Topics in Sustainable Finance: *Sustainability and Financial Performance*

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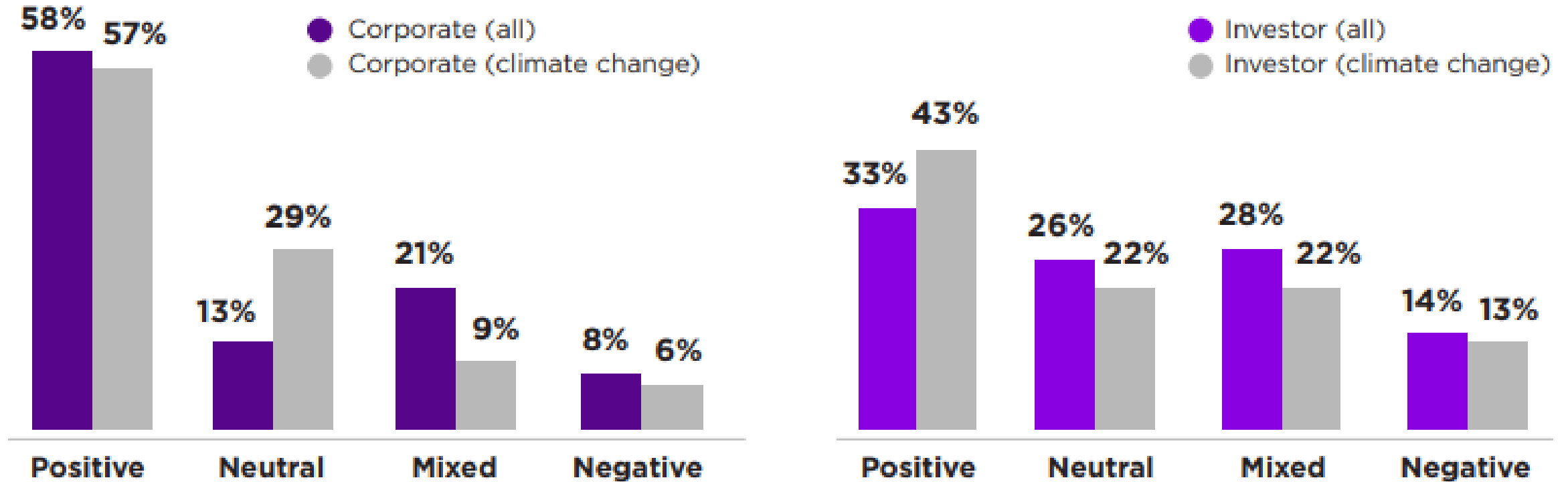Athens University of Economics and Business
March 2025

Business: ESG criteria and Financial performance

Figure 1. Positive and/or neutral results for investing in sustainability dominate. Very few studies found a negative correlation between ESG and financial performance (based on 245 studies published between 2016 and 2020).

- A *Direct positive relationship* between ESG and performance in more than 245 studies from 2016 to 2020

Athens Stock Exchange (ATHEX) ESG Index

.ATHESG ◻ ATHEX ESG INDEX ▲ 1,065.0600 EUR -4.1100 -0.38 % O 1,061.0100 L 1,057.6200 H 1,074.2000

🔗 ← → .ATHESG 🔍 📋 **Index Overview** ⟳ ☰ _ □ ✕

CHART

.ATHESG : 5.12 %   .ATG : 3.36 %

- 5.12%
- 3.36%

11.00%
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
-1.00%
-2.00%
-3.00%
-4.00%
-5.00%
-6.00%

ug   17   Sep   16   Oct   Nov   16   Dec   16   2022   19

Today 5D 3M 6M 1Y 5Y YTD

ATHEX COMPOSITE SHARE PRICE IND... ⌄

• Launched July 2020

Goal to support ESG initiatives and Corporate Social Responsibility in line with 2030 Agenda for Sustainable Development

• **Eligibility Criteria**
• Companies listed on ATHEX Main Market
• ESG scoring greater than or equal to 0.30
• **Selection Process**
• Companies fulfilling the eligibility criteria are ranked in descending order based on their ESG scoring
• The first 60 companies of the rank are included in the index composition

The Impact of ESG performance on the Financial Performance of European Area Companies

- Action for Climate crisis: UN Agenda 2030-17SDGs, Paris Agreement, European Green Deal

- Business sector must contribute – Incorporation of ESG in their operations

- Increasing interest of companies in the ESG framework: Good reputation and Performance improvement

Hypothesis :
- **Good ESG performance => Good overall performance in terms of profitability, valuation, capital efficiency and risk?**

Sample:
STOXX Europe ESG Leaders 50 index (global leaders in terms of environmental, social and governance criteria) **Vs**
EURO STOXX 50 Index (Europe's leading blue-chip index for the Eurozone)

Work :
1. We reviewed their ESG reporting framework
2. We examined whether there is a pattern of a better financial performance of ESG Leaders vs Others

Sustainability Reporting Framework
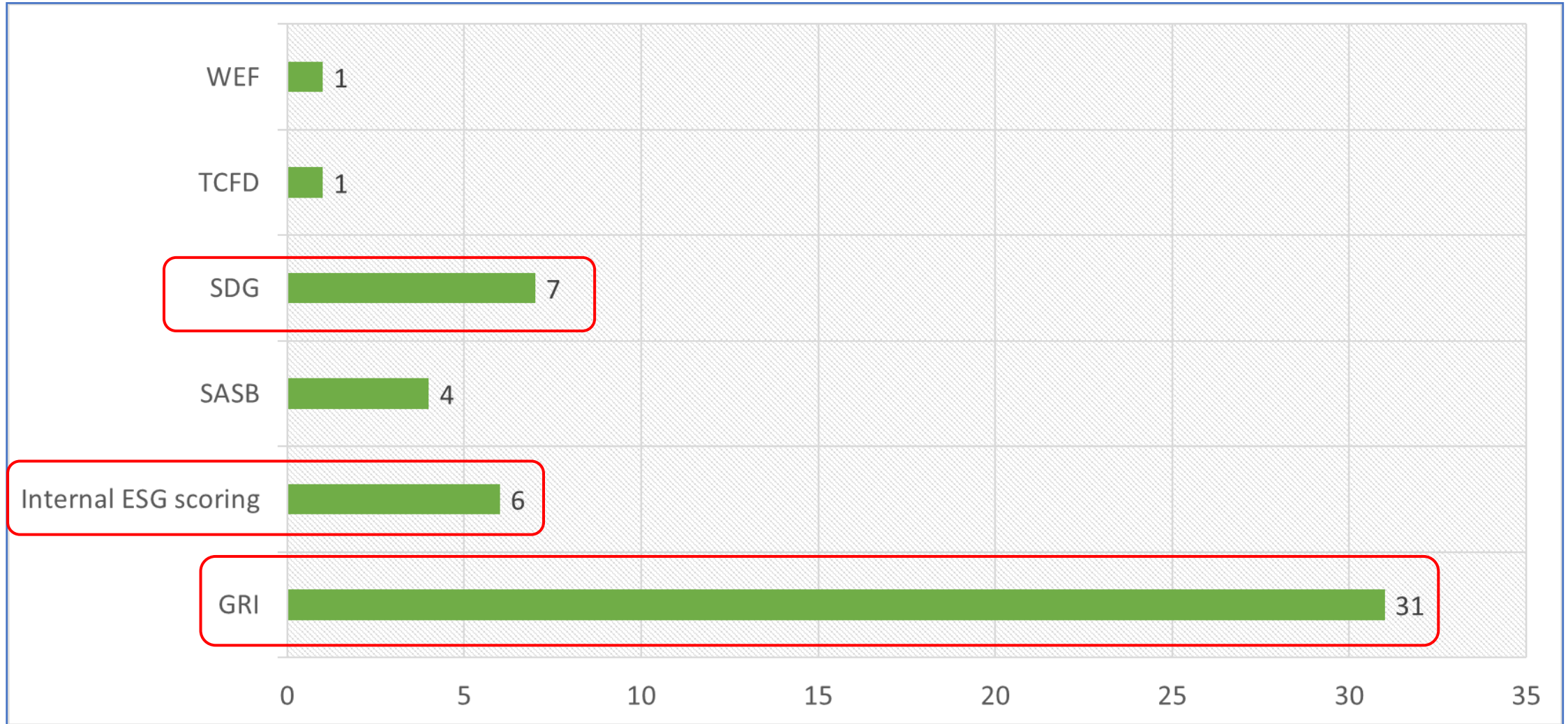
STOXX Europe ESG Leaders 50

ISIN: CH0183680310 | WKN: A1N57L | Symbol: 09J3 | Type: Index

Overview   **Charts**   Price History

CH0183680   D   ⌇   ⊕ Compare   ⌇₊ Indicators   ↶ ↷   ⚙ ⤢

☐ **+1.27 (+0.92%)**
EU0009658145, STOX ⌄ ◉ ⬚ ☒

24.00%

19.88%
18.23%

16.00%

12.00%

8.00%

4.00%

0.00%

-4.00%

-8.00%

-12.00%

-16.00%

-20.00%

-24.00%

-28.00%

-32.00%

-36.00%

Oct   2019   Apr   Jul   Oct   2020   Apr   Jul   Oct   2021   Apr   Jul

1 Woche   3 Monate   6 Monate   1 Jahr   5 Jahre   Max
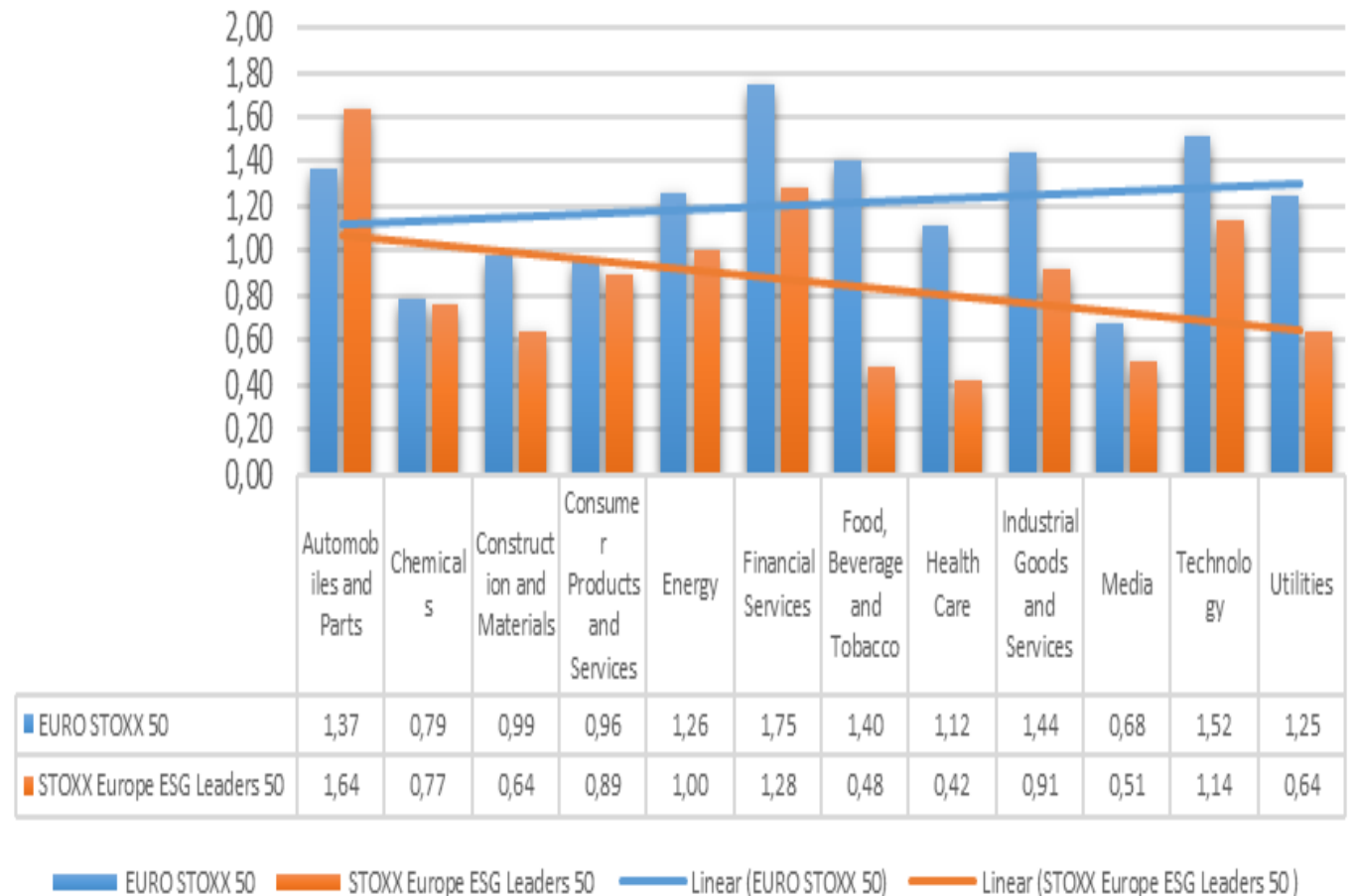
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	Average of Beta (5Y Monthly)	Average of Total Debt/Equity (mrq)	Average of Profit Margin	Average of Return on Assets (ttm)	Average of Return on Equity (ttm)
Automobiles and Parts					
EURO STOXX 50	1,37	158,74	5%	2%	9%
STOXX Europe ESG Leaders 50	1,64	216,08	5%	2%	13%
Chemicals					
EURO STOXX 50	0,79	33,06	10%	3%	6%
STOXX Europe ESG Leaders 50	0,77	83,50	8%	5%	11%
Construction and Materials					
EURO STOXX 50	0,99	106,28	3%	3%	5%
STOXX Europe ESG Leaders 50	0,64	127,05	10%	7%	26%
Consumer Products and Services					
EURO STOXX 50	0,96	96,71	11%	5%	13%
STOXX Europe ESG Leaders 50	0,89	54,01	9%	5%	11%
Energy					
EURO STOXX 50	1,26	80,82	-11%	0%	-11%
STOXX Europe ESG Leaders 50	1,00	74,29	-5%	-1%	-8%
Financial Services					
EURO STOXX 50	1,75	2,63	-23%	0%	-6%
STOXX Europe ESG Leaders 50	1,28	26,59	14%	1%	8%
Food, Beverage and Tobacco					
EURO STOXX 50	1,40	125,80	9%	1%	4%
STOXX Europe ESG Leaders 50	0,48	110,70	9%	6%	13%
Health Care					
EURO STOXX 50	1,12	79,77	-12%	2%	-18%
STOXX Europe ESG Leaders 50	0,42	58,43	21%	11%	32%
Industrial Goods and Services					
EURO STOXX 50	1,44	102,09	3%	3%	7%
STOXX Europe ESG Leaders 50	0,91	70,89	11%	5%	18%
Media					
EURO STOXX 50	0,68	46,81	9%	3%	10%
STOXX Europe ESG Leaders 50	0,51	339,17	17%	8%	56%
Technology					
EURO STOXX 50	1,52	90,12	47%	-3%	-1%
STOXX Europe ESG Leaders 50	1,14	50,30	17%	7%	19%
Utilities					
EURO STOXX 50	1,25	113,10	-3%	2%	-2%
STOXX Europe ESG Leaders 50	0,64	104,44	7%	3%	8%

Risk – CAPM Beta

- Beta indicator: Express the volatility of a stock

- High-beta are considered riskier

- Companies with good ESG performance tend to have lower beta, therefore lower risk

- Differences are **statistical significant** at 5%.

Average of Beta (5Y Monthly) per sector

	Automobiles and Parts	Chemicals	Construction and Materials	Consumer Products and Services	Energy	Financial Services	Food, Beverage and Tobacco	Health Care	Industrial Goods and Services	Media	Technology	Utilities
EURO STOXX 50	1,37	0,79	0,99	0,96	1,26	1,75	1,40	1,12	1,44	0,68	1,52	1,25
STOXX Europe ESG Leaders 50	1,64	0,77	0,64	0,89	1,00	1,28	0,48	0,42	0,91	0,51	1,14	0,64

Legend: EURO STOXX 50 — STOXX Europe ESG Leaders 50 — Linear (EURO STOXX 50) — Linear (STOXX Europe ESG Leaders 50)

Financial Leverage Debt-to-Equity (D/E) ratio

- Debt-to-equity (D/E) ratio: Total liabilities divided by shareholder equity,

- It is used to assess financial leverage

- D / E ratio is at similar levels in all sectors (except for media sector companies)

- ESG performance seem to have no impact on financial leverage levels
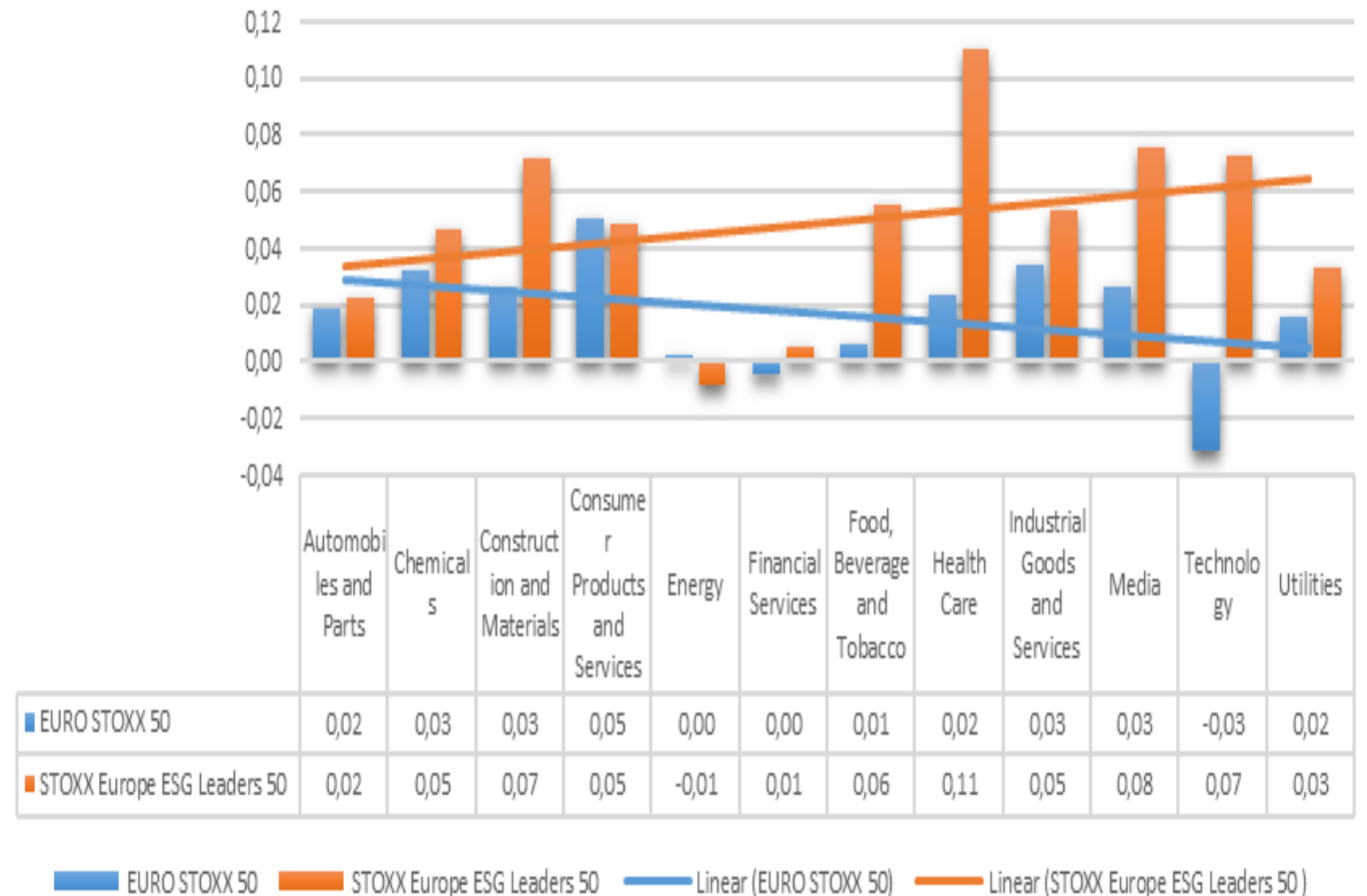
- Differences are **not significant** at 5%

Average of Total Debt/Equity per sector

	Automobiles and Parts	Chemicals	Construction and Materials	Consumer Products and Services	Energy	Financial Services	Food, Beverage and Tobacco	Health Care	Industrial Goods and Services	Media	Technology	Utilities
EURO STOXX 50	158,74	33,06	106,28	96,71	80,82	2,63	125,80	79,77	102,09	46,81	90,12	113,10
STOXX Europe ESG Leaders 50	216,08	83,50	127,05	54,01	74,29	26,59	110,70	58,43	70,89	339,17	50,30	104,44

Legend: ■ EURO STOXX 50　■ STOXX Europe ESG Leaders 50　— Linear (EURO STOXX 50)　— Linear (STOXX Europe ESG Leaders 50)

Performance - Return on Assets (ROA)

- Return on assets (ROA): A company's profitability to its total assets

- Good ESG performers tend to have Higher ROA

- Differences are **statistical significant** at 5%.

