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ESG Momentum in International Equity Returns and the SDG content of financial asset portfolios

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Abstract

This study investigates the relationship between Environmental, Social, and Governance (ESG) momentum and Sustainable Development Goals (SDG) integration within international equity markets. Leveraging a robust dataset spanning 2002–2023, we identify pronounced ESG momentum effects in stock returns across 63 global markets. Our ESG momentum factor, derived through monthly rebalancing, demonstrates an impressive, annualized Sharpe ratio of 0.7, underscoring its financial viability. Beyond returns, the study highlights the pivotal role of ESG controversies in shaping short-term financial performance. We advanced the discourse by integrating ESG principles with the SDG framework, proposing a novel model to calculate the SDG footprint of financial portfolios. This alignment between ESG momentum and SDG implementation emerges as a significant tool for investors and policymakers, particularly considering regulatory advancements like the Corporate Sustainability Reporting Directive (CSRD).

Introduction

The concept of environmental, social, and governance (ESG) factors has gained significant momentum over time, underscoring the growing awareness of the intricate connections between business operations and broader societal and environmental concerns. ESG factors have evolved from investment approaches rooted in sustainability, initially emphasizing socially responsible investing.

The “E” in ESG addresses environmental considerations such as energy usage and efficiency, carbon footprints, greenhouse gas emissions, land use, deforestation and afforestation, biodiversity and ecosystem services, circular

economy challenges, and water management. The “S” focuses on key social dimensions, including labor conditions and standards, fair wages, workplace and board-level diversity in terms of gender and ethnicity, pay equity, human rights protection, talent development, community engagement, privacy and data protection, health and safety, supply chain management, and broader issues of human capital and social justice. The “G” pertains to governance aspects that intersect with environmental and social issues. This includes corporate board composition and structure, strategic oversight of sustainability initiatives, compliance, executive compensation, political contributions and lobbying, and measures to prevent bribery and corruption.

The European Union (EU) has positioned itself as a global leader in advancing sustainable finance through its ambitious Sustainable Finance Framework. As a cornerstone of the EU's broader sustainability agenda, this framework represents a comprehensive strategy to align financial markets with ESG objectives. Introduced in response to growing awareness of climate change and environmental degradation, the framework signifies a paradigm shift in the financial sector, encouraging investors, businesses, and policymakers to embed sustainability considerations into decision-making processes.

At its foundation, the EU Sustainable Finance Framework consists of a suite of regulations and initiatives aimed at fostering a more sustainable and resilient financial system. The EU Taxonomy Regulation serves as its linchpin, providing a classification system to define environmentally sustainable economic activities. By establishing a common language for investors, companies, and policymakers to identify and assess sustainable practices, taxonomy promotes transparency and consistency in reporting. Efforts to create a unified framework for non-financial reporting, emphasizing sustainability issues, have been ongoing for over 30 years (Figure 1), with recent advancements in the EU representing significant progress.

To further reinforce the institutional infrastructure for sustainable finance and corporate sustainability, the European Commission launched the Corporate Sustainability Reporting Directive (CSRD) in 2023. This directive mandates that both large enterprises and small- and medium-sized enterprises (SMEs) produce sustainability reports, with a particular emphasis on large companies compared to earlier iterations of the CSRD. Notably, integrating sustainable practices into resource management—such as improving resource allocation efficiency and adopting integrated approaches—supports environmental and ecological goals while maintaining a viable economic system (Koundouri, 2004). The sustainability reports of the initial group of companies will be incorporated into their 2025 financial reports, which will include all relevant information and data from the previous financial year (e.g., 2024). Additionally, the European Sustainability Reporting Standards (ESRS), introduced in July 2023, aim to enhance both qualitative and quantitative aspects of sustainability reporting. One of its primary objectives is to enable direct comparisons of sustainability reports across all companies subject to the CSRD requirements. The ESRS framework is highly comprehensive, encompassing twelve topic-specific standards that address various ESG factors and dimensions. Fundamentally, this institutional framework advances two critical pillars of sustainability reporting: transparency and accountability. As a result, stakeholders can gain a more holistic and standardized view of a company’s performance

through uniform sustainability performance indicators.

