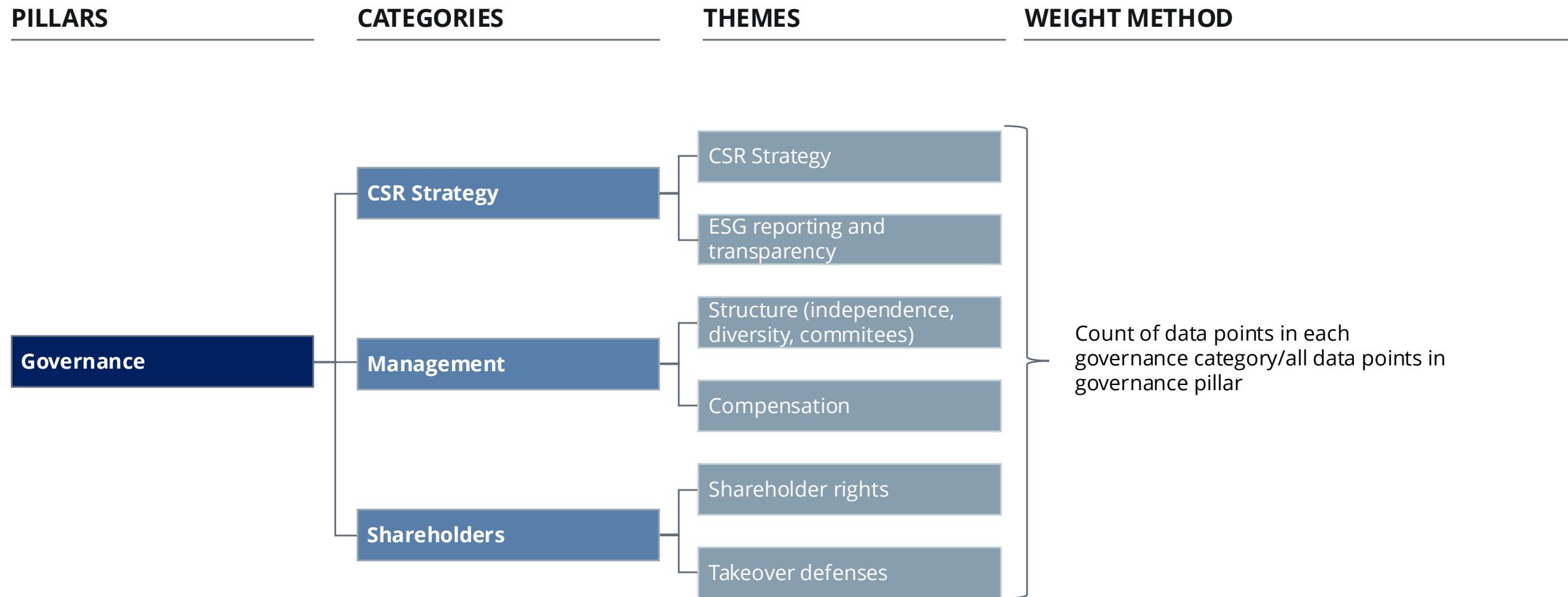
PILLARS	CATEGORIES	THEMES	WEIGHT METHOD
Social	Community	Equally important to all industry groups	» Equally important to all industry groups
	Human rights	Human rights	» Transparency weights
	Product responsibility	Responsible marketing	» Transparency weights
		Product quality	» Transparency weights
		Data privacy	» Transparency weights
Workforce use	Diversity and inclusion	» Quant industry median	
	Career development and training	» Transparency weights	
	Working conditions	» Quant industry median	
	Health and safety	» Transparency weights	

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GOVERNANCE ATTRIBUTE

Evaluating Companies' Governance Practices through the ESG Score



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FINDING REASONS: ENVIRONMENTAL SCORE

The influence of emissions, innovation and resource use

Delmas: Dynamics of environmental and financial performance¹

- » Results suggest that the relationship between environmental and financial performance depends on the time horizon over which financial performance is evaluated
- » Reducing emissions is unprofitable only from a short-term perspective
- » Reason: risk of regulations, investors "want" proactive environmental strategies

Cucchiella: The management of greenhouse gas emissions and its effect on firm performance²