Average of Return on Assets per sector

	Automobiles and Parts	Chemicals	Construction and Materials	Consumer Products and Services	Energy	Financial Services	Food, Beverage and Tobacco	Health Care	Industrial Goods and Services	Media	Technology	Utilities
EURO STOXX 50	0,02	0,03	0,03	0,05	0,00	0,00	0,01	0,02	0,03	0,03	-0,03	0,02
STOXX Europe ESG Leaders 50	0,02	0,05	0,07	0,05	-0,01	0,01	0,06	0,11	0,05	0,08	0,07	0,03

Legend: EURO STOXX 50 — STOXX Europe ESG Leaders 50 — Linear (EURO STOXX 50) — Linear (STOXX Europe ESG Leaders 50)

Performance - Return on Equity (ROE)

- Return on equity (ROE): Net income divided by shareholders' equity

- It is a measure of a company's profitability to its stockholders' equity

- As with ROA, that companies with good ESG performance have a Higher return on equity

- Differences are **statistical significant** at 5%.

Average of Return on Equity per sector

	Automobiles and Parts	Chemicals	Construction and Materials	Consumer Products and Services	Energy	Financial Services	Food, Beverage and Tobacco	Health Care	Industrial Goods and Services	Media	Technology	Utilities
EURO STOXX 50	0,09	0,06	0,05	0,13	-0,11	-0,06	0,04	-0,18	0,07	0,10	-0,01	-0,02
STOXX Europe ESG Leaders 50	0,13	0,11	0,26	0,11	-0,08	0,08	0,13	0,32	0,18	0,56	0,19	0,08

EURO STOXX 50   STOXX Europe ESG Leaders 50   Linear (EURO STOXX 50)   Linear (STOXX Europe ESG Leaders 50)

Impact on Financial Performance on Big Caps-Reporting ESG, US Stock Exchanges 2008-2015

Panel A: Russell 3000	SASB material items		All ESG items	
	Mean	N	Mean	N
Good ESG	0.017	482	0.038	1069
Bad ESG	-0.014	334	0.046	3777

Panel B: S&P 500	SASB material items		All ESG items	
	Mean	N	Mean	N
Good ESG	0.013	392	0.035	859
Bad ESG	-0.001	113	0.045	1121

- Pricing Data from CRSP database, ESG items from Bloomberg.

- Scaled z-score around the median (Binary and Continuous variables).

- Good ESG performance – Score > 0.5
- Bad ESG performance – Score < 0.2

- SASB based ESG KPIs – Material items for company's sector.

Insurance	Oil and Gas – Exploration and Production
Customer welfare	GHG emissions
Fair marketing and advertising	Air quality
Lifecycle impacts of products and services	Water and wastewater management
Environmental, social impacts on assets & operations	Human rights and community relations
Systemic risk management	Employee health, safety and wellbeing
	Accident and safety management
	Business ethics and transparency of payments
	Regulatory capture and political influence
	Supply chain management

Source: SASB Materiality Map

SDG and ESG consistent Asset Pricing

Comprehensive International Database

North America
4050+

Europe
2550+

Asia Pacific
4050+

Latin America
380+

Africa and Middle East
450+
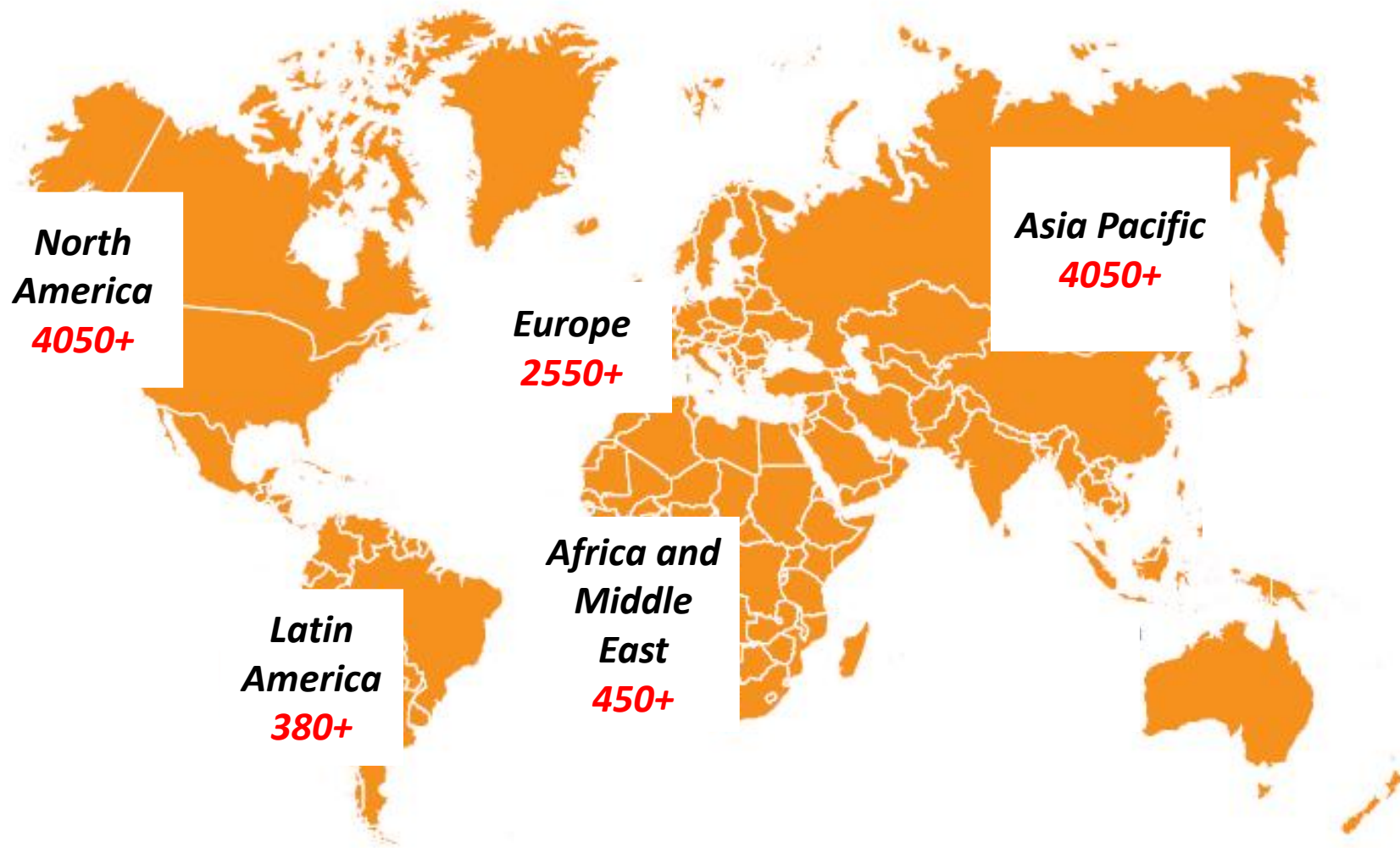
- **11.400+** Companies In International Markets (**90% Of Global Market Capitalization**)

- **68 Markets** and **59 Industries, 20+ years (2002-2023)**

- **AIM:** Calculate ESG holistic Performance indicator per company

- ***Explore*** Sources of priced risk related to ESGs in International Stock Returns

Thomson Reuters Refinitive/ EIKON Scores

ESG Categories	Material Issues / Categories
Environmental	Emissions
	Environmental Innovation
	Resource Use
Social	Workforce
	Human Rights
	Community
	Product Responsibility
Governance	Management
	Shareholders
	CSR

- >600 **ESG Key Performance Indicators** (KPIs) under 10 categories
- Generic and Sector Specific
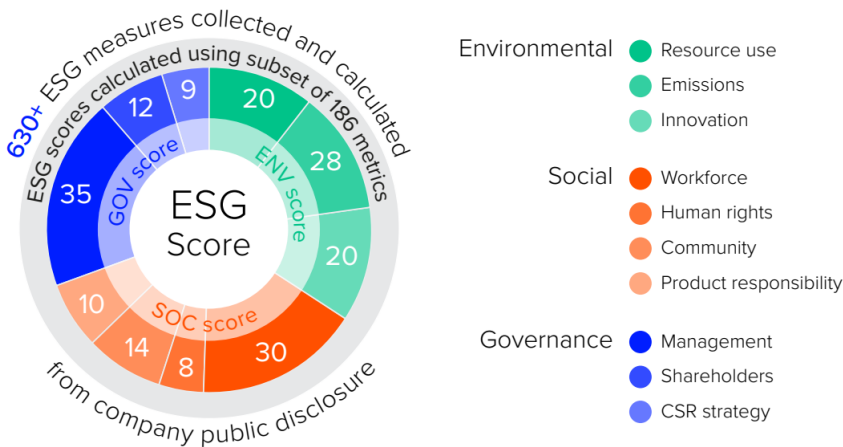
- **KPI Score - Percentile score** calculation against peers in Market & Industry
- **Scores** for each **Category/ Pillar** are calculated based on Industry specific KPIs - following an Industry **materiality** assessment
- **ESG Scores** are aggregated to an overall ESG score for the company following an Industry **materiality** assessment

ESG Controversies Scores

- **ESG Controversies Score**: Data Driven Score which measure a company's exposure to environmental, social and governance controversies and negative events reflected in global media.

Examples:

- Resource use – Category -

  Environmental controversies

  Number of controversies related to the environmental impact of the company's
  operations on natural resources or local communities.

- Workforce

  Employee health and safety controversies Number of controversies published in the media
  linked to workforce health and safety

- **ESG Controversies Score**: Considering "GreenWashing" practices, these type of Scores can provide an "unbiased" estimate of company's performance.
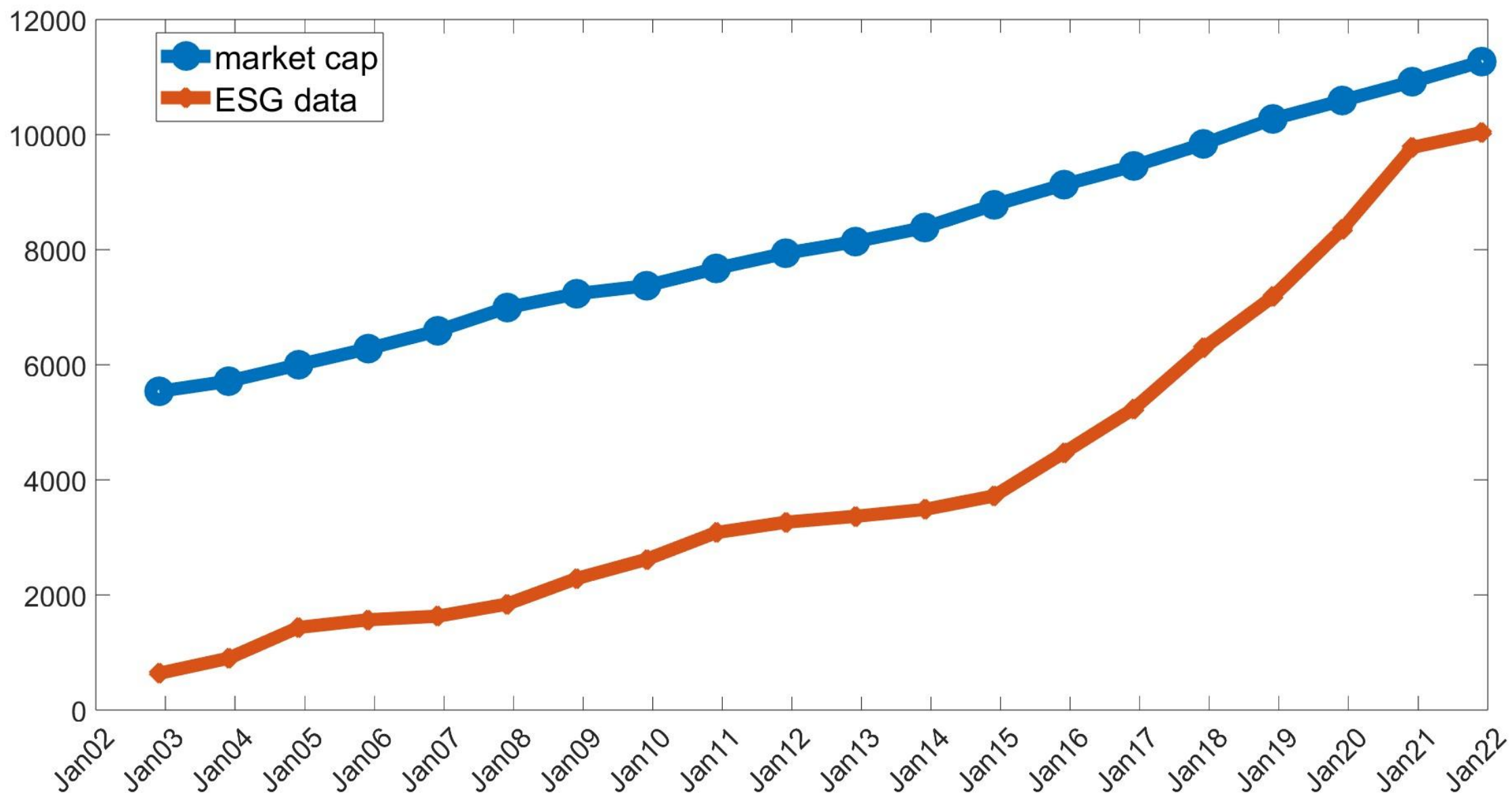
ESG Performance – International

Panel A: ESG Score

#Portfolios	5	10	20	30	50	100	150	200
GMB vw	0.0005	0.0008	0.0021	0.0018	0.0027	0.0021	0.0006	0.0030
se	0.0014	0.0016	0.0016	0.0016	0.0018	0.0025	0.0027	0.0028
p-value	0.7081	0.5959	0.1899	0.2734	0.1311	0.4085	0.8331	0.2938
GMB ew	-0.0007	-0.0003	0.0007	0.0001	0.0015	0.0014	-0.0001	0.0013
se	0.0012	0.0013	0.0014	0.0016	0.0017	0.0024	0.0030	0.0039
p-value	0.7081	0.5959	0.1899	0.2734	0.1311	0.4085	0.8331	0.2938

Panel B: ESG Controversies

#Portfolios	5	10	20	30	50	100	150	200
GMB vw	-0.0001	-0.0008	-0.0013	-0.0015	-0.0018	-0.0025	-0.0022	-0.0021
se	0.0006	0.0010	0.0011	0.0012	0.0014	0.0019	0.0021	0.0019
p-value	0.8952	0.4241	0.2366	0.2108	0.2239	0.2001	0.2899	0.2711
GMB ew	-0.0002	0.0002	0.0001	-0.0003	0.0000	0.0006	-0.0001	-0.0015
se	0.0005	0.0008	0.0009	0.0010	0.0011	0.0016	0.0017	0.0018
p-value	0.8952	0.4241	0.2366	0.2108	0.2239	0.2001	0.2899	0.2711

ESG Performance – Europe

Europe - ESG Performance
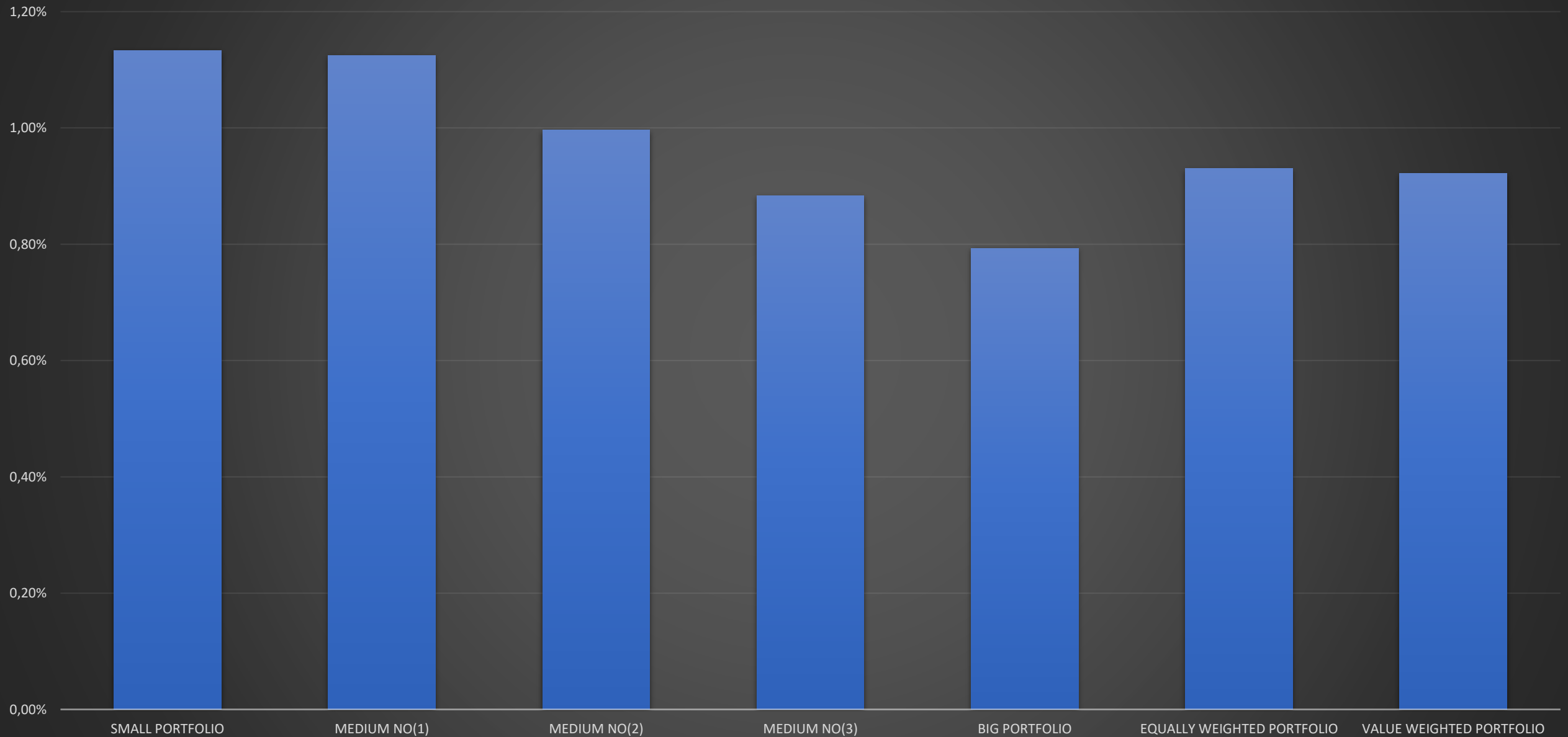
ESG Momentum

- ESG Momentum = Growth of Company's Score during the last 24 months (2 years)

$$ESG\ mom_{t-1} = \frac{ESG\ Score_{t-1}}{ESG\ Score_{t-24}} - 1$$

- 10 portfolios based on ESG Momentum Metric.