Following the current policy developments, there has been a growing interest in financial investors, asset owners, and academics in investigating the impact of Good/ Bad performance relative to the Environmental, Social, and Governance (ESG) criteria on the company's financial performance, as expressed by the Cost of Capital (Bauer And Hann,2010; Schneider, 2011), Stock Valuation (Jiao,2010) and stock returns (Gerhard et al, 2015; Kahn et al, 2016; Henriksson et al, 2018).

In recent years, there has been a global surge in interest and scrutiny regarding how companies incorporate ESG principles into their operations. In this context, one challenging issue is that of discussing how divergence across ESG metrics and ratings (Berg et al., 2020) affects the integration of the ESGs in the business mindset[1]. Therefore, conducting relevant surveys in real markets at a national level can offer input to inform this endeavor. Not surprisingly, the necessity to achieve 'green transitions' based on relevant regulations and designs (Steuer & Tröger, 2022), can be highly supported by implementing an ESG strategy across nations. Interestingly, connections between ESGs with Sustainable Development Goals (SDGs) should be put into practice to expand their applicability across all dimensions of the socio-economic system. Indicatively, Bekaert et al. (2023) suggest a concrete link between ESGs, SDGs, and portfolio Alphas.

Many studies relate good company ESG performance with higher corporate financial performance and equity returns, Whelan et. al (2021) in an extensive meta-analysis of the literature report that only:

"26% of studies that focused on disclosure alone found a positive correlation with financial performance comparedto 53% for performance-based ESG measures (e.g., assessing a firm's performance on issues such as greenhouse gas emission reductions). This result holds in a regression analysis that controls for several factors simultaneously".

In the same direction, Friede (2015), based on over 2000 empirical studies concludes that ESG criteria have a positive impact on corporate financial performance. Specifically, the study finds a predominantly positive relationship between ESG criteria and financial performance, with around 90% of the studies showing a non-negative relationship. During the last decade, many studies have explored the presence of priced risk related to ESG factors and the usefulness of ESG factors in arbitrage pricing theory models. Pástor et al. (2021) concluded that green assets generally have lower expected returns due to ESG-driven investor preferences, though they can outperform during ESG-positive shocks. The study highlighted that ESG investing motivates firms to adopt greener practices, with green assets benefiting from temporary performance boosts during ESG-related shocks. Pedersen et al. (2019) demonstrated that ESG scores influence asset pricing by impacting firm fundamentals and investor preferences. Using a dataset that included MSCI ESG scores, corporate governance information, and data on sin stocks and carbon emissions, they proposed that ESG scores shape investor choices and define equilibrium prices through an ESG-adjusted capital asset

[1] Berg et al. (2020) compare ESG ratings from six providers: KLD, Sustainalytics, Moody's ESG, Thompson Reuters Refinitiv, MSCI, and S&P Global.

pricing model. Avramov et al. (2020) investigated how ESG rating disagreements influence market premiums, stock demand, and systematic risk exposure. Their dataset incorporated ESG ratings from six major agencies (Thomson Reuters Refinitive, KLD, MSCI IVA, Bloomberg, Sustainalytics, and RobecoSAM). They found that higher disagreement increases market premiums and risk aversion while influencing stock returns and risk profiles. Giese et al. (2019) studied how ESG information impacts equity valuation, risk, and performance. Using MSCI ESG Ratings data and financial variables, they found that ESG information reduces systematic risk, enhances valuations, and improves profitability. Gibson Brandon et al. (2019) observed that higher ESG rating disagreement correlates with higher stock returns, reflecting a risk premium. Their dataset included ESG ratings from seven providers for S&P 500 firms between 2010 and 2017, revealing that the positive relationship is mainly driven by disagreement about the environmental dimension. Billio et al. (2020) also highlighted the lack of commonality in ESG rating criteria across agencies, leading to significant disagreement. The study found that this heterogeneity disrupts investment benchmarks and portfolio construction due to inconsistencies in ESG investment universes. In the same direction, Dimson et al. (2020) reported significant inter-agency disagreement in ESG ratings, finding that ESG indexes neither outperform nor underperform market indexes. The study attributed variability to differing weights assigned to ESG components by agencies.