- » analyze whether a firm's GHG management (namely the adoption of an EMS and the emission reduction) improves economic performance through two separated effects: an increase in demand and/or an improvement in productivity (in Italy)
- » the adoption of an EMS (Environmental Management System) together with an appropriate control of emissions could lead to profits through an increase in demand and productivity



Lee: Green R&D for eco.innovation and its impact in carbon emissions and firm performance³

- » negative relationship between green research and development and carbon emissions
- » green research and development is positively related to financial performance at the firm level

Miah: Carbon Emissions and firm performance⁴

- » examines the effects of carbon emissions on the accounting and market-based performance of financial and non-financial firms in emerging economies
- » results show that carbon emissions reduce firms' return on equity, Tobin's Q, Z-score, and credit rating



EFFECTS OF CSR ON MARKET VALUATION AND FINANCIAL PERFORMANCE

Corporate Social Responsibility Activities Influence (Governance Pillar)



Corporate social responsibility and market valuation¹

- » CSR activities positively affect the stock market valuation of companies in the consumer goods industry, but not in the financial services or healthcare industries.
- Companies in the consumer goods industry may receive higher market valuation premiums due to their CSR activities, as consumers are more likely to favor companies that align with their value.
- suggests that the positive effect of CSR activities on market valuation may be influenced by the level of competition in a given industry, with companies in less competitive industries benefitting more from their CSR engagement.
- also imply that companies in the healthcare and financial services industries could benefit from finding new and innovative ways to engage in CSR activities that resonate more with investors and consumers.



Impact of corporate social responsibility disclosure on financial performance²

- » CSR activities have a stronger positive impact on the financial performance of companies in the energy and materials sectors, compared to companies in other sectors.
- Stronger positive correlation between CSR disclosure and return on assets for companies in the energy and materials sectors.
- highlights the potential importance of CSR disclosure in the energy and materials sectors, where environmental and social issues may have a greater impact on a company's financial performance.
- investors and stakeholders are increasingly valuing CSR activities and disclosure, and that companies that fail to engage in these activities may face reputational and financial risks.

ESG AND SHARE PRICE IN DIFFERENT INDUSTRIES

1.4

ESG Influence

Evidence from Recent Studies

Corporate social responsibility and access to finance

- » Companies with high ESG ratings have lower capital constraints and higher access to finance
- » This effect is stronger for companies in *polluting industries*.
- » High ESG ratings are positively related to firm value, suggesting that investors value ESG performance.
- » The relationship between ESG ratings and access to finance is stronger for companies with a high proportion of institutional ownership.



Relationship between corporate sustainability performance and idiosyncratic risk

- » Higher ESG ratings are associated with lower idiosyncratic risk for companies in the consumer goods, healthcare, and technology industries.
- » The relationship between ESG performance and idiosyncratic risk is stronger for firms with higher *intangible asset intensity*.
- » Companies with high ESG ratings are less likely to experience negative earnings surprises, which suggests that ESG performance can serve as an indicator of operational efficiency.



Impact of ESG screening on investment performance

- » ESG screening can lead to higher investment performance in the *financial, healthcare, and information technology sectors*, but not in the *energy, materials, or utilities sectors*.
- » ESG screening can improve investment performance by reducing downside risk and improving risk-adjusted returns.
- » The effect of ESG screening on investment performance is stronger for actively managed funds than for passive index funds.