  Portfolio 1 invests in 10% stocks with low ESG momentum (Bad)
  Portfolio 10 invests in the 10% of stocks with a high ESG momentum (Good)

- Value of 1$ Invested in a strategy that goes *Long* The Good ESG momentum and ***Short*** the Bad ESG momentum Portfolio - Strategy outperforms the **market** (red line) by 50%.

  - Average Value weighted Monthly return **0.73%** (NW t-stat = 2.70)**,** annualized Sharpe Ratio **0.5**

- **Robust to the period used to define Momentum (12,18,24)**
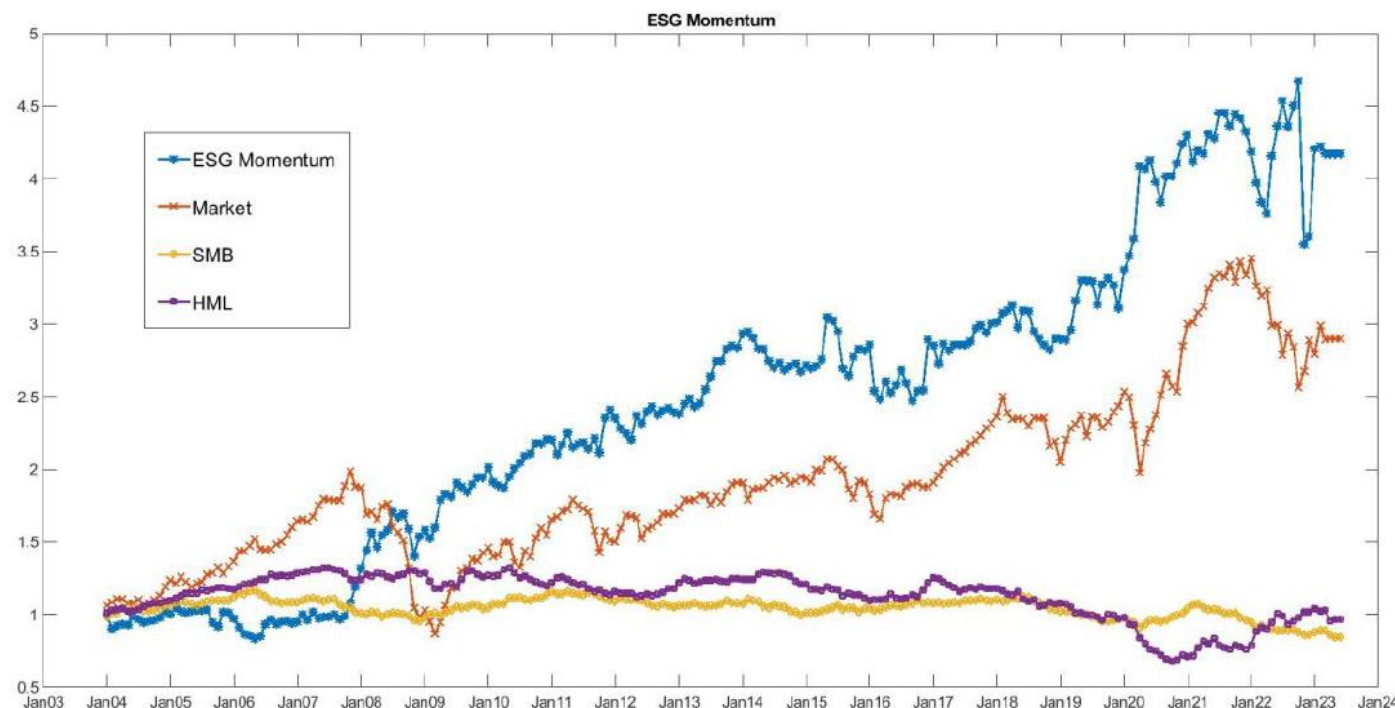
Results 2012-2022

- Strong **ESG Momentum** In International Stock Exchanges 2012-2022
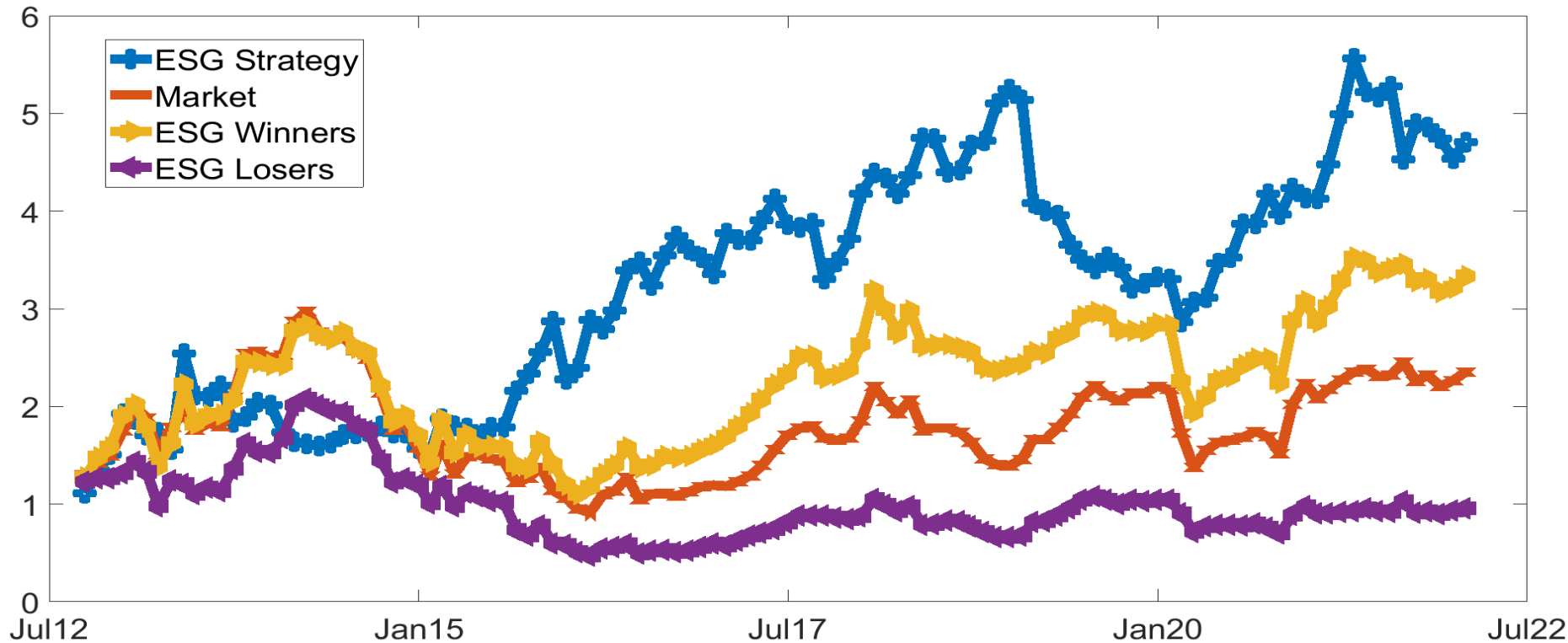
- Value of 1 dollar Invested to ESG Winners vs ESG Losers
- ESG Winners significantly outperform the market
-   ESG Losers significantly underperform the market

Panel A:	ESG Momentum Winners	Market	ESG Momentum Losers
Monthly Average Returns	2.11%	1.28%	0.59%
(hac t stat)	(2.24)	(1.29)	(0.51)
Panel B:	Winners - Market		Winners – Losers (ESG Strategy)
Monthly Average Returns	0.83%		1.52%
(hac t stat)	(1.98)		(2.38)

ESG Controversies Momentum

- ESG Momentum = Growth of Company's Controversies Score during the last 24 months (2 years)

$$ESG\ mom_{t-1} = \frac{ESG\ Controversies\ Score_{t-1}}{ESG\ Controversies\ Score_{t-24}} - 1$$

- 10 portfolios based on ESG Controversies Momentum Metric.

  Portfolio 1 invests in 10% stocks with low ESG Controversies momentum (Bad)
  Portfolio 10 invests in the 10% of stocks with a high ESG Controversies momentum (Good)

- Value of 1$ Invested in a strategy that goes *Long* The Good ESG Controversies momentum and *Short* the Bad ESG Controversies momentum Portfolio outperforms the **market** (red line) by 120%.
- Average Value Weighted Return **0.26%**, annualized Sharpe Ratio **0.55**

- **Robust to the period used to define Momentum (12,18,24)**

ESG Controversies Momentum
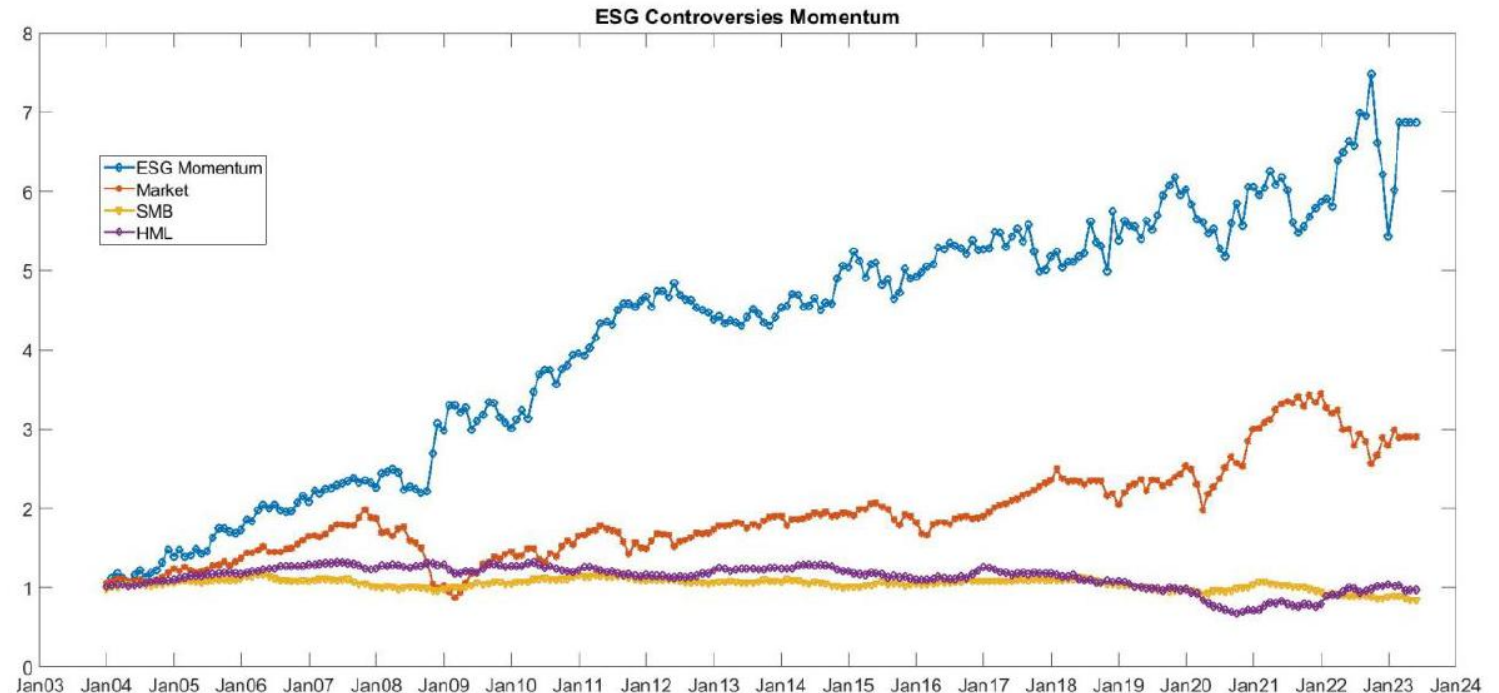
Level of Greenwashing in International Stock Exchange
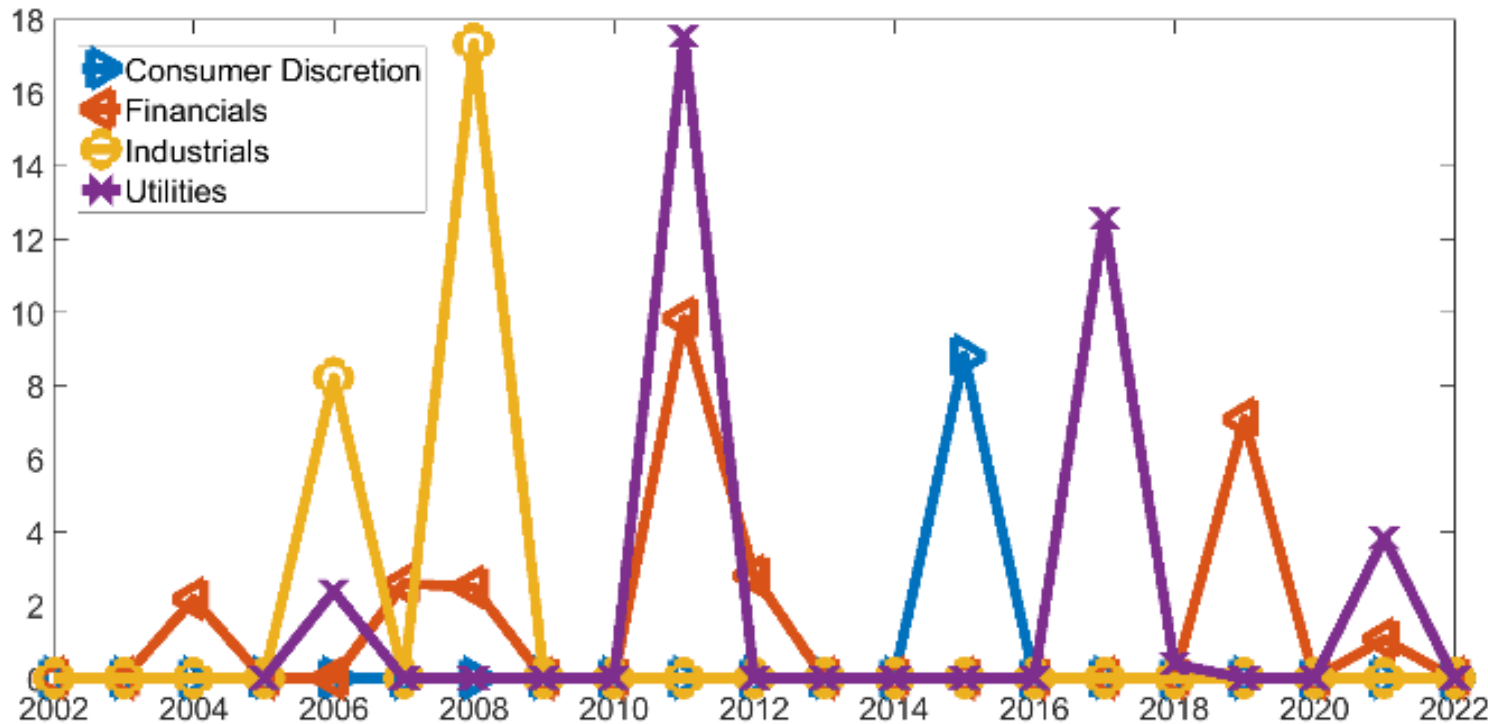
- ESG Score VS **ESG Controversies**

- Controversies reveal **Inconsistencies** in Performance as **reported by Company**

- Absence of a policy to impose auditing of Sustainability Related data

- Example: Greek Companies listed in the Athens Stock Exchange

Consumer Discretion	Financials	Industrials	Utilities
0.42	**1.34**	1.22	**2.04**
(1.12)	**(2.92)**	(1.31)	**(2.64)**

- Statistically Significant Green-Washing to **Financials** and **Utilities** Sectors

- Green-Washing decrease post 2019 with the introduction of EU policies

- Strong **ESG Momentum (ESGM)** In Shipping Sector Global
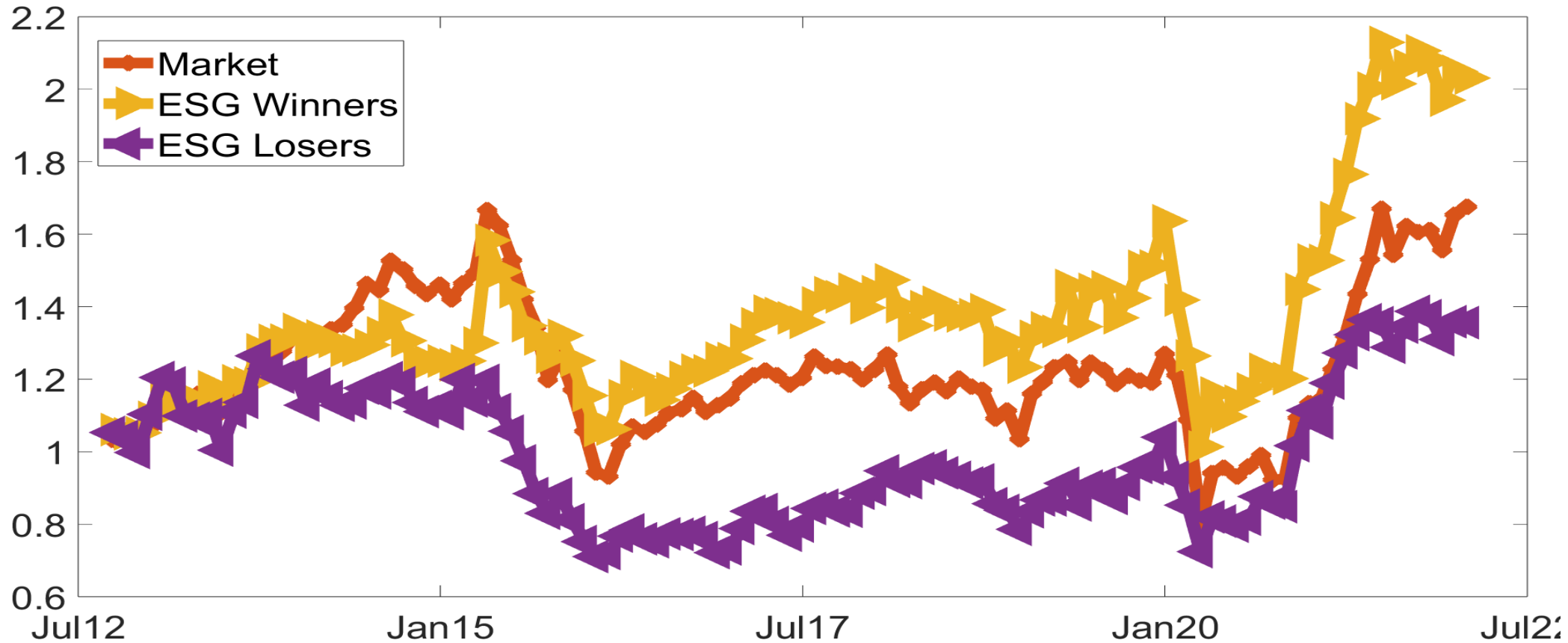
- Value of 1 dollar Invested to **ESGM Winners vs ESGM Losers**
  ESGM Winners significantly outperform the market
  ESGM Losers significantly underperform the market