Fulton et al. (2012) concluded that ESG factors correlate with superior risk-adjusted returns and lower cost of capital. The study highlighted that companies with high ESG ratings consistently show market-based and accounting-based outperformance, with governance emerging as the most significant ESG pillar. Maiti (2020) demonstrated that ESG factors play a vital role in predicting asset returns, with ESG-based portfolios showing better Sharpe ratios compared to traditional size and value-based portfolios. Using a combination of ESG and market data, the study found that three-factor models integrating ESG factors perform better than traditional models. Zerbib (2022) developed the Sustainable Capital Asset Pricing Model (S-CAPM) to assess the effects of ESG integration and exclusionary screening on asset returns. Focusing on U.S. stocks and sin stocks, the study estimated that ESG premia average 2.79% annually, varying across industries. Hübel et al. (2019) integrated ESG risks into asset pricing models and developed three ESG risk factors. They concluded that portfolios with high ESG risks have greater overall risk but that integrating ESG risks into portfolio construction can achieve comparable risk-adjusted performance while reducing ESG exposure. De et al. (2015) found that high ESG ratings are associated with lower stock volatility, higher returns, and improved risk-adjusted performance. The study emphasized the role of ESG factors in enhancing portfolio performance from an active management perspective. Gregory (2021) showed that non-financial firms with higher environmental and governance scores outperformed during the COVID-19 pandemic, effectively hedging against fiscal policy-related risks. Bennani et al. (2018) observed that ESG investing has been rewarded since 2014, with strong performances from environmental factors in North America and governance factors in the Eurozone. Despite mixed evidence, ESG investing remains an alpha strategy in North America while evolving into a beta strategy in the Eurozone. Cao et al. (2018) showed that the rise of ESG investing creates inefficiencies in stock market pricing, with underpriced firms with poor ESG performance achieving higher risk-adjusted returns. The study highlights a mispricing obstacle introduced

by socially responsible institutions avoiding trades against ESG preferences. Bang et al. (2023) identified ESG controversy as a potential asset-pricing factor, noting that investors demand a risk premium for exposure to such controversies. Finally, Nakagawa et al. (2023) proposed the ESG-CAPM model, finding that firms with high ESG scores generate lower expected returns due to smaller ESG betas.

More recently research indicates that "ESG momentum", representing improvements in ESG practices, may lead to positive stock returns. Using data from the MSCI ESG database, Nagy et al (2016), that stocks that increased their ESG performance during the last 12 months, realize higher future short-term returns for the period 2007 to 2014. In the same direction, focusing on US stocks in the S&P500, Sverner et al. (2023) found a return premium of 0.23% to 0.35% for portfolios with high ESG score upgrades. Similarly, Padyšák (2020) based on a sample of 691 stocks, for the period 2010-2019, demonstrated that combining ESG scores with price momentum using a knapsack algorithm resulted in portfolios with better risk-adjusted returns and lower volatility. Magnani et al. (2024) based on a sample of 800 stocks, over 2010-2020 from MSCI and Sustainalytics, observed that short-term ESG momentum is priced in stock returns, but its impact on the cost of capital varies.

Our study contributes to the literature in three important directions. First, using a thorough international sample covering 63 markets and more than 90% of global market capitalization, we document, strong ESG momentum time series and cross-sectional effects in international stock returns during the years 2002 to 2023. An out-of-sample monthly rebalancing ESG momentum Factor mimicking portfolio (double sorted on market capitalization and ESG momentum) yields an annualized Sharpe ratio of 0.7 for the sample period. Moreover, we underline the importance of ESG controversies, as an important determinant of short-term financial performance, implying that negative ESG shocks are significantly affecting future short-term returns. Finally, we expand the literature further by developing a framework to integrate the Sustainable Development Goals (SDGs) properly. We describe how our models can be used to trivially calculate the SDG footprint of financial portfolios, which is expected to be very relevant in the years following the introduction of the Corporate Sustainability Reporting Directive (CSRD).

This chapter is structured as follows. In **Section 2**, we describe the data and methodologies used in our study. In **Section 3** we present the methodologies used for portfolio, factor, and model evaluations, Section 4 elaborates on our main empirical results and the implementation of the international ESG and SDG asset pricing factors. **Section 4** summarizes and provides concluding remarks.

Data and Methodology

Our ESG sample consists of pricing and ESG-related metrics for 11.328 equities listed in 84 stock exchanges, spanning 69 countries, 59 industries, and 22 years from 31 December 2002 to 31 May 2023[2]. The Regional breakdown is provided in Table 1. We use London Stock Exchange Group (LSEG) International Data & Analytics (formerly Refinitiv

[2] We use all stocks with ESG data coverage in Thomson Reuters Refinitiv.