1 Cheng, Ioannou, Serafeim; 2: Jo, Harjoto, 3 Charles, Darné, Fouilloux.

EFFECTS OF CSR ON MARKET VALUATION AND FINANCIAL PERFORMANCE

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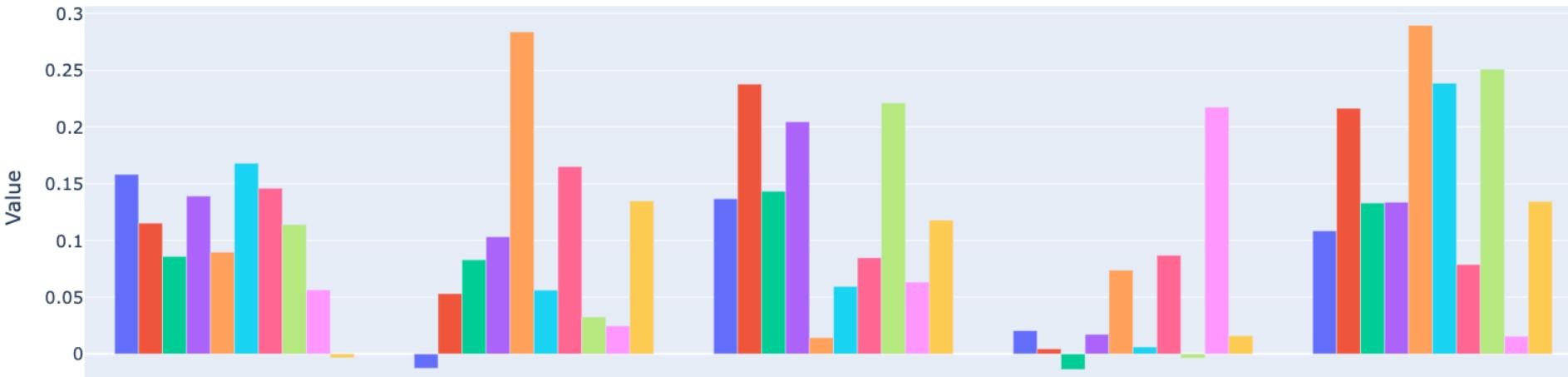
DEEP DIVE IN THE FACTORS

4.

Results

May something interesting appears?

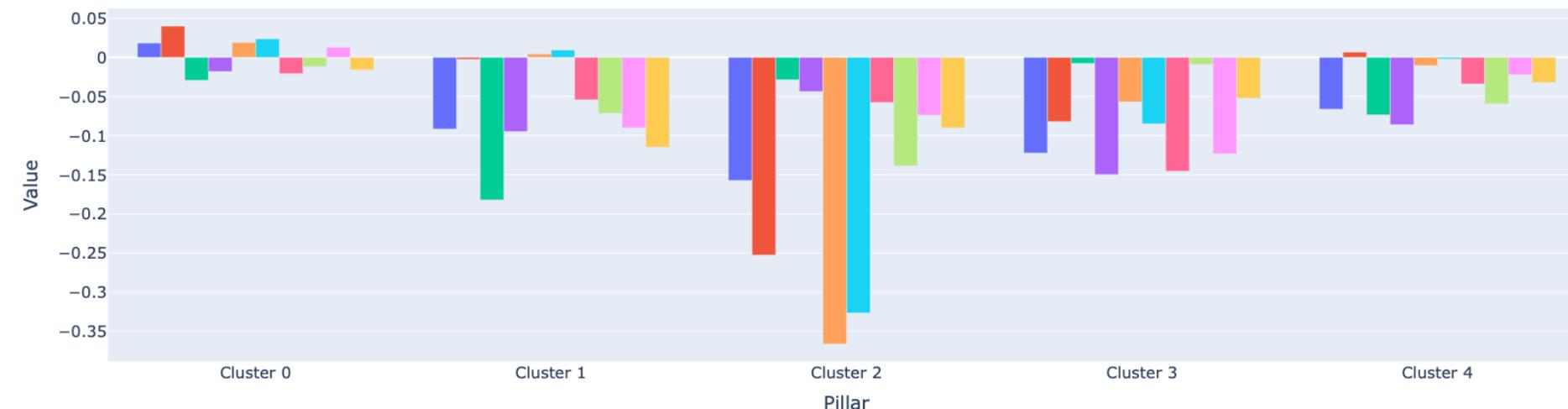
Lagged Correlations ESG EBITDA



Pillar

- Resource Use Score
- CSR Strategy Score
- Biodiversity Impact Reduction Score
- GRI Report Guidelines Score
- Total Donations To Revenues USD Score
- Turnover of Employees Score
- Stakeholder Engagement Score
- CSR Sustainability External Audit Score
- Total Energy Use To Revenues USD Score
- Executive Members Gender Diversity, Percent Score

Lagged Correlations ESG Volatility



Pillar

- Policy Fair Competition Score
- Whistleblower Protection Score
- Green Buildings Score
- Product Responsibility Monitoring Score
- Policy Business Ethics Score
- Policy Bribery and Corruption Score
- Policy Sustainable Packaging Score
- Training Costs Per Employee Score
- Independent Board Members Score
- HRC Corporate Equality Index Score