Level of Greenwashing in Shipping Sector (Global)
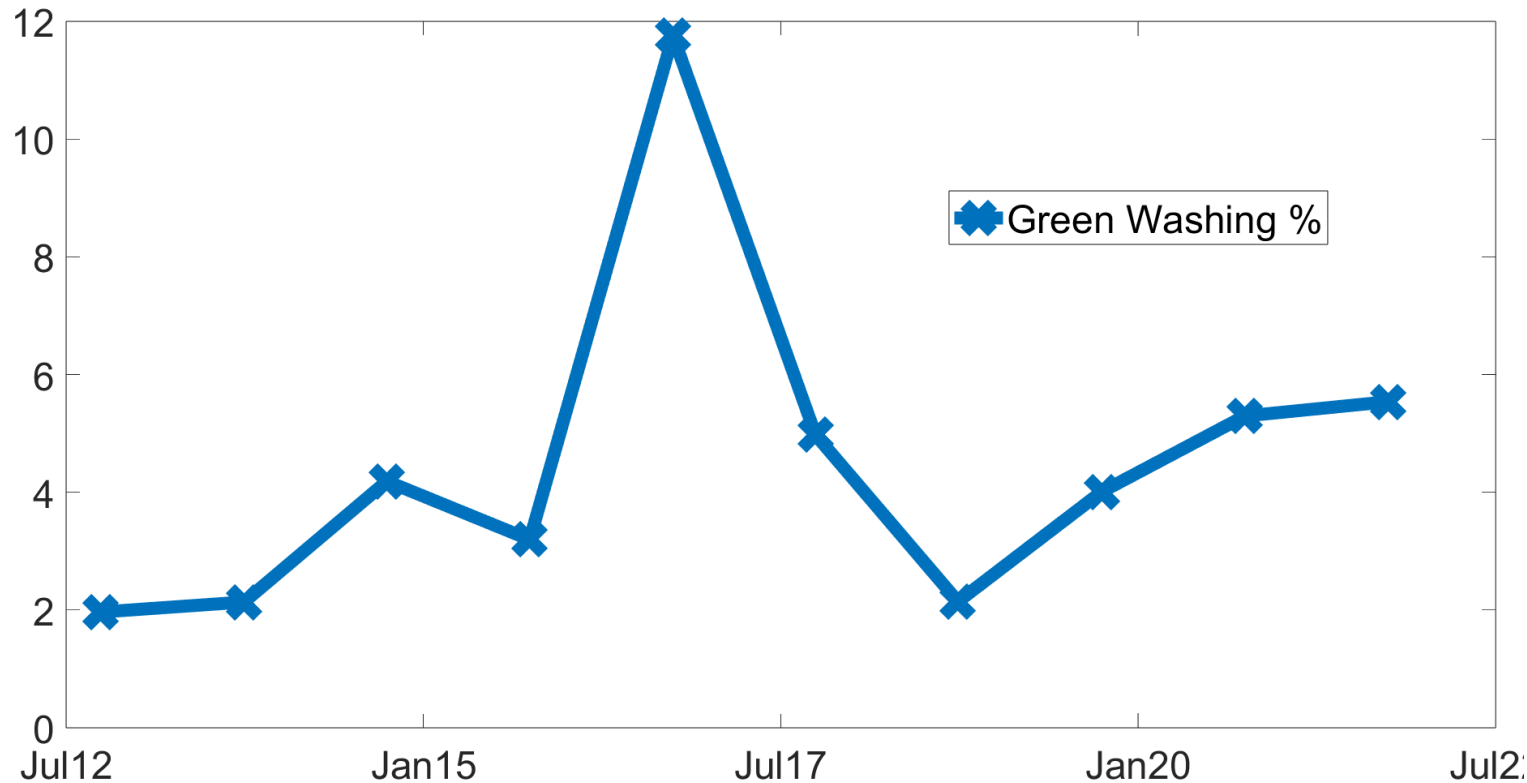
Green Washing %

- ESG Score VS **ESG Controversies**

- Controversies reveal **Inconsistencies** in Performance as **reported by Company**

- Absence of a policy to impose auditing of Sustainability Related data

- Example: Shipping Companies listed in International Stock Exchanges

Shipping
4.52
(4.66)

- Statistically Significant Green-Washing to **Shipping Sector**

ESG Pricing Model

- The Capital Asset Pricing Model (CAPM, Sharpe 1964) describes the relationship between systematic risk and expected return for assets: linear relationship between the required return on an investment and its risk. The model is based on the relationship between an asset's beta, the risk-free rate (typically the Treasury bill rate), and the equity risk premium, or the expected return on the market minus the risk-free rate.

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \varepsilon_t$$

- Fama and French (1992,1993) augmented the model to account for other sources of priced risk, that is size (market capitalization) of companies and their Value (book value: shareholder's equity to market capitalization ratio).

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \varepsilon_t$$

- **Expand Fama and French Methodology to account for ESG related risks**:

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \beta_4 \left(ESG_t \right) + \varepsilon_t$$

Market Equilibrium
C A P M

The Opportunity Set with N Risky Assets
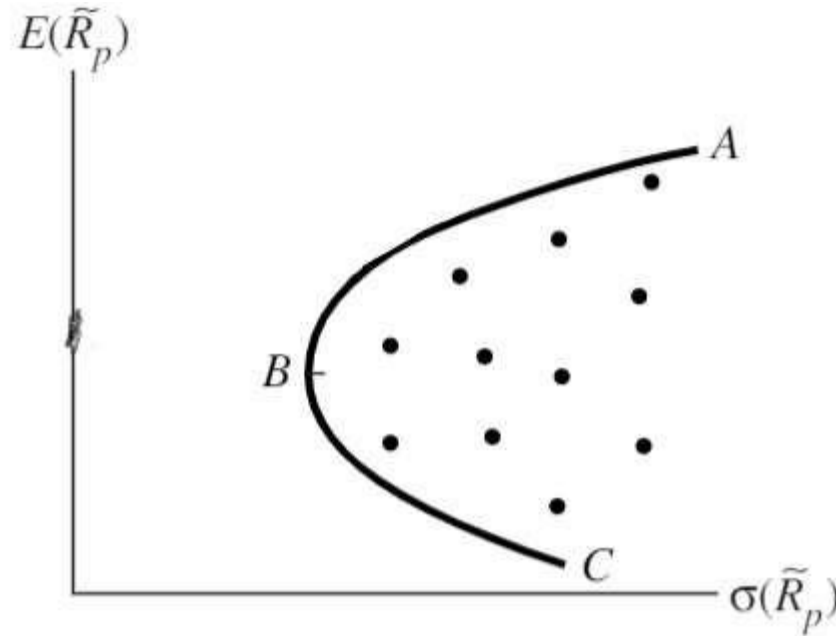
When considering portfolios with many assets, we can discover the opportunity set and efficient set if we know the expected returns and the variances of individual assets as well as the covariances between each pair of assets.

The efficient set with one risk-free and many risky assets
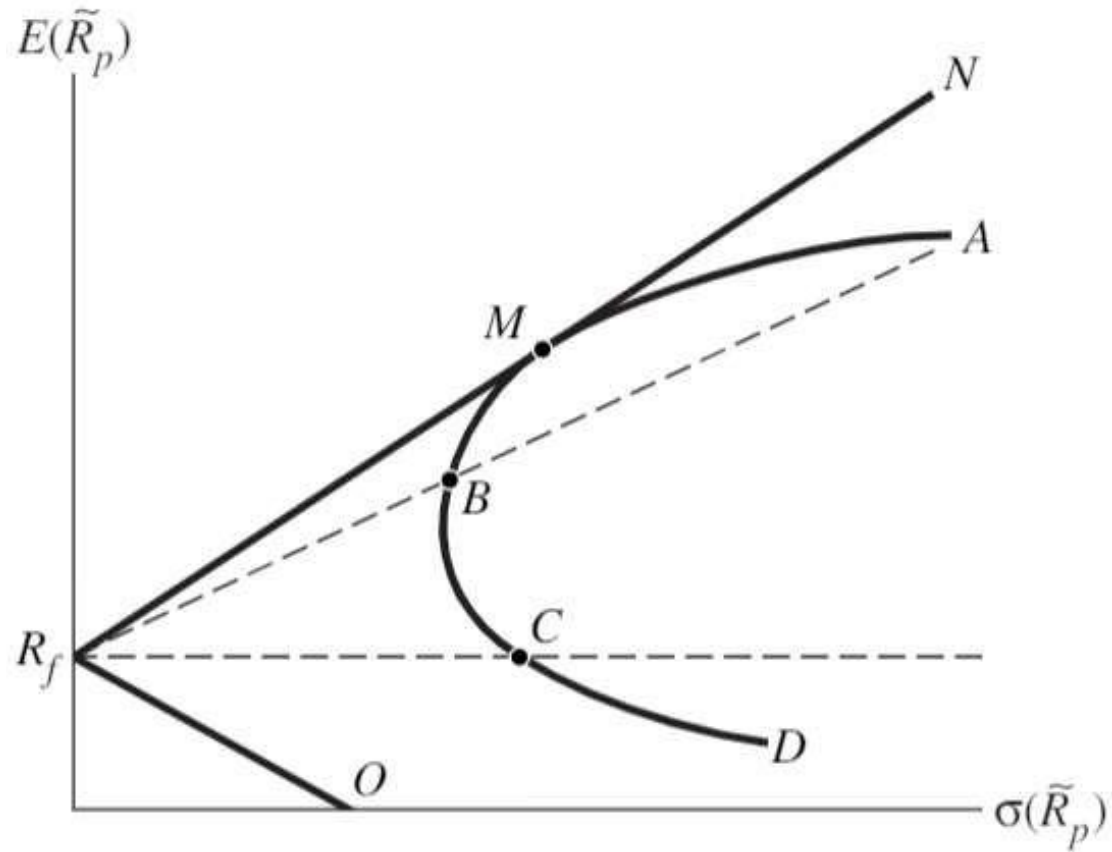
- Assume Borrowing rate equals the Lending rate then we can draw a straight line between any risky asset and risk-free asset.
- Points along the line represent portfolios consisting of combinations of the risk-free and risky assets. Several possibilities are graphed
- Portfolios along any of the lines are possible, but only one line dominates.
- All investors will prefer combinations of the risk-free asset and portfolio M on the efficient set.
- These combinations lie along the positively sloped portion of line NMRfO.

- Therefore the efficient set (which is represented by line segment RfMN) is linear in the presence of a risk-free asset.
- All an investor needs to know is the combination of assets that makes up portfolio M as well as the risk-free asset.
- This is true for any investor, regardless of his or her degree of risk aversion (Indifference Curves – Utility Score Functions for different levels of risk aversion A>0 (I, II and III).

➢ Investor III is the most risk-averse of the three and will choose to invest nearly all of his or her portfolio in the risk-free asset.

➢ Investor I, who is the least risk averse, will borrow (at the risk-free rate) to invest more than 100% of his or her portfolio in the risky portfolio M.

➢ However, no investor will choose to invest in any other risky portfolio except portfolio M.
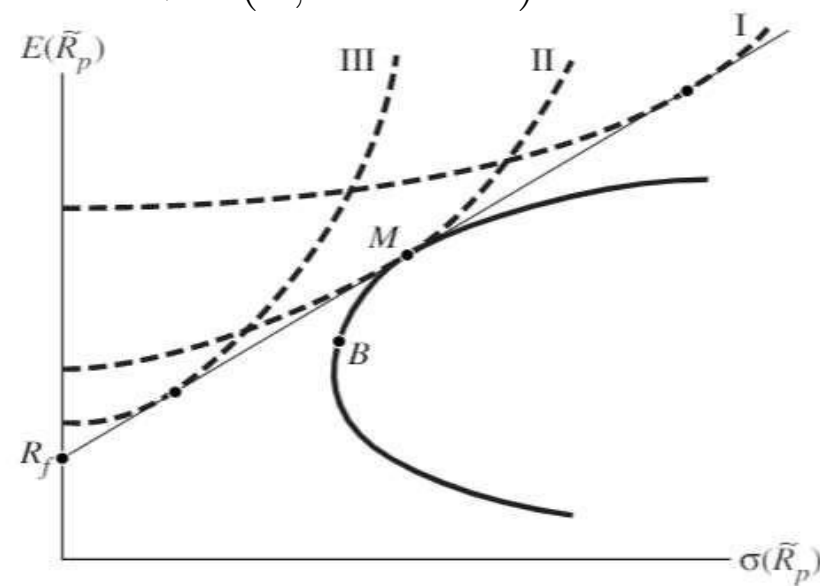
➢ For example, all three could attain the minimum variance portfolio at point B, but none will choose this alternative because all do better with some combination of the risk-free asset and portfolio M.

The CAPM (Capital Asset Pricing Model) is developed in a hypothetical world where the following
assumptions are made about investors and the opportunity set.

1. Investors are risk-averse individuals who maximize the expected utility of their wealth.

2. Investors are price takers and have homogeneous expectations about asset returns

3. There exists a risk-free asset such that investors may borrow or lend unlimited amounts at a risk-free rate.

4. The quantities of assets are fixed. Also, all assets are marketable and perfectly divisible.

5. Asset markets are frictionless, and information is costless and simultaneously available to all investors.

6. There are no market imperfections such as taxes, regulations, or restrictions on short selling.

Implications:

Since investors have homogeneous beliefs. They all make decisions based on **an identical opportunity set (IMI')**. In other words, no one can be fooled because everyone has the same information at the same time.

Since all investors maximize the expected utility of their end-of-period wealth, the model is implicitly a **one-period model**.
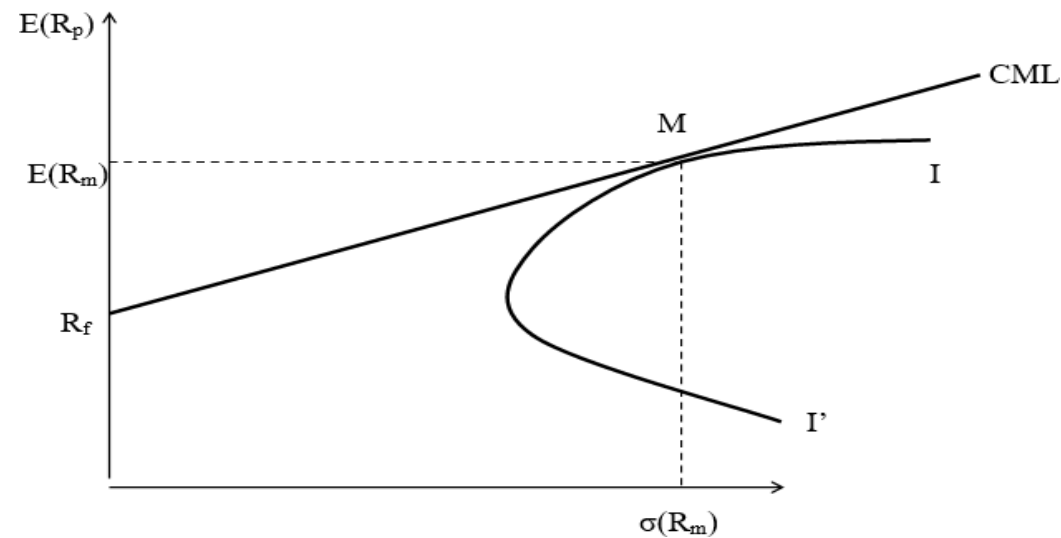
## Two-fund separation Theorem and Capital market line (CML):

- If investors have homogeneous beliefs, then they all have the same linear efficient set called the capital market line (CML)

- Therefore, they will try to hold some combination of the risk-free asset and the portfolio M, which under CAPM is called the Market Portfolio.

  (Two-Fund Separation Theorem)
- Under Assumptions 1-6, the market portfolio will consist of all marketable assets held in proportion to their weight values (wi).
 ➤ The equilibrium proportion of each asset in the market portfolio must be

$$w_i = \frac{\text{Market Value of individual asset}}{\text{Market value of all assets}}$$
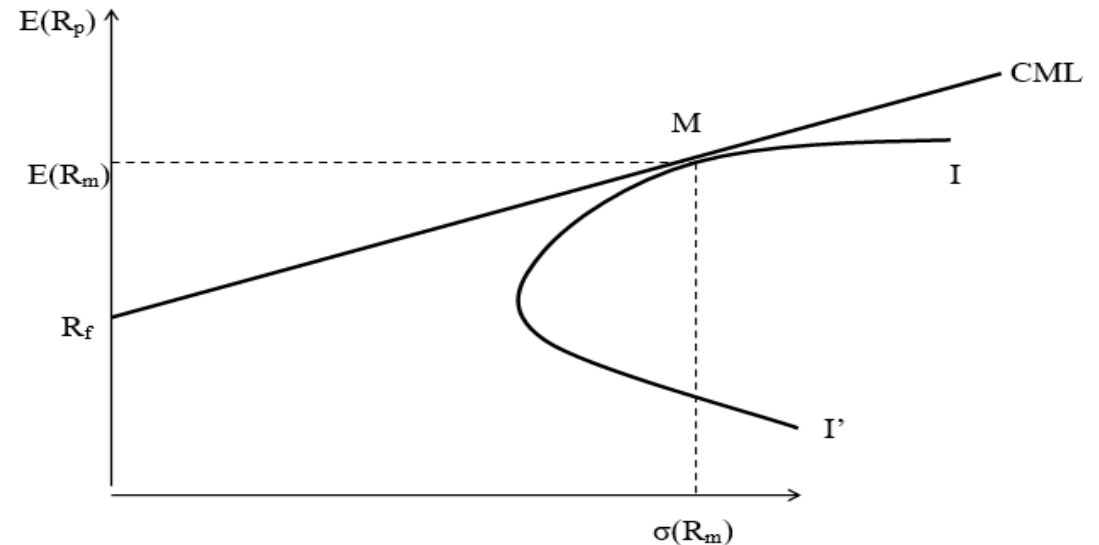
- **CAPM** is also called the security market line (SML) :

$$E(\tilde{R}_i) = R_f + \left[E(\tilde{R}_m) - R_f\right]\frac{\sigma_{im}}{\sigma_m^2}$$

- The required rate of return on any asset, $E(R_i)$, is equal to the risk-free rate of return plus a risk premium.

- The risk premium is the **price of risk** multiplied by the **quantity of risk**.

$E(\tilde{R}_i)$

Security market line

$E(\tilde{R}_m)$

R_f

$\beta_m = 1$

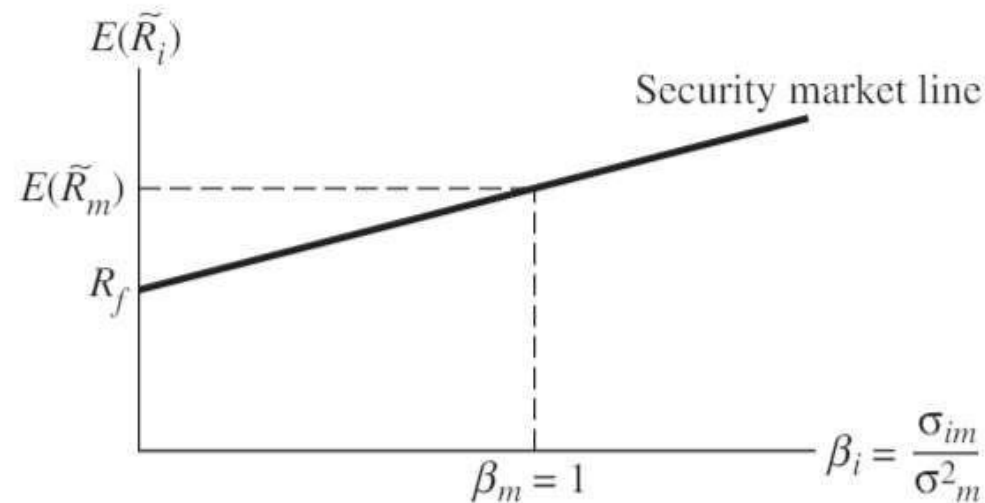$$\beta_i = \frac{\sigma_{im}}{\sigma^2_m}$$
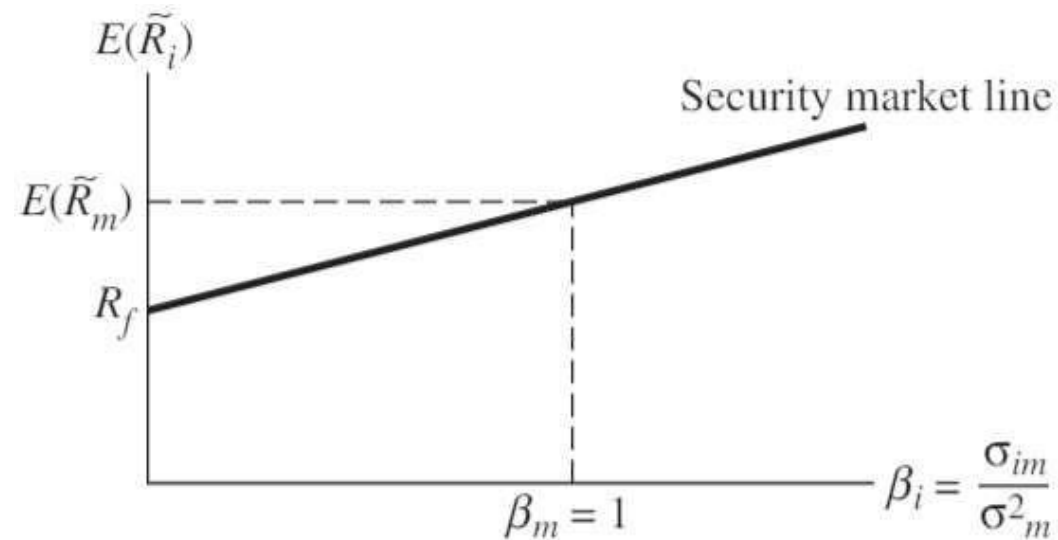
- The price of the risk is the slope of the SML line, the difference between the expected rate of return on the market portfolio and the risk-free rate of return.