– TRF- and Thomson Reuters EIKON Datastream -TDS-) to extract daily data for total return indexes, market Capitalization, and a set of static/descriptive datatypes and ESG-related metrics. Appendix Table A.1 reports the descriptions for all datatypes used in our paper. Daily return and market capitalization data are filtered, following the methodologies proposed by Landis and Skouras (2021). Daily returns are aggregated to monthly and expressed in US dollars ($). To avoid any impact of outliers, monthly returns are cross-sectionally winsorized to [1,99].

Table 1 International Sample - Coverage

Region	# Equities
North America	4.060
Latin America	389
Europe	2.579
Asia Pacific	4.107
Africa	193

To measure ESG performance we use the TRF metrics and scores. TRF offers one of the most comprehensive ESG databases, covering over 90% of the global market capitalization, and offering more than 600 ESG-related metrics, with a history dating back to 2002. TRF's ESG scores cover 10 categories including under the environmental pillar: emissions, environmental product innovation, and resource use, under the social pillar: community, human rights, product responsibility, and workforce; and under the governance pillar: CSR strategy, management, and shareholders.

The categories scores account for the most material industry metrics (70 to 170 metrics are used for each sector based on a set of 25 themes). The scores are calculated using a percentile rank scoring methodology and are based on the relative performance of stocks with the company's sector (for environmental and social pillar scores), and the country of incorporation (for governance-related scores). Moreover, materiality weights are used to aggregate category scores to the three pillars, as well as the company's ESG score overall. Moreover, the performance metrics are supplemented with a data-driven controversy score, which is based on 23 ESG controversy topics, where companies' actions are verified against commitments, to magnify the impact of significant controversies on the overall ESG scoring. Controversies are benchmarked on industry groups and a company with no controversies will get a score equal to 100.

Kahn et al. (2016), note that the identification of material items and the use of scores based on industry material items can lead to outperformance of the Good ESG companies relative to Bad. In the same direction, ESG scores using material items are also positively correlated with the stock's performance during the year following portfolio construction (Henriksson et al., 2018). Consistent with the previous research, we use the scores provided by TRF,

which incorporate, as explained earlier, an industry materiality assessment. Moreover, the non-mandatory nature of corporate sustainability reporting, together with the absence of any third-party auditing reports, constitutes, as discussed later in the chapter, the identification of Controversies to most accurately identify companies that do perform well relative to their industry and country peers.

TRF metrics have found its application in recent academic studies (Park, 2018; Vasilescu et al., 2019; Dorfleitner et al., 2020), where all studies underline a thin relationship between ESG performance and stock returns, while the heterogeneity of results is strengthened even further with the use of various stock selection criteria.

Appendix Table A.2 reports the number of stocks per country and per industry in our sample. To be consistent with the calculations of the TRF scores, we use the Refinitiv Business Classification Codes.[3] To map stocks to industries.

As global factor mimicking portfolios in our tests, we do use Fama and French's Developed Markets 3 Factors[4], while all our univariate or bivariate sorted portfolios, use the common methodologies of Fama and French (2015) and consider Landis and Skouras (2021) considerations for calculating international asset pricing factors and univariate/bivariate sorted portfolios using data from TDS.

Univariate Sorting of Stocks into Portfolios

Univariate sorting involves ranking stocks based on a single characteristic, such as size, book-to-market ratio, or momentum, and then grouping them into portfolios. First, stocks are ranked according to the chosen characteristic, such as market capitalization or past returns. They are then divided into quantiles, such as deciles or quintiles. For instance, the smallest 10% of firms may form one decile and the largest 10% may form another. After sorting, portfolio returns are computed for each quantile, either on an equally weighted or value-weighted basis, over a specific period such as monthly. This approach is typically employed to test whether a single characteristic explains the cross-section of stock returns, such as the size effect or the value premium.

Bivariate Sorting of Stocks into Portfolios

Bivariate sorting simultaneously ranks stocks on two characteristics to create a two-dimensional grid of portfolios. For example, stocks might be ranked by size (market capitalization) and another characteristic. The stocks are then divided into quantiles for each characteristic. A common setup is dividing size into Small (bottom 50%) and Big (top 50%) groups, while the second characteristic is divided into Low (bottom 30%), Medium (middle 40%), and High (top 30%) groups. This results in six portfolios: Small-Low, Small-Medium, Small-High, Big-Low, Big-Medium, and Big-High. Returns are then calculated for each portfolio. This method allows for controlling one characteristic while analyzing the effect of another, making it possible to assess the independent and combined effects of both size and the characteristic of Interest.