- The quantity of risk is often called beta, β_i.

Beta

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2} = \frac{COV(R_i, R_m)}{VAR(R_m)}$$

- It is the covariance between returns on the risky asset I, and the market portfolio M, divided by the variance of the market portfolio.

- The risk-free asset has a beta equal to zero because its covariance with the market portfolio is zero.

- The market portfolio has a beta of one because the covariance of the market with itself is the variance of

  the market portfolio.

$$\beta_m = \frac{COV(\tilde{R}_i, \tilde{R}_m)}{VAR(\tilde{R}_m)} = \frac{VAR(\tilde{R}_m)}{VAR(\tilde{R}_m)} = 1.$$

$\beta_i = \frac{\sigma_{im}}{\sigma_m^2}$
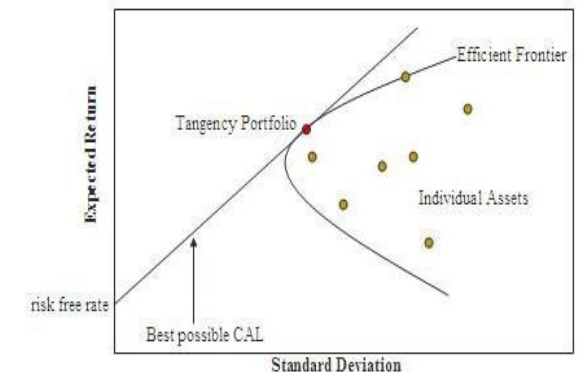
ESG Pricing Model

- The Capital Asset Pricing Model (CAPM, Sharpe 1964) describes the relationship between systematic risk and expected return for assets: linear relationship between the required return on an investment and its risk. The model is based on the relationship between an asset's beta, the risk-free rate (typically the Treasury bill rate), and the equity risk premium, or the expected return on the market minus the risk-free rate.

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \varepsilon_t$$

- Fama and French (1992,1993) augmented the model to account for other sources of priced risk, that is size (market capitalization) of companies and their Value (book value: shareholder's equity to market capitalization ratio).

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \varepsilon_t$$

- **Expand Fama and French Methodology to account for ESG related risks:**

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \beta_4 \left(ESG_t \right) + \varepsilon_t$$

ESG Pricing Model

- We use the ESG scores calculated for companies publishing Sustainability Reports.

- For each ESG we calculate sectoral zero- cost portfolios, mimicking ESG factors, using the Fama and French (2015) methodology (For Global Factors).

- Sector Specific Factor Mimicking Portfolios are double sorted on Size (market Capitalization) and performance on ESG:

  6 value weighted Portfolios from the intersection of 2 Size and 3 ESG Performance categories :

     90% Big stocks are those in the top 90% of market cap for the region, and small stocks are those in the bottom 10% .
   (Small – Big)
     30%-40%-30% breakpoints are used to classify companies as having a good performance on ESG_i
     (high ESG_i – medium ESG_i - low ESG_i)

ESG_i factor is calculated as the difference between the average return of the 2 portfolios which contain stocks with a high performance on ESG_i minus the average of the two portfolios which contain stocks with a low performance on ESG_i.

$$ESG_i = \frac{1}{2}(highESG_I\text{Big} + highESG_I\text{Small}) - \frac{1}{2}(lowESG_I\text{Big} + lowESG_I\text{Small})$$

ESG Momentum Factor

Combined ESG Momentum Factor
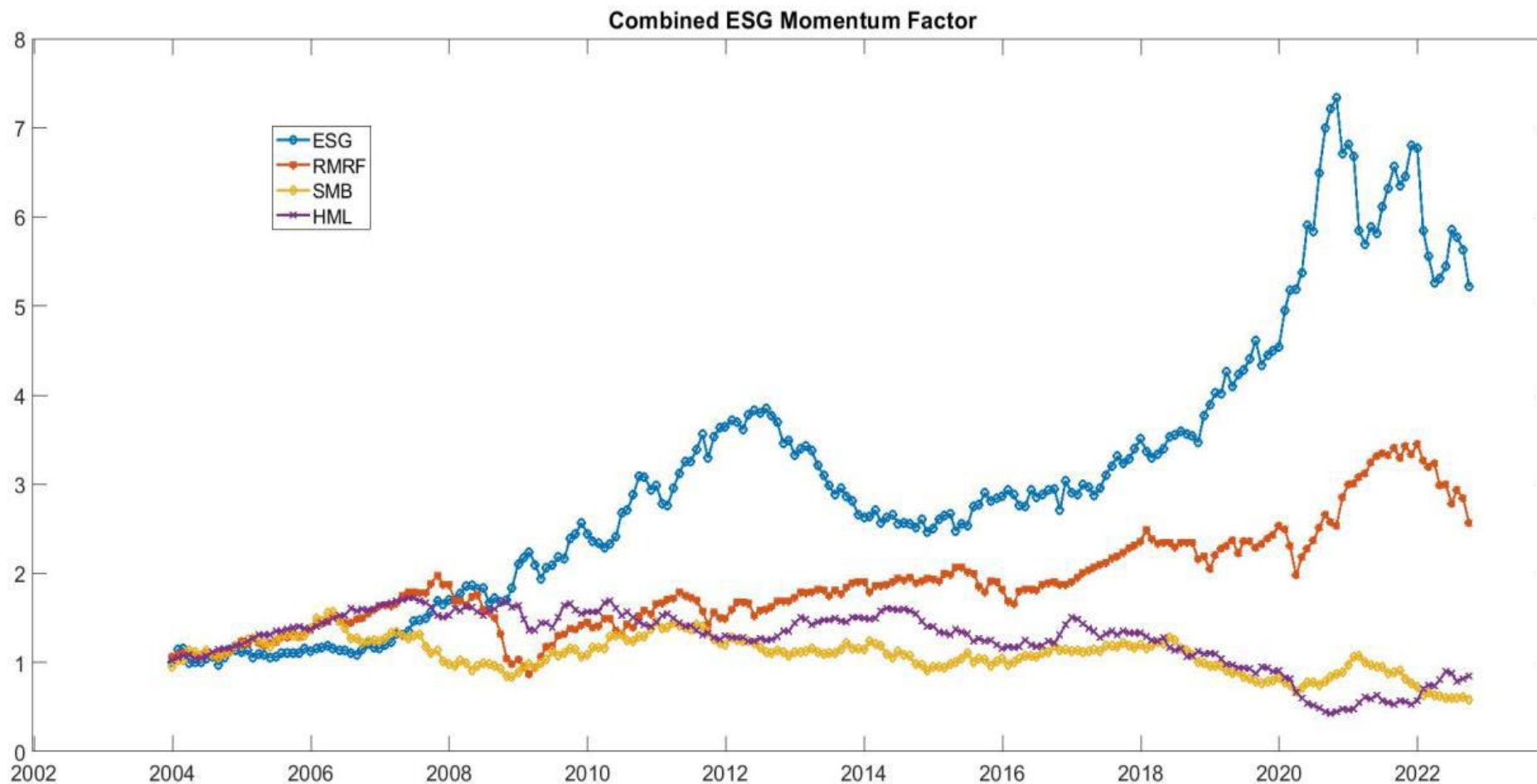
- **ESG** (ESG + Controversies) Momentum **Factor Mimicking Portfolio**

- – A well-diversified Double sorted Portfolio on Size (market cap and ESG momentum) following Fama and French methodology

	$\dfrac{\sum_{i=1}^{20}|a_i|}{20}$	**GRS Test**
3 Factor Model	0.0015	2.73*** (p=0.00)
ESG Factor Model	0.001	2.05** (p=0.02)

- Model Produces lower absolute pricing errors and a lower GRS tests in pricing 20 double sorted on Size ESG Momentum and Controversies portfolios.
- Similar Results using the 100 Size and B/M portfolios of FF data library.

ESG Momentum – Future Returns

Table 6 ESG Momentum Future Returns

Holding Period	Beta	HAC se	HAC tstat
t	0.06	0.004	4.1
t to t+1	0.03	0.01	4.06
t to t+2	0.05	0.01	4.26
t to t+3	0.07	0.02	4.37
t to t+4	0.09	0.02	4.64
t to t+5	0.11	0.02	4.59
t to t+6	0.12	0.03	4.68
t to t+7	0.14	0.03	4.57
t to t+8	0.15	0.03	4.49
t to t+9	0.15	0.04	4.41
t to t+10	0.16	0.04	4.28
t to t+11	0.16	0.04	4.15
t to t+12	0.16	0.04	4.06

- **Fama Mac Beth Cross Sectional Regressions**

- Regress Stock **future returns** $R(t+h)$ on Stock ESG Momentum

- **Significant increase** in Fama Mac Beth Betas for the year following **portfolio formation** (Continues to be Significant until M36)

- IN LINE WITH HENRIKSSON ET AL (2018)

Pricing SMEs

Panel A. Stocks With Significant Negative Load on ESG Momentum Factor

Variable	N stocks	Mean	std
hac tstat	5342	-2.34	0.456
Returns on Year +1	5342	-0.029	0.653

Panel B. Stocks With Significant Positive Loading on ESG Momentum Factor

Variable	N stocks	Mean	std
hac tstat	1832	2.65	0.534
Returns on Year +1	1832	0.033	0.498

- Using All stocks with no ESG data available from EIKON

- -2.9% for Companies (on Year t+1) with significant negative loadings on factor Mimicking Good ESG performance.

- +3.3% for Companies (on Year t+1) with significant positive loadings on factor Mimicking Good ESG performance.

Impact on Financial Performance on SMEs
US Stock Exchanges 2008-2015

Summary Statistics - Analysis Based on SASB Material Items

Panel A: Observations with significant negative loadings on ESG GMB

Variable	N	Mean	Std Dev	10th Pctl	25th Pctl	50th Pctl	75th Pctl	90th Pctl
t-statistic	2131	-2.496	0.482	-3.184	-2.721	-2.370	-2.131	-2.018
Future annual excess return	2131	-0.032	0.653	-0.604	-0.285	-0.042	0.195	0.536
Material ESG score	625	0.257	0.276	0.000	0.000	0.200	0.500	0.667
ESG score - All items	896	0.238	0.257	0.000	0.077	0.154	0.351	0.556
Book/Market ratio	2131	1.425	13.721	0.194	0.359	0.662	1.155	2.080
Analysts' average B/M	1497	0.836	4.638	0.150	0.282	0.476	0.777	1.206
Analysts' average implied return	1497	1.334	2.299	1.022	1.091	1.172	1.305	1.571
Market value ($mil.)	2131	5002	19678	24	91	729	3609	11098

Panel B: Observations with significant positive loadings on ESG GMB

Variable	N	Mean	Std Dev	10th Pctl	25th Pctl	50th Pctl	75th Pctl	90th Pctl
t-statistic	1561	2.535	0.523	2.040	2.158	2.374	2.764	3.276
Future annual excess return	1561	0.027	0.441	-0.338	-0.126	0.022	0.180	0.399
Material ESG score	510	0.339	0.302	0.000	0.000	0.333	0.500	0.750
ESG score - All items	944	0.331	0.343	0.000	0.000	0.214	0.524	1.000
Book/Market ratio	1561	0.789	0.956	0.201	0.381	0.602	0.888	1.325
Analysts' average B/M	1237	0.612	0.532	0.176	0.321	0.531	0.770	1.063
Analysts' average implied return	1237	1.211	2.281	0.994	1.045	1.101	1.189	1.328
Market value ($mil.)	1561	10220	35573	111	298	1005	4041	18164

- Pricing Data from CRSP database, ESG items from Bloomberg.

- Good defined as loading positively on the on the Good minus Bad ESG factor in a 4-factor asset pricing model.

- SASB based ESG KPIs – Material items for company's sector. Factor is calculated based on the Large Cap companies which have ESG data available.

- -3.2% for Companies with significant negative loadings on factor Mimicking Good ESG performance.

- +2.7% for Companies with significant positive loadings on factor Mimicking Good ESG performance.
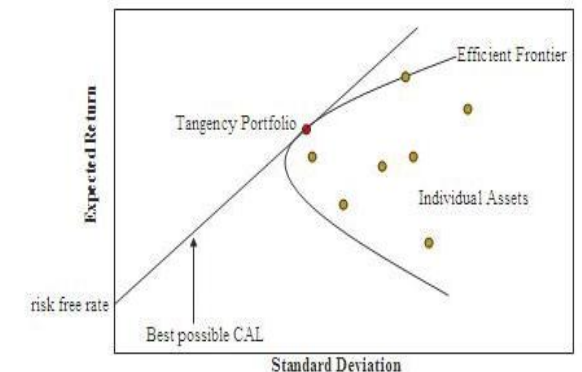
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    50% breakpoint are used to classify companies as Big or Small based on Market Capitalization
    (Small – Big)
    30%-40%-30% breakpoints are used to classify companies as having a good performance on SDG_i
    (high SDG_i – medium SDG_i - low SDG_i)

SDG_i factor is calculated as the difference between the average return of the 2 portfolios which contain stocks with a high performance on SDG_i minus the average of the two portfolios which contain stocks with a low performance on SDG_i.

$$SDG_i = \frac{1}{2}(highSDG_I\text{Big} + highSDG_I\text{Small}) - \frac{1}{2}(lowSDG_I\text{Big} + lowSDG_I Small)$$

Combined ESG Momentum Factor
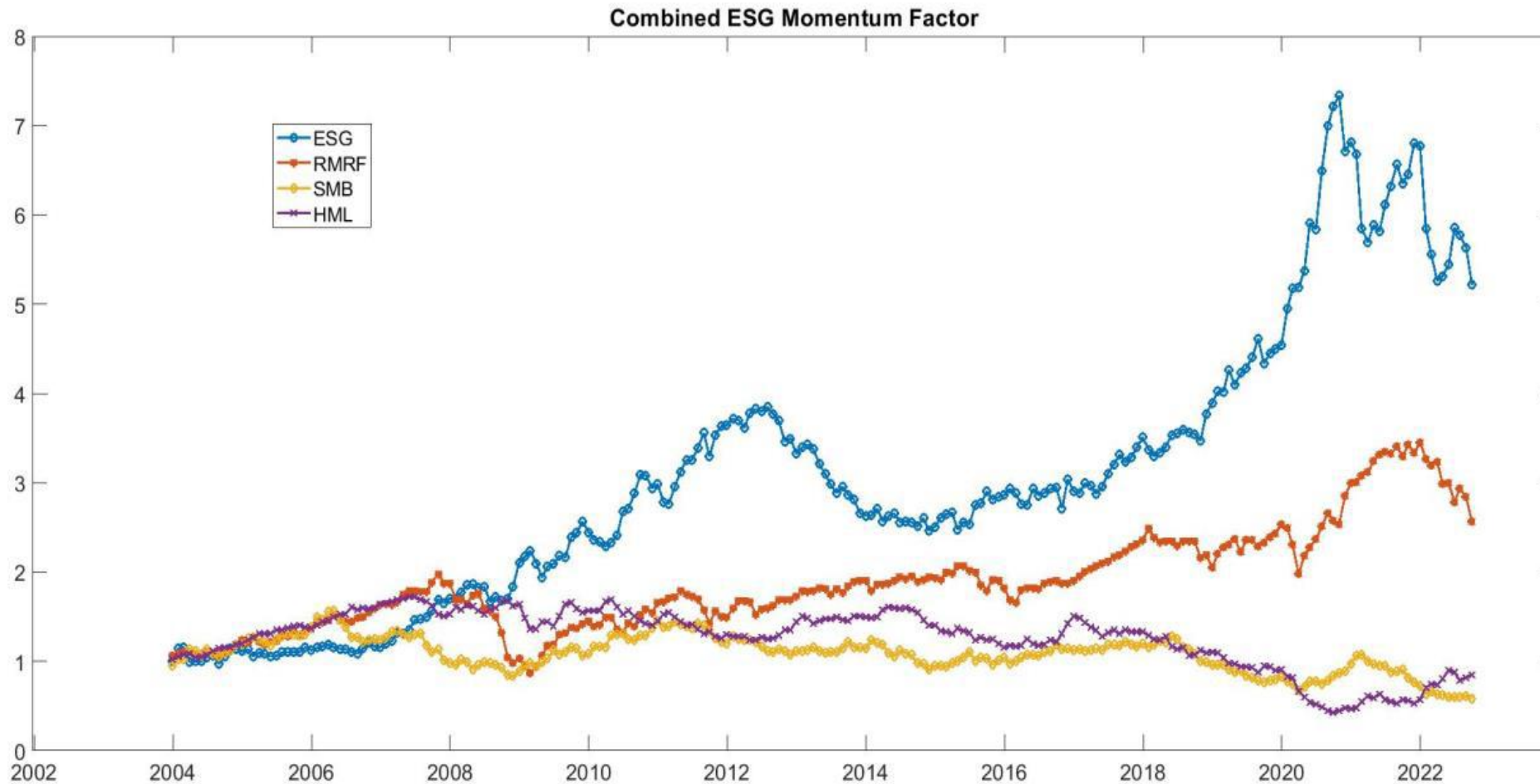
- **ESG Combined** (ESG + Controversies) Momentum **Factor Mimicking Portfolio** – A well diversified Double sorted Portfolio on Size (market cap and ESG momentum) following Fama and French methodology

- Model Produces lower absolute pricing errors and a lower GRS tests in pricing 20 ESG Momentum and Controversies portfolios.

	$\frac{\sum_{i=1}^{20}|a_i|}{20}$	GRS Test
3 Factor Model	0.0015	2.73*** (p=0.00)
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- **Fama Mac Beth Cross Sectional Regressions**

- Regress Stock **future returns** R(t+h) on Stock ESG Momentum

- **Significant increase** in Fama Mac Beth Betas for the year following **portfolio formation**

```
-------------------------------------------------------------------------
   Panel A - FM Betas World
-------------------------------------------------------------------------
           fm |   Coefficient    hac Std.Err    t stat    p-value
-------------------------------------------------------------------------
     intercept |     0.021293      0.003916     5.4368    0.000 ***
  ESG Momentum |     0.009842      0.003569     2.7576    0.006 ***


-------------------------------------------------------------------------
T observations = 253
Newey West (HAC) Standard errors
Average R2 fm regressions : 0.15486
Average R2 Adjusted fm regressions : 0.15447


-------------------------------------------------------------------------
   Panel B - FM Betas - Europe
-------------------------------------------------------------------------
           fm |   Coefficient    hac Std.Err    t stat    p-value
-------------------------------------------------------------------------
     intercept |     0.019539      0.003783     5.1646    0.000 ***
  ESG Momentum |     0.021435      0.008614     2.4884    0.013 **


-------------------------------------------------------------------------
T observations = 253
Newey West (HAC) Standard errors
Average R2 fm regressions : 0.19118
Average R2 Adjusted fm regressions : 0.18984
```

- **Integrate** SDGs in **CSR** Framework
- **Machine Learning Algorithms (Cosine Similarity)** to Map **ESG** KPIs vs 232 SDG Indicators

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$

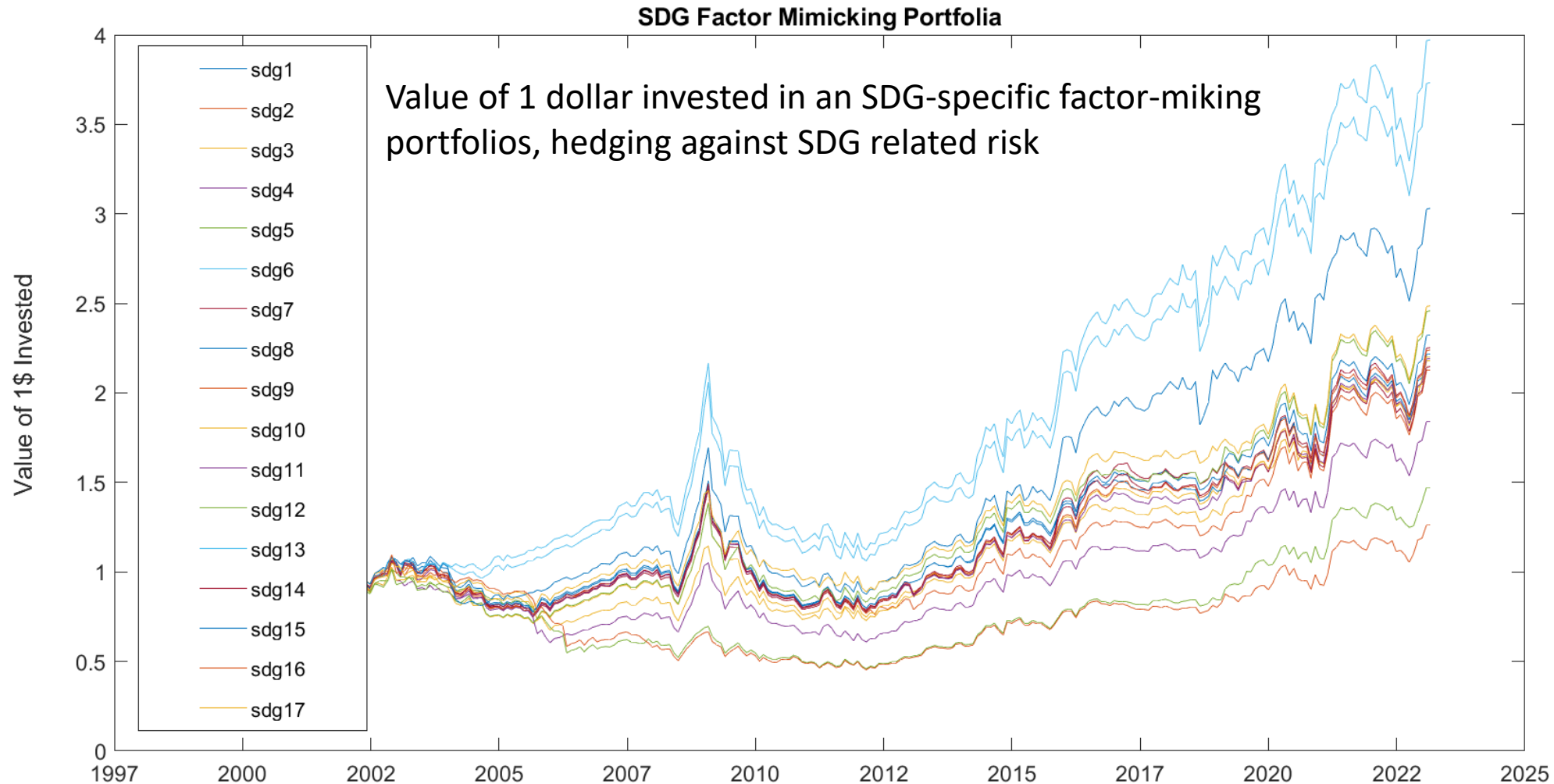$$W_{i,k}^{SDG} = \frac{\sum SDG\ Indicators\ mapped\ to\ KPI_k\ under\ SDG_i}{\sum Indicators\ under\ SDG_i}$$

- Linear Least Squares – Time series – 20 years – Aggregate Market Performance of ESG KPIs- Sensitivies to SDG

- Model to Evaluate **SDG performance** at the **Company Level**
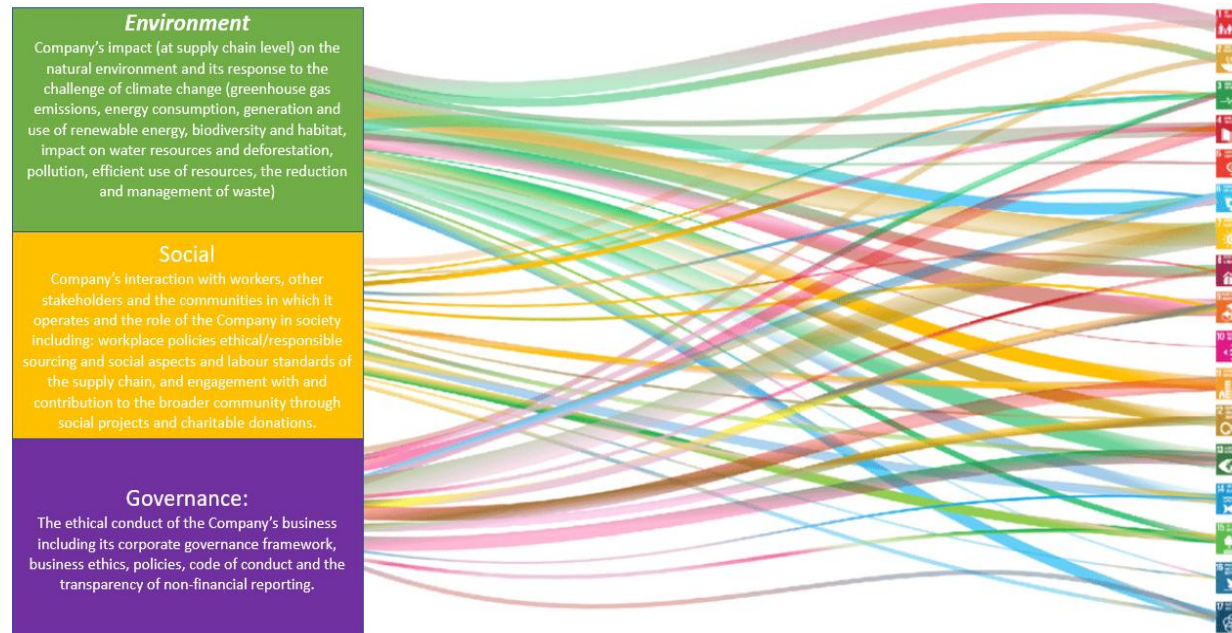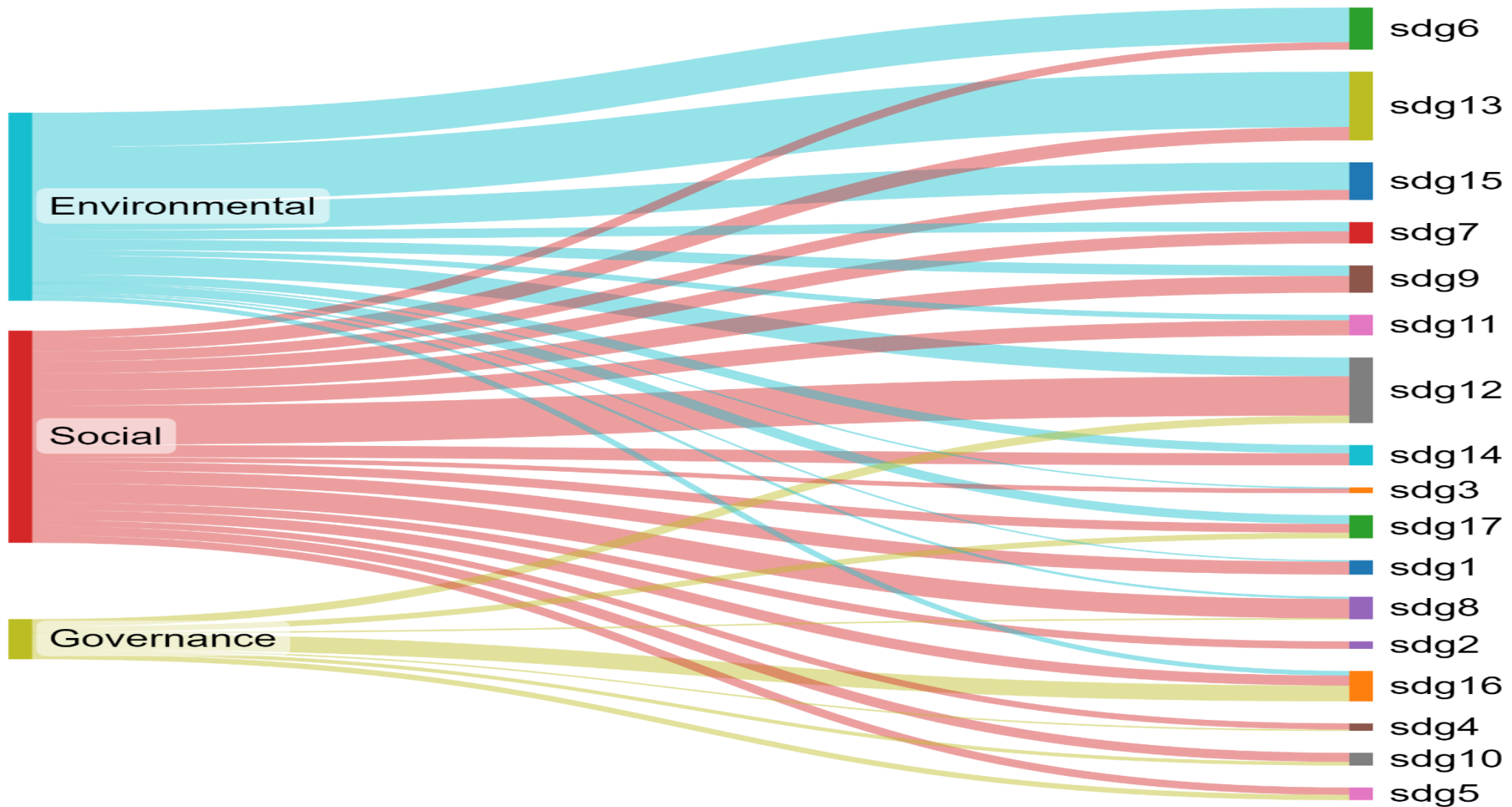
$$W_{i,k}^{SDG} = \frac{\sum SDG\ Indicators\ mapped\ to\ KPI_k\ under\ SDG_i}{\sum Indicators\ under\ SDG_i}$$

$$\widetilde{W_{i,k}^{SDG}} = \frac{W_{i,k}^{SDG}}{\sum_{k=1}^{K} W_{i,k}^{SDG}}$$

SDG Factor Mimicking Portfolia

Value of 1 dollar invested in an SDG-specific factor-miking portfolios, hedging against SDG related risk

- The SDG weights are used to calculate the stock specific SDG scores, using the following methodology:

$$Score_i^{SDG} = \sum_{p=1}^{3} \widetilde{W_{i,p}^{SDG}} \, Pillar \, Score_p$$

		Name	WKN			ISIN	SHORT NAME	TICKER	Portfolio weight
Fixed Income	Total government bonds	0,5% Societe Generale Covered	A19H9E		A19H9E WPK	FR0013259413	SOCIETE GENERALE	SOCSFH	0.96%
		0,8% Belgien	A19B7A		A19B7A WPK	BE0000341504	BELGIAN GOVT	BGB	2.75%
		0,75 % Frankreich	A19QFA		A19QFA WPK	FR0013286192	FRANCE O.A.T.	FRTR	2.63%
		iShares € Govt Bond Climate UCITS ETF EUR(Acc)	A2P2A7		A2P2A7 WPK	IE00BLDGH553	ISH EUR GV CLM€A	SECA GR	2.43%
		iShares $ Treasury Bond 3-7yr UCITS ETF EUR Hedged (Dist)	A2PDTT		A2PDTT WPK	IE00BGPP6473	ISH $TR 3-7 €HD	CBUE GR	3.83%
	Total corporate bonds	2% ITV PLC NT. V. 2016 REG.S	A189VC		A189VC WPK	XS1525536840	ITV PLC	ITVLN	3.23%
		0,95 % Rentokil Initial PLC	A19SM7		A19SM7 WPK	XS1722897623	RENTOKIL INITIAL	RTOLN	3.15%
		0,625% Atlas Copco	A185MP		A185MP WPK	XS1482736185	ATLAS COPCO	ATCOA	3.05%
		0,375 Commerzbank 2027	CZ45V8		CZ45V8 WPK	DE000CZ45V82	COMMERZBANK AG	CMZB	2.37%
		1,125% Heidelberg Cement	A2R37Q		A2R37Q WPK	XS2018637327	HEIDELCEMENT FIN	HEIGR	2.92%
		0,75% Total	A1830R		A1830R WPK	XS1443997819	TOTAL CAP INTL	TTEFP	0.91%
		0,2% Coca-Cola Europacific	A285YC		A285YC WPK	XS2264977146	COCA-COLA EURO	CCEP	2.70%
		0,75% E.ON	A254QS		A254QS WPK	XS2103014457	E.ON SE	EOANGR	2.34%
		iShares € Corp Bond ESG UCITS ETF EUR (Dist)	A142NT		A142NT WPK	IE00BYZTVT56	ISH € CORP ESG	OM3F GR	4.31%
		iShares € Corp Bond 0-3yr ESG UCITS ETF EUR (Dist)	A142NU		A142NU WPK	IE00BYZTVV78	ISH € CP ESG03YD	QDVL GR	2.20%
		iShares € High Yield Corp Bond ESG UCITS ETF EUR (Acc)	A2PNZM		A2PNZM WPK	IE00BJK55C48	ISH €HYCP ESG €A	AYE2 GR	2.98%
	Europe incl. UK	Allianz SE		840400	840400 WPK	DE0008404005	ALLIANZ SE-REG	ALV GR	0.82%
		AXA S.A.		855705	855705 WPK	FR0000120628	AXA	AXA GR	1.20%
		ROCHE HOLDING AG-GENUSSCHEIN		855167	855167 WPK	CH0012032048	ROCHE HLDG-GENUS	RHO5 GR	1.22%
		Linde plc	A2DSYC		A2DSYC WPK	IE00BZ12WP82	LINDE PLC	LIN GR	1.53%
		Deutsche Post AG		555200	555200 WPK	DE0005552004	DEUTSCHE POST-RG	DPW GR	0.92%
		Schneider Electric		860180	860180 WPK	FR0000121972	SCHNEIDER ELECTR	SND GR	0.96%
		VINCI SA		867475	867475 WPK	FR0000125486	VINCI SA	SQU GR	1.16%
		SAP AG		716460	716460 WPK	DE0007164600	SAP SE	SAP GR	0.74%
		ASML Holding N.V.	A1J4U4		A1J4U4 WPK	NL0010273215	ASML HOLDING NV	ASME GR	1.05%
		Orange		906849	906849 WPK	FR0000133308	ORANGE	FTE GR	1.16%
		Mercedes-Benz Group AG		710000	710000 WPK	DE0007100000	MERCEDES-BENZ GR	MBG GR	0.96%
		Danone		851194	851194 WPK	FR0000120644	DANONE	BSN GR	0.69%
		LVMH Moët Hennessy Louis Vuitton		853292	853292 WPK	FR0000121014	LVMH MOET HENNE	MOH GR	1.09%
		Oréal S.A., L'		853888	853888 WPK	FR0000120321	L'OREAL	LOR GR	1.38%

- Assessing the SDG Footprint of a sample Portfolio

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- Fetching Data from Financial Databases (Thomson Reuters), Evaluate Models 2012-2023.

- Main Modules for the calculation of Factor Mimicking Portfolios implemented in MATLAB (can be delivered in Python, R also).

- Regress portfolio returns on factor directly or on portfolio that mimics SDG factor:

$$r_{p,t} - r_{f,t} = \beta_0 + \beta_1 \left(r_{m,t} - r_{f,t} \right) + \beta_2 \left(SMB_t \right) + \beta_3 \left(HML_t \right) + \sum_{i=4}^{20} \beta_i \left(SDG_{i-3,t} \right) + \varepsilon_t$$

   where:

   $r_{f,t}$ = risk free rate – A short Term Treasury Bill or Interbank rate as a proxy.

- Suppose portfolio contains N shares α_1, …, α_N with $\sum_j^N \alpha_j$ =1.
   Weights of Portfolio Assets Sum to 1.

- Sensitivity of portfolio with respect to factor f_k is
   $\gamma_k = \sum_j \alpha_j \beta_{jk}$

- Footprint to SDGs as the sensitivity of portfolio to the specific SDG factors.

Sensitivities to SDG related factors (factor loadings-betas)