[3] TR3 datatype

[4] French data library, see: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#International

Fama-French Methodology for Calculating Asset Pricing Factors

The Fama-French (Fama et al., 1993) approach extends the Capital Asset Pricing Model (CAPM) by incorporating additional risk factors to better explain stock returns. The original 3-factor model includes the market factor (MKT), the size factor (SMB), and the value factor (HML) mimicking portfolios. The market factor (MKT) is calculated as the excess return of the market portfolio over the risk-free rate.

To construct the annually rebalanced SMB and HML factors, we sort stocks in a country or region into two market caps and three book-to-market equity (B/M) groups at the end of each June. The methodology differs for global factors where big stocks are those in the top 90% of June market cap for the region, and small stocks are those in the bottom 10%. The B/M breakpoints for a region are the 30th and 70th percentiles of B/M for the big stocks of the region. An exception to the regional data stands for the developed portfolios which use developed size breaks, but the B/M breakpoints for the four regions to allocate the stocks of these regions to the developed portfolios.

The independent 2x3 sorts on size and B/M produce six value-weight portfolios: SG, SN, SV, BG, BN, and BV, where S and B indicate small or big and G, N, and V indicate growth (low B/M), neutral, and value (high B/M).

SMB is the difference between the average of small stock portfolios (SG, SN, and SV) and the average of big stock portfolios (BG, BN, and BV). HML is the difference between the average value-weighted return of value portfolios (SV and BV) and the average value-weighted return of the growth portfolios (SG and BG). Stocks are sorted at the beginning of a period, often in June for U.S. stocks, and portfolios are held for a specific period, such as July to the following June. Portfolios are periodically rebalanced, usually on an annual basis. This methodology is widely used to test asset pricing effects, explain variations in stock returns, and evaluate performance.

Empirical Results

To investigate the cross-sectional relationship between ESG performance and stock returns, we calculate monthly rebalancing univariate portfolio sorts based on the overall ESG and the ESG controversies scores. Following the common methodology, each month, t, we use stocks with a valid market capitalization for period t-1 and a valid score for month t-6. In other words, to ensure that the scores will be available to investors on the investment date, t-1, and avoid any instance of look-ahead bias, we used scores lagged for 6 months. **Table 2** reports the premium of Good ESG performers relative to Bad performers (Good Minus Bad, GMB), for the case of 5 (quintiles), 10 (deciles), 20, 30, 50, 100 (percentiles), 150, and 200 portfolios, value and equally weighted (denoted as “vw” and “ew” respectively) using the overall ESG Score (Panel A) and the ESG Controversies Score (Panel B). Focusing on Panel A as we move to more extreme Good/Bad Portfolios, the premium of good performers increases but in line with previous research (Dorfleitner et al, 2020) the differences are not significant[5]. It is interesting to note that the thin

[5] Newey-West heteroskedasticity and autocorrelation robust standard errors (HAC) are reported in parenthesis.

premium shrinks (for instance 13 basis points vs 30 bs focusing on the case of 200 univariate portfolios.[6]) when we apply equally weighted returns, which indicates that the difference between Good and Bad performers mostly refers to large stocks in our sample.

[6] Univariate Portfolios, refer to portfolios sorted based on a single characteristic.

Table 2 Good Minus Bad Performance – Univariate Portfolios – ESG & ESG Controversies Scores

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
	(0.0014)	(0.0016)	(0.0016)	(0.0016)	(0.0018)	(0.0025)	(0.0027)	(0.0028)
GMB ew	-0.0007	-0.0003	0.0007	0.0001	0.0015	0.0014	-0.0001	0.0013
	(0.0012)	(0.0013)	(0.0014)	(0.0016)	(0.0017)	(0.0024)	(0.0030)	(0.0039)

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
	(0.0006)	(0.0010)	(0.0011)	(0.0012)	(0.0014)	(0.0019)	(0.0021)	(0.0019)
GMB ew	-0.0002	0.0002	0.0001	-0.0003	0.0000	0.0006	-0.0001	-0.0015
	(0.0005)	(0.0008)	(0.0009)	(0.0010)	(0.0011)	(0.0016)	(0.0017)	(0.0018)

Moreover, Fama mac Beth cross-sectional regressions (Fama et al,1973) of stock returns to the ESG and ESG Controversies Scores yield insignificant results.7.