		Name	Intercept	RMRF	SMB	HML	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10
Fixed Income	Total government bonds	0,5% Societe Generale Covered	-0.006062	0.20158	-0.04737	0.00838	3.15881	0.15695	-2.52729	-0.83652	-0.00759	-0.6594	1.59664	-2.45742	-0.30626	0.30664
		0,8% Belgien	-0.005911	0.23497	-0.07178	-0.05485	3.13452	0.17245	-2.59192	-0.63904	-0.05464	-1.61126	0.74675	-2.44939	0.71394	0.12967
		0,75 % Frankreich	-0.007011	0.23654	-0.0303	-0.0364	2.82833	0.34688	-3.58824	-0.84059	0.55089	-2.13863	-0.66192	-1.77869	-0.62931	-0.53565
		iShares € Govt Bond Climate UCITS ETF EUR(Acc)	-0.018759	-0.03955	-0.26212	0.02185	-21.8186	5.276	3.74586	-9.99434	9.19393	14.8241	17.4316	17.3497	-4.43423	-9.43995
		iShares $ Treasury Bond 3-7yr UCITS ETF EUR Hedged (Dis	-0.004998	0.1569	-0.10171	-0.06288	2.64779	-0.2994	-1.38187	-0.70115	-0.0554	-3.30897	1.33441	-2.0658	-5.83732	0.53338
	Total corporate bonds	2% ITV PLC NT. V. 2016 REG.S	-0.001277	0.25524	-0.10776	0.04846	3.37805	0.33525	-0.67008	-0.85053	-0.60419	1.491	0.77671	-2.86944	0.56352	0.85209
		0,95 % Rentokil Initial PLC	-0.005682	0.28114	-0.0496	0.06928	4.41403	0.39041	-2.99215	-1.27888	-0.3377	-0.63632	0.13922	-3.57864	-1.0497	0.85684
		0,625% Atlas Copco	-0.005157	0.3182	-0.1444	-0.05886	1.9913	0.09064	-1.57858	-0.75718	-0.09986	-4.49624	0.6762	-1.65641	-0.02412	0.4776
		0,375 Commerzbank 2027	-0.011399	0.21061	-0.24754	0.07176	-24.5742	4.70148	-5.40416	-8.60599	0.7753	13.843	13.802	24.0894	-2.5236	-0.48015
		1,125% Heidelberg Cement	-0.01437	0.46145	-0.05463	0.22091	3.11893	1.01083	-0.37133	-2.33006	3.00836	1.6078	4.84795	-7.67073	-4.45031	-2.25174
		0,75% Total	-0.007617	0.42804	-0.17925	-0.03653	3.34487	0.19327	-1.72426	-0.92381	0.07753	-5.69347	0.68947	-3.00153	0.45911	0.34071
		0,2% Coca-Cola Europacific	-0.01831	0.0981	-0.21122	0.10128	-36.6338	12.3734	-5.24424	-5.54234	1.84315	16.1084	14.6259	21.8904	-9.79715	-1.76268
		0,75% E.ON	-0.028452	0.52093	-0.24994	0.32692	-7.12528	0.69587	-7.32664	-2.47307	3.92969	14.6152	16.8591	-1.08728	3.73386	-2.79268
		iShares € Corp Bond ESG UCITS	-0.006989	0.3882	-0.08832	0.00674	3.72296	0.29392	-2.09804	-1.13595	-1.26419	0.45186	-0.06383	-3.35674	-0.51902	1.76497
		iShares € Corp Bond 0-3yr ESG	-0.002119	0.24969	-0.07229	0.00035	1.08722	-0.40164	-0.71634	-0.39549	-1.16044	-3.27574	-0.55272	-0.94077	0.7517	1.58822
		iShares € High Yield Corp Bond	-0.0115	0.631	-0.12553	0.28873	0.63554	0.43286	-3.40066	-2.35514	2.64457	4.33889	5.57324	-2.50236	-1.72758	-1.37164
	Europe incl. UK	Allianz SE	-0.00388	1.0201	-0.31874	0.45931	1.43062	1.18506	-0.22639	-0.98793	-2.11911	-1.65902	0.39235	-1.18591	-0.45927	2.02409
		AXA S.A.	-0.004441	1.137	-0.22167	0.54708	1.83767	1.54339	2.83902	-1.08019	-2.1732	0.52065	1.93065	-1.78977	-1.06922	2.14903
		ROCHE HOLDING AG-GENUSSCHEIN	0.0014121	0.40434	-0.22266	-0.36796	-1.03066	-1.43699	-0.14742	0.3126	1.93893	-12.5265	-0.21657	2.13349	1.46351	-1.65391
		Linde plc	0.0041478	0.86389	-0.37338	0.14781	2.73122	-1.46892	-3.51739	1.08235	-2.45229	-12.4709	-2.15707	-1.78258	0.77021	1.97511
		Deutsche Post AG	-0.002976	1.22067	-0.13384	0.105	0.71295	-2.04074	-2.99137	2.72637	-2.49009	-3.63641	0.35611	0.25319	-1.85959	1.64371
		Schneider Electric	-0.001219	1.10564	0.20082	-0.21903	0.41527	-0.48585	-0.06447	0.13578	-2.49246	2.84079	-1.58845	0.14845	-0.49043	2.6262
		VINCI SA	-0.00147	0.86121	-0.15502	0.19806	-1.22019	1.18461	2.81599	-0.06077	0.34774	5.46494	0.54138	0.83337	0.35239	-0.47218
		SAP AG	-0.006479	1.10065	-0.4256	-0.39331	3.35394	-1.61749	-3.54804	2.4111	-1.91919	-11.9792	0.45537	-1.5234	0.1995	0.32731
		ASML Holding N.V.	0.0111809	1.15354	0.19266	-0.1537	-1.69353	-0.96649	1.78235	2.3208	-2.65703	-13.2051	-1.58594	0.265	1.32195	1.93325
		Orange	0.0010282	0.28184	-0.5134	0.25382	-1.69094	-0.97903	1.05224	0.45911	0.90922	-0.28952	-1.22083	3.77883	0.61382	-1.00405
		Mercedes-Benz Group AG	-0.000436	1.29058	0.15724	0.7463	-1.58307	-0.81018	-0.94106	0.19954	-2.34181	-3.55371	-1.32858	1.30536	-1.25734	2.86166
		Danone	-0.006519	0.57447	-0.3571	0.06482	-0.72455	-1.02867	-1.32851	0.80036	2.31113	-11.6128	-2.0228	1.95092	0.0853	-2.01616
		LVMH Moët Hennessy Louis	0.0056524	0.89542	-0.00355	-0.22323	-1.76355	-0.17581	1.58666	1.08109	-2.86747	14.4056	-0.93521	1.1161	0.85776	2.33852
		Oréal S.A., L'	0.002412	0.66817	-0.30964	-0.38001	-0.72089	-2.49268	-0.24539	1.18531	-0.64874	-11.9337	-2.30938	1.45623	-0.31193	1.15694
		RECKITT BENCKISER	-0.000715	0.62678	-0.34812	-0.20507	-1.69364	-1.8828	-3.33158	0.81668	-0.50114	6.15748	-1.42041	3.02881	1.92901	1.12884

		Name	Intercept	RMRF	SMB	HML	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14
Fixed Income	Total government bonds	0,5% Societe Generale Covered	0.0469754	0.00024	0.6224	0.89133	0.08455	0.7475	0.05966	0.13331	0.99457	0.88442	0.51577	0.15087	0.8118	0.78335	0.85778	0.06033	0.6031	0.62373
		0,8% Belgien	0.0481019	4.07E-05	0.47057	0.3745	0.07638	0.73384	0.03474	0.2608	0.95765	0.73303	0.75294	0.1347	0.48614	0.90076	0.42674	0.2506	0.86952	0.3478
		0,75 % Frankreich	0.0424401	0.00012	0.78384	0.59788	0.16314	0.52495	0.01753	0.17311	0.65835	0.67616	0.87605	0.34997	0.66426	0.6677	0.97399	0.04485	0.9442	0.57375
		iShares € Govt Bond Climate UCITS ETF EUR(Acc)	0.1919075	0.80683	0.12245	0.86675	0.09644	0.30029	0.6037	0.06118	0.36849	0.0583	0.01613	0.41024	0.53828	0.34379	0.98195	0.30772	0.16046	0.5666
		iShares $ Treasury Bond 3-7yr UCITS ETF EUR Hedged (Dis	0.2980911	0.06829	0.55504	0.51885	0.59919	0.69779	0.63192	0.4041	0.98664	0.69861	0.82576	0.6725	0.35225	0.86977	0.86703	0.55124	0.98524	0.64836
	Total corporate bonds	2% ITV PLC NT. V. 2016 REG.S	0.6643344	1.85E-05	0.29635	0.44606	0.06508	0.52203	0.58438	0.14833	0.56775	0.76022	0.75104	0.09063	0.57592	0.42606	0.88818	0.40319	0.32862	0.63243
		0,95 % Rentokil Initial PLC	0.069722	2.02E-06	0.62759	0.27798	0.01946	0.43634	0.03292	0.02693	0.77767	0.8916	0.97127	0.04386	0.42801	0.47216	0.61488	0.20608	0.62467	0.8815
		0,625% Atlas Copco	0.110152	2.10E-06	0.19906	0.38998	0.24109	0.87143	0.24629	0.23397	0.93188	0.38483	0.80193	0.29383	0.98258	0.68662	0.76193	0.57108	0.55391	0.7638
		0,375 Commerzbank 2027	0.3636034	0.177	0.13786	0.59289	0.06238	0.32279	0.43478	0.06221	0.8682	0.05839	0.02961	0.2446	0.72136	0.90661	0.6715	0.51206	0.04065	0.41009
		1,125% Heidelberg Cement	0.0105334	0.00011	0.74797	0.03576	0.55463	0.23772	0.93545	0.01025	0.37384	0.85103	0.43414	0.2407	0.49452	1.49451	0.63621	0.47431	0.49283	0.83127
		0,75% Total	0.0328328	2.55E-08	0.14815	0.62738	0.07373	0.75408	0.25055	0.18771	0.952	0.31815	0.81652	0.08379	0.7061	0.79395	0.2761	0.40069	0.43101	0.70675
		0,2% Coca-Cola Europacific	0.3893746	0.73745	0.52881	0.71935	0.09205	0.26399	0.65028	0.43435	0.92236	0.17522	0.17099	0.49932	0.62152	0.92602	0.51922	0.93004	0.20252	0.99271
		0,75% E.ON	0.0110919	0.00417	0.31557	0.0675	0.36325	0.63477	0.27149	0.10402	0.43431	0.2283	0.09443	0.91756	0.72766	0.56231	0.62083	0.54723	0.24824	0.2251
		iShares € Corp Bond ESG UCITS ETF EUR (Dist)	0.0806944	1.50E-06	0.5392	0.93526	0.13676	0.65795	0.3891	0.12793	0.48064	0.94794	0.99013	0.15222	0.77381	0.32168	0.83471	0.38916	0.67319	0.77223
		iShares € Corp Bond 0-3yr ESG UCITS ETF EUR (Dist)	0.4116801	8.12E-06	0.44913	0.99512	0.42128	0.39745	0.54024	0.45959	0.24339	0.46262	0.81215	0.45531	0.42807	0.11837	0.33478	0.14829	0.8622	0.96962
		iShares € High Yield Corp Bond ESG UCITS ETF EUR (Acc)	0.0795744	2.38E-05	0.48174	0.02107	0.91286	0.61948	0.4772	0.01174	0.46472	0.6185	0.43168	0.75145	0.82625	0.69412	0.55871	0.56039	0.24733	0.87529
		Allianz SE	0.4595156	5.30E-14	0.10793	0.00092	0.57217	0.27164	0.92697	0.43974	0.35235	0.85455	0.82108	0.62464	0.81338	0.39118	0.61389	0.06241	0.79841	0.7543
		AXA S.A.	0.4941721	4.16E-12	0.36457	0.0014	0.55801	0.24785	0.35441	0.49504	0.44093	0.96295	0.36981	0.55115	0.65734	0.46207	0.47291	0.2057	0.66666	0.53374
		ROCHE HOLDING AG-GENUSSCHEIN	0.7344779	3.08E-05	0.15691	0.00084	0.60845	0.0947	0.94012	0.758	0.28447	0.08376	0.87514	0.26907	0.34473	0.37787	0.85112	0.37244	0.08797	0.79563
		Linde plc	0.3011784	4.36E-16	0.0145	0.15307	0.15968	0.07582	0.0645	0.26845	0.15992	0.07345	0.10575	0.33638	0.60439	0.2738	0.2144	0.06579	0.058	0.27786

- Cross Sectional Fama Mac Beth (1974) regressions support results.

- This Pilot Case is showcased using our European Factors – International, Asian, America and MENA are also available.
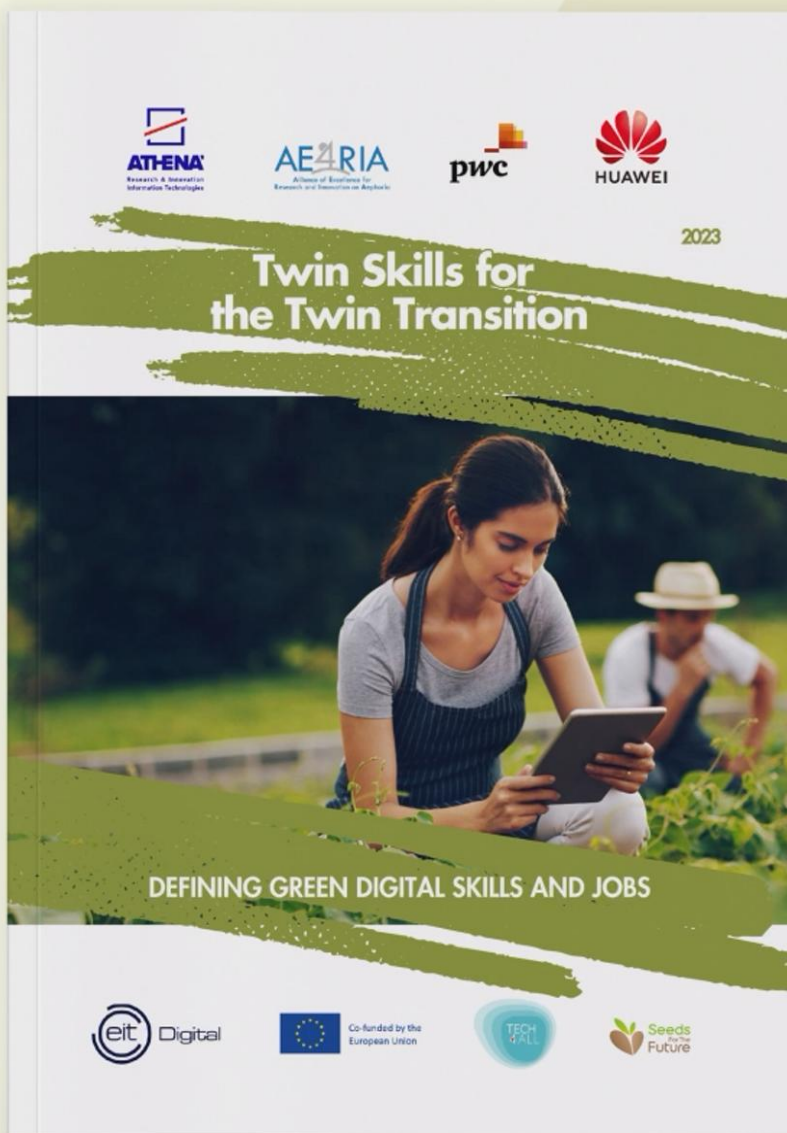
- Aggregate Factor Loadings/ Betas to Portfolio Level.
- Portfolio SDG Footprint. Tendency of Portfolio to move with the SDG factors.
- A Negative Footprint implies portfolio has a Bad performance in the underlying SDG.
- A Positive Footprint implies portfolio has a Good performance in the underlying SDG.

Impact on Financial Performance on SMEs US Stock Exchanges 2008-2015

Summary Statistics - Analysis Based on SASB Material Items

Panel A; Observations with significant negative loadings on ESG GMB

Variable	N	Mean	Std Dev	10th Pctl	25th Pctl	50th Pctl	75th Pctl	90th Pctl
t-statistic	2131	-2.496	0.482	-3.184	-2.721	-2.370	-2.131	-2.018
Future annual excess return	2131	-0.032	0.653	-0.604	-0.285	-0.042	0.195	0.536
Material ESG score	625	0.257	0.276	0.000	0.000	0.200	0.500	0.667
ESG score - All items	896	0.238	0.257	0.000	0.077	0.154	0.351	0.556
Book/Market ratio	2131	1.425	13.721	0.194	0.359	0.662	1.155	2.080
Analysts' average B/M	1497	0.836	4.638	0.150	0.282	0.476	0.777	1.206
Analysts' average implied return	1497	1.334	2.299	1.022	1.091	1.172	1.305	1.571
Market value ($mil.)	2131	5002	19678	24	91	729	3609	11098

Panel B; Observations with significant positive loadings on ESG GMB

Variable	N	Mean	Std Dev	10th Pctl	25th Pctl	50th Pctl	75th Pctl	90th Pctl
t-statistic	1561	2.535	0.523	2.040	2.158	2.374	2.764	3.276
Future annual excess return	1561	0.027	0.441	-0.338	-0.126	0.022	0.180	0.399
Material ESG score	510	0.339	0.302	0.000	0.000	0.333	0.500	0.750
ESG score - All items	944	0.331	0.343	0.000	0.000	0.214	0.524	1.000
Book/Market ratio	1561	0.789	0.956	0.201	0.381	0.602	0.888	1.325
Analysts' average B/M	1237	0.612	0.532	0.176	0.321	0.531	0.770	1.063
Analysts' average implied return	1237	1.211	2.281	0.994	1.045	1.101	1.189	1.328
Market value ($mil.)	1561	10220	35573	111	298	1005	4041	18164

- Pricing Data from CRSP database, ESG items from Bloomberg.

- Good defined as loading positively on the on the Good minus Bad ESG factor in a 4-factor asset pricing model.

- SASB based ESG KPIs – Material items for company's sector. Factor is calculated based on the Large Cap companies which have ESG data available.

- -3.2% for Companies with significant negative loadings on factor Mimicking Good ESG performance.

- +2.7% for Companies with significant positive loadings on factor Mimicking Good ESG performance.

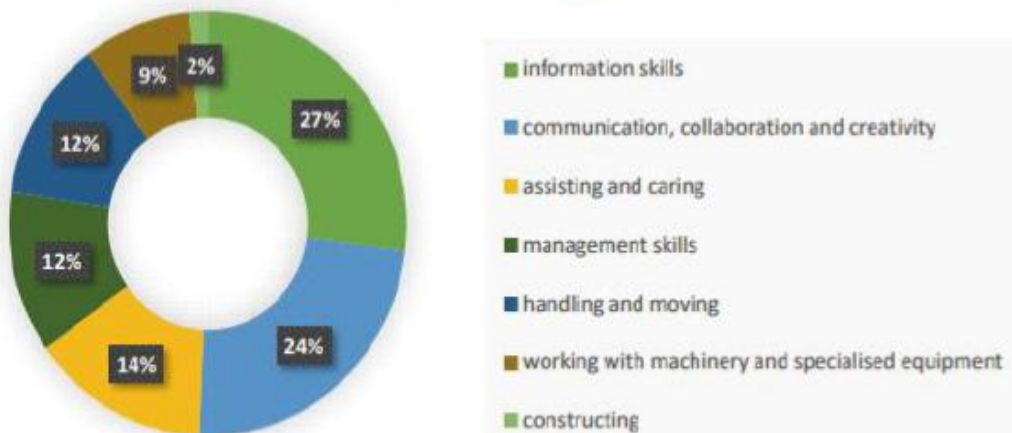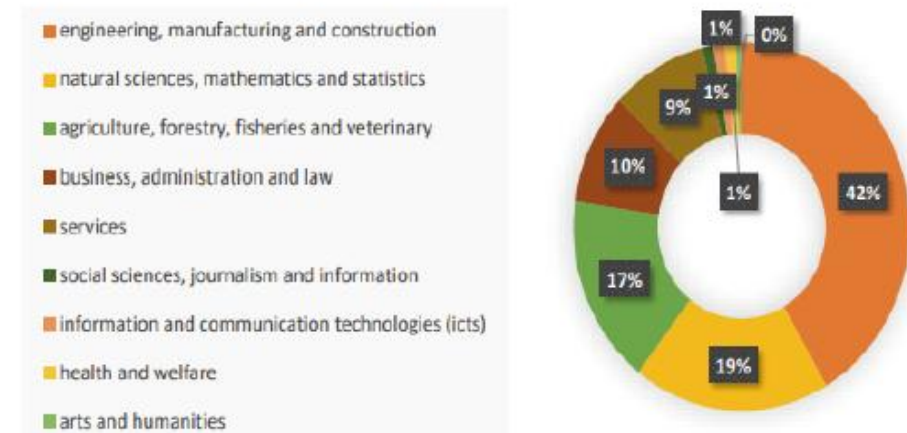# European Skills, Competences, Qualifications, and Occupations (ESCO) Framework

➤ The ESCO framework is the multilingual classification of European Skills, Competences and Knowledge Concepts, following the International Skills Classification (ISCO).

➤ ESCO provides the relations between the Occupations and the Skills and Knowledges, e.g. which skills and Knowledge concepts are relevant for the each of the occupations.