Contrary to the results in Table 1, we document a strong ESG Momentum for the entire period 2002 – 2023. Stocks that tend to increase their ESG performance during the months t-24 to t-1 tend to realize high abnormal returns. Our metric for the ESG momentum is defined as:

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

Figure 1 plots the value of 1 $ invested in a value-weighted GBM portfolio using 100 univariate sorted portfolios on ESG momentum for the period 2004-2023.

[7] Results are available from authors upon request.

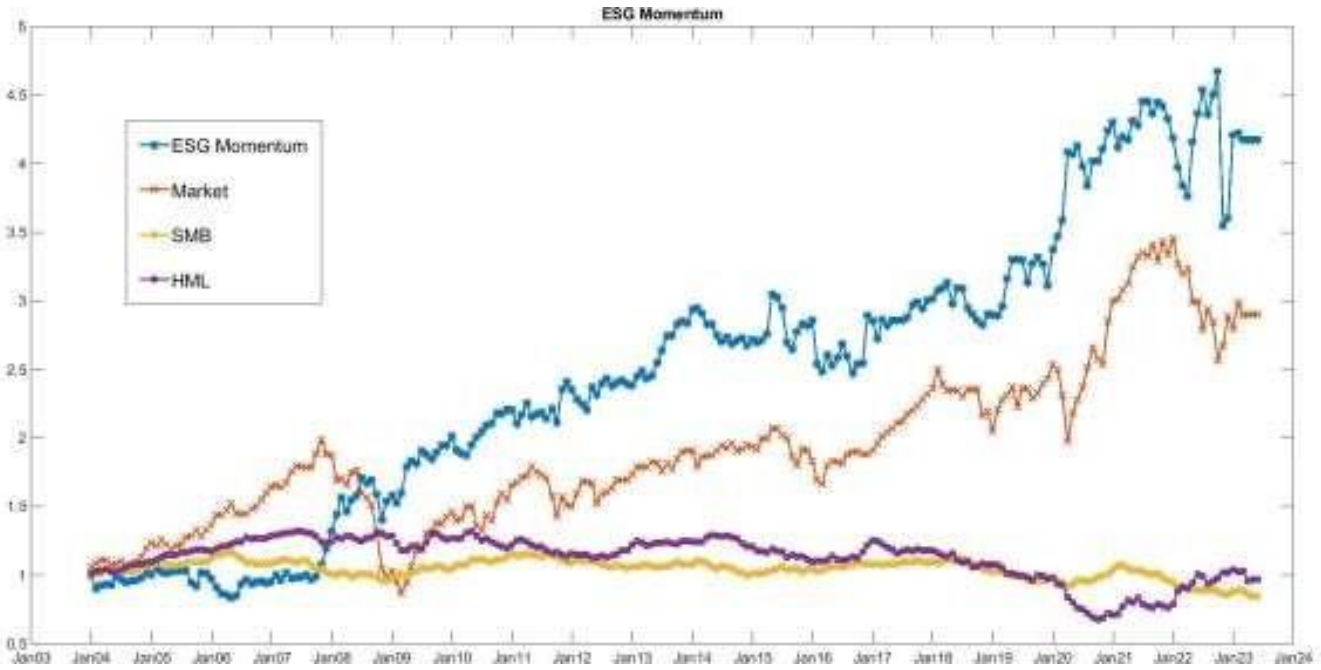

Figure 1 *ESG Momentum Effect*

The average monthly return of the GBM extreme portfolios is 0.73%, highly significant with a Newey West Robust standard error of 0.0027 (t statistic is equal to 2.70), and an annualized Sharpe ratio of 0.55. Using the Fama French methodology (FF), a bivariate monthly rebalancing ESG momentum GMB factor mimicking portfolio, sorted on size and ESG momentum is calculated and presented in **Figure 2**. The methodologies follow closely the calculations of the FF's developed factors for the international returns[8].

Figure 2 ESG Momentum Effect

[8] Big stocks are those in the top 90% of market cap for the region, and small stocks are those in the bottom 10%.

Apart from the ESG performance, as measured with the ESG Score, the momentum