Green Skills

- information skills — 27%
- communication, collaboration and creativity — 24%
- assisting and caring — 14%
- management skills — 12%
- handling and moving — 12%
- working with machinery and specialised equipment — 9%
- constructing — 2%

Green Knowledge Concepts

- engineering, manufacturing and construction — 42%
- natural sciences, mathematics and statistics — 1%
- agriculture, forestry, fisheries and veterinary — 9%
- business, administration and law — 10%
- services — 1%
- social sciences, journalism and information — 17%
- information and communication technologies (icts) — 1%
- health and welfare — 19%
- arts and humanities — 0%

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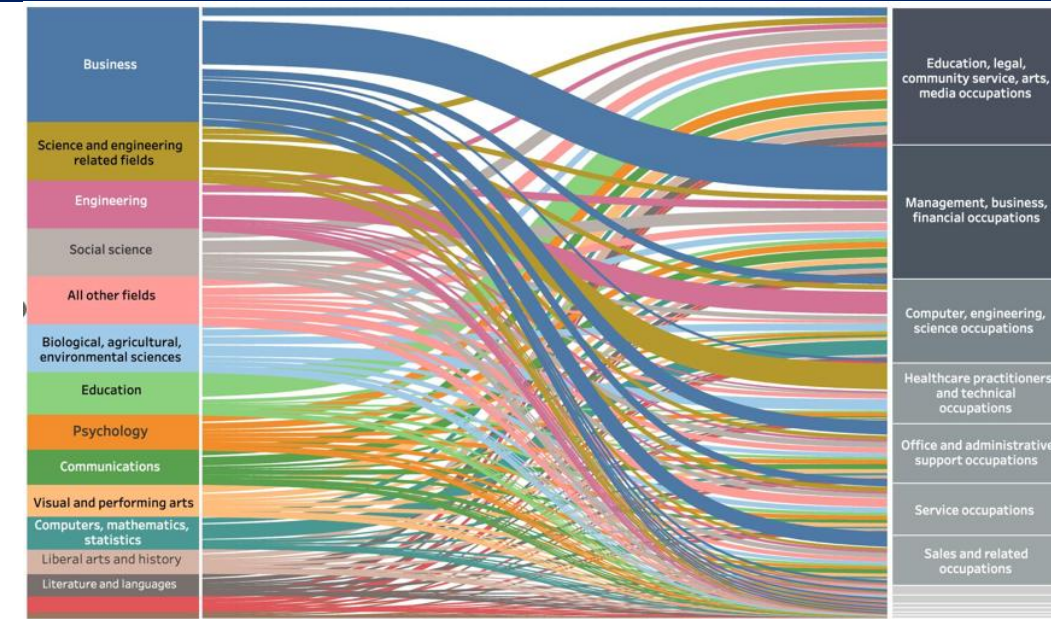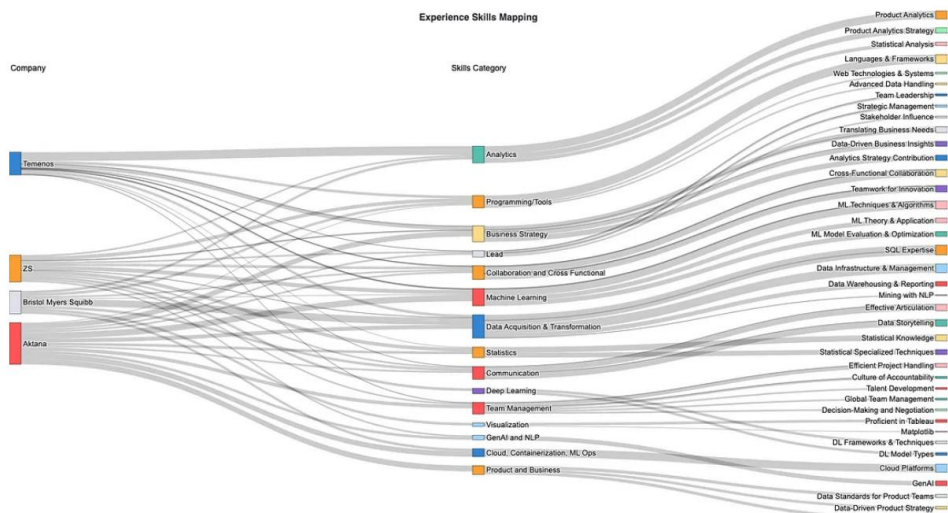
A New Framework for Green & Digital Occupations

➤ Machine Learning to Map Skills/Competences/Qualifications and Knowledge Concepts to Occupations (Rank importance of skills in each occupation)


➤ Map Policies/Projects to Skills and Occupations Needed for their implementation

The New Set of Green & Digital Skills

EU Policy[10]	Sector (NACE Rev. 2)	Green Digital Skills	Green Digital Occupations
Corporate Sustainability Reporting (ESG)	All sectors	advising on environmental issues	environmental education officer
EU Taxonomy Regulation		analysing and evaluating information and data	environmental expert
EU Sustainable Finance Disclosure Regulation (SFDR)		complying with environmental protection laws and standards	green ICT consultant
EU Sustainable Investment Plan		computer use	natural resources consultant
Corporate Sustainability Reporting Directive (CSRD)		database and network design and administration	nature conservation officer
EU Action Plan on Financing Sustainable Growth		environmental sciences	sustainability manager
Environmental and Energy Policies		analysing and evaluating information and data	electric meter technician
European Green Deal	Agriculture, Forestry and Fishing	complying with environmental protection laws and standards	electrical transmission system operator
EU Biodiversity strategy for 2030	Construction	computer use	electricity distribution technician
Circular Economy Action Plan	Energy Supply	database and network design and administration	energy assessor
Waste Framework Directive	ICT	designing electrical or electronic systems or equipment	energy systems engineer
Air Quality Directive	Manufacturing	disposing of non-hazardous waste or debris	environmental education officer
Water Framework Directive	Transport and Storage	electricity and energy	geothermal technician
Renewable Energy Directive	Water and Wastewater Treatment	environmental protection technology	green ICT consultant
Energy Efficiency Directive		handling and disposing of hazardous materials	hazardous waste inspector
EU Emission Trading System (EU ETS)		maintaining electrical, electronic and precision equipment	irrigation technician
Just Transition Fund		monitoring environmental conditions	recycling specialist
Connecting Europe Facility (CEF)		operating agricultural or forestry equipment	smart home engineer
Fit for 55		using precision measuring equipment	smart home installer
Industry Policies		analysing and evaluating information and data	acoustical engineer
EU Industrial Policy	Construction	analysing scientific and medical data	botanist
Green Deal Industrial Plan	Energy Supply	complying with environmental protection laws and standards	ecologist
EcoDesign	Health and Social Care	computer use	energy assessor
Critical Raw Materials Act	ICT	database and network design and administration	energy systems engineer
Chips Act	Manufacturing	designing electrical or electronic systems or equipment	environmental education officer
	Mining and Quarrying	electronics and automation	green ICT consultant
		maintaining electrical, electronic and precision equipment	smart home engineer
		using precision measuring equipment	smart home installer

Framework to Rank Green and Digital Occupations

➢ Using the classifications and hierarchies provided by the ESCO API, we develop a **data driven Scoring model** to classify Occupations based on their level of "Greenness", "Digitalization" and "Greenness and Digitalization".

➢ Machine Learning – weighting scheme for the weight of Skills, Competences and Knowledge concepts to Occupations
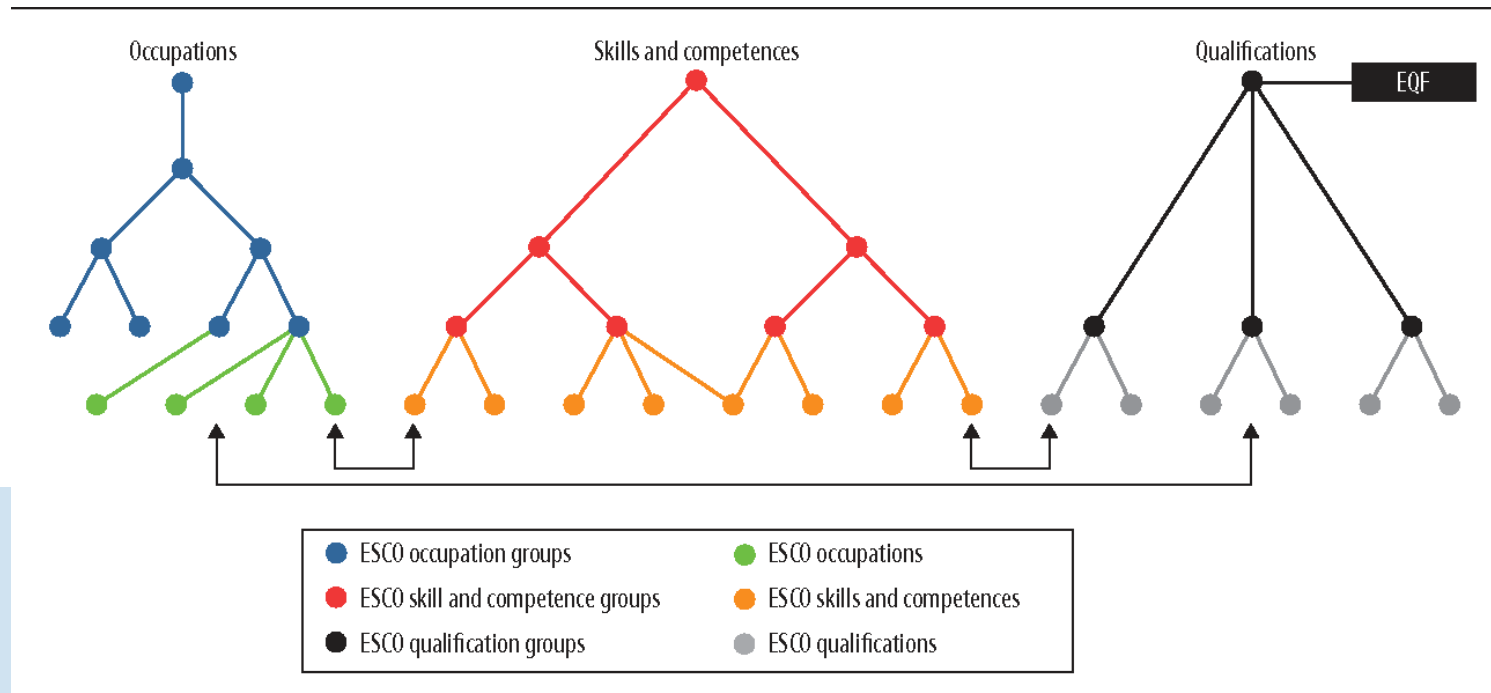
Ranking Green and Digital Occupations

Table 2 Top 15 Green, Digital and Green and Digital Occupations

Green Occupations	Score
energy assessor	90.909
natural resources consultant	78.788
energy conservation officer	75.000
environmental policy officer	75.000
energy analyst	70.833
environmental expert	70.588
hazardous waste inspector	69.697
recycling specialist	67.568
sustainability manager	65.278
environmental geologist	64.706
environmental protection manager	64.583
environmental education officer	64.000
forestry adviser	62.857
nature conservation officer	60.345
liquid waste treatment plant operator	60.000

Digital Occupations	Score
webmaster	98.837
software tester	96.154
user interface developer	93.878
ICT network administrator	93.684
database integrator	93.548
system configurator	93.478
database designer	93.069
mobile application developer	92.941
ICT network engineer	92.784
data warehouse designer	92.593
knowledge engineer	91.954
embedded systems software developer	91.892
integration engineer	91.860
web developer	91.837
ICT integration tester	91.667

Green and Digital Occupations	
smart home engineer	6.818
smart home installer	6.667
geothermal technician	4.878
green ICT consultant	4.762
irrigation technician	4.348
environmental education officer	4.000
acoustical engineer	3.846
electricity distribution technician	3.571
electric meter technician	3.571
energy systems engineer	3.448
ecologist	3.448
interior planner	3.333
electrical transmission system operator	3.333
pastry chef	3.226
botanist	3.125

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Alliance of Excellence for
Research and Innovation on Aephoria

Green and Digital Skills, Occupations and Employment

Sector (NACE Level 2)	Green and Digital Score			
	b	p value	n	R2
1.1 Administrative Services	-0.02	0.78	9	0.02
1.2 Arts and Recreation and other services	**0.07**	0.04	9	0.67
1.3 Finance and Insurance	**0.13**	0.02	6	0.56
1.4 ICT	**0.10**	0.03	7	0.46
1.5 Professional Services	**0.10**	0.01	8	0.57
2.1 Construction	0.03	0.83	8	0.01
3.1 Accommodation and Food	0.05	0.12	8	0.17
3.2 Transport and Storage	-0.06	0.41	9	0.13
3.3 Wholesale and Retail Trade	0.00	0.97	9	0.00
4.1 Manufacturing	**0.09**	0.04	9	0.45
5.1 Education	0.00	0.96	8	0.00
5.2 Health and Social Care	0.04	0.20	9	0.08
5.3 Public Sector and Defence	0.00	0.98	9	0.00
6.1 Agriculture, Forestry and Fishing	0.08	0.19	8	0.18
6.2 Energy Supply Services	**0.10**	0.01	9	0.51
6.3 Mining and Quarrying	-0.05	0.13	5	0.11
6.4 Water and Wastewater treatment	-0.01	0.82	8	0.00

➤ Significant Positive Effect

Green and Digital Score of Occupations and their **employment growth** (from 2016 to 2022) in NACE Level 2 Sectors

Arts and Recreation Services
Finance and Insurance
ICT
Professional Services
Manufacturing
Energy Supply Services

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Green and Digital Occupations, Future Demand 2023-2035

Table 5 Future job prospects for Level 1 Occupations

Occupations	Value
Professionals	100
Managers	78
Technicians and associate professionals	75
Elementary occupations	75
Plant and machine operators and assemblers	64
Service and sales workers	60
Craft and related trades workers	43
Clerical support workers	41
Skilled agricultural, forestry and fishery workers	0

Table A2.3 Top 15 Green and Digital Occupations (Level 0,1 and 2)

Green and Digital Occupations	Score
Level 1	
Professionals	0.077
Craft and related trades workers	0.067
Technicians and associate professionals	0.063
Managers	0.051
Service and sales workers	0.041
Plant and machine operators and assemblers	0.013
Armed forces occupations	0.000
Clerical support workers	0.000
Skilled agricultural, forestry and fishery workers	0.000
Elementary occupations	0.000

- Data from **CEDEFOP** *(European Centre for the Development of Vocational Training)*

- Occupations with the highest 2023-2035 projected demand are the Occupations ranked as Top jointly Green & Digital from our model

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Online Adds – The Top Green and Digital Skills and Knowledge concepts are among the most requested skills for all Occupations

Occupations (Level 2)	Skills and Knowledge Concepts (Level 1)	Share In online Adds
	information and communication technologies (icts)	9.5
health associate professionals	engineering and engineering trades	5.6
	information and communication technologies (icts)	49.4
Information and communications technicians	engineering and engineering trades	13.8
Legal, social, cultural and related associate professionals	information and communication technologies (icts)	10.8
business and administration associate professionals	information and communication technologies (icts)	19.3
	engineering and engineering trades	30.1
Science and engineering and engineering trades associate professionals	information and communication technologies (icts)	19.5
Numerical and material recording clerks	information and communication technologies (icts)	14.7
Customer services clerks	information and communication technologies (icts)	12.5
General and keyboard clerks	information and communication technologies (icts)	19.5
	information and communication technologies (icts)	15.4
Other clerical support workers	engineering and engineering trades	6.3
	engineering and engineering trades	3.2
Agricultural, forestry and fishery labourers	information and communication technologies (icts)	1.1
Cleaners and helpers	engineering and engineering trades	1.0
Food preparation assistants	engineering and engineering trades	1.6
	engineering and engineering trades	4.4
Refuse workers and other elementary workers	information and communication technologies (icts)	1.4
	information and communication technologies (icts)	16.3
Street and related sales and service workers	engineering and engineering trades	6.0
Food processing, wood working, garment and other craft and related trades workers	engineering and engineering trades	3.1
	information and communication technologies (icts)	10.1
Market-oriented skilled agricultural workers	engineering and engineering trades	9.9
Market-oriented skilled forestry, fishery and hunting workers	information and communication technologies (icts)	11.5
Administrative and commercial managers	information and communication technologies (icts)	26.6
Chief executives, senior officials and legislators	information and communication technologies (icts)	29.5
Hospitality, retail and other services managers	information and communication technologies (icts)	44.1
Production and specialized services managers	information and communication technologies (icts)	28.8
Assemblers	engineering and engineering trades	52.1
	engineering and engineering trades	4.0
Drivers and mobile plant operators	information and communication technologies (icts)	2.5
Machine & plant operators	engineering and engineering trades	18.4
	information and communication technologies (icts)	5.1
health professionals	engineering and engineering trades	2.8
Information and communications technology professionals	information and communication technologies (icts)	64.3
Legal, social and cultural professionals	information and communication technologies (icts)	11.6
business and administration professionals	information and communication technologies (icts)	29.7

Financial Sector:
- Mainstream ESGs
- Enhance skills in ESG and SDG metrics

Energy:
- technical knowledge for application of energy-efficiency measures
- technical knowledge for application of renewable energy technologies
- • upgraded skills for emergent energy markets

Manufacturing:
- raw material collection
- pre-processing
- production
- distribution
- trade (marketing)
- sustainable business and product development

Agricultural and Food:
- advanced wastewater treatment practices
- improved packaging
- improved sensors and process control (to reduce waste and improve productivity)
- food irradiation
- water and wastewater reduction using closed loop/zero emission systems
- use of information and communication technology (ICT) in agriculture
- technical knowledge for new practices like organic farming and agroforestry

- Identify **Gaps** In Curriculum in relation to Key Green and Digital Skills Needed to Support the Twin Transition in Different Sectors

Green Skills:
- Renewable Energy Expertise: Proficiency in designing, installing, and maintaining renewable energy systems, such as solar panels, wind turbines, and hydropower systems.
- Energy Efficiency: Skills related to improving energy efficiency in buildings, industries, and transportation, including energy auditing and retrofitting.
- Circular Economy Knowledge: Understanding of circular economy principles, sustainable materials management, and waste reduction strategies.
- Environmental Regulations: Knowledge of EU environmental regulations and compliance requirements, including emissions standards and waste management.

Digital Skills:
- Data Analytics: Proficiency in data analysis and interpretation for optimizing energy consumption, predicting equipment failures, and enhancing energy efficiency.
- Internet of Things (IoT): Skills related to IoT device deployment and management for monitoring and controlling energy systems remotely.
- Cybersecurity: Understanding of cybersecurity measures to protect critical energy infrastructure and data.
- AI and Machine Learning: Knowledge of AI and machine learning algorithms for optimizing energy production, consumption, and grid management.

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Figure 2 — White-collar jobs demand mapping in the maritime industry (Level 3)

- Identify "Blue" Occupations, i.e. which are the most demanded occupations in "Blue Economy" (Shipping, Ports, Maritime Logistics and Maritime Technology NACE Level 3 sectors)

- Use our Methodologies and Models to Map Policies and identify the top Green and Digital Skills needed in the Maritime Sector

- ## Use our Methodologies to Map Occupations and Skills to "Maritime" Policies

Policy	Industrial Sector (NACE Rev. 2)	Green and Digital Skills (Level 3)	Green and Digital Occupations (Level 2)
IMO Regulations MARPOL Convention Ballast Water Management Convention Energy Efficiency Design Index (EEDI) ship Energy Efficiency Management Plan (SEEMP)	Shipping, Ports, Industrial Transportation	conducting academic or market research promoting products, services, or programs installing and repairing electrical, electronic and precision equipment complying with health and safety procedures 'accompanying and welcoming people installing wooden and metal components	Electrical equipment installers and repairers Hotel and restaurant managers Electrotechnology engineers Electronics and telecommunications installers and repairers Process control technicians Life science professionals Travel attendants, conductors and guides Engineering professionals (excluding electrotechnology)
EU Policies EU MRV Regulation Clean Water Act Vessel Incidental Discharge Act (VIDA)	All Sectors	advising on environmental issues analysing and evaluating information and data complying with environmental protection laws and standards computer use database and network design and administration designing electrical or electronic systems or equipment electronics and automation maintaining electrical, electronic and precision equipment	environmental education officer environmental expert nature conservation officer sustainability manager green ICT consultant natural resources consultant

- ## Use our Model to identify the top "Green and Digital Skills in the Maritime Sector

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Green & Digital Occupations		
Electrotechnology engineers	White	0,252881
Engineering professionals (excluding electrotechnology)	White	0,231481
Information and communications technology service managers	White	0,173913
Business services agents	White	0,059102
Finance professionals	White	0,046083
Financial and mathematical associate professionals	White	0,046082
Managing directors and chief executives	White	0,046081
Sales, marketing and development managers	White	0,04608
Sales, marketing and public relations professionals	White	0,046079
Software and applications developers and analysts	White	0,046078
Physical and engineering science technicians	Blue	0,046077
Mining, manufacturing and construction supervisors	Blue	0,046076
Manufacturing, mining, construction, and distribution managers	White	0,046075
Process control technicians	Blue	0,046074
Ship and aircraft controllers and technicians	Blue	0,046073

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Green and Digital Skills	Score
complying with environmental protection laws and standards	48,5%
environmental protection technology	45,5%
monitoring environmental conditions	39,4%
electronics and automation	33,3%
database and network design and administration	33,3%
designing electrical or electronic systems or equipment	33,3%
computer use	27,3%
analysing and evaluating information and data	27,3%
electricity and energy	21,2%
maintaining electrical, electronic and precision equipment	15,2%
analysing scientific and medical data	9,1%
handling and disposing of hazardous materials	9,1%
using precision measuring equipment	6,1%
operating agricultural or forestry equipment	0,0%
disposing of non-hazardous waste or debris	0,0%

- "Green and Digital" Skills among the most demanded in "Blue" Occupations (Online Adds)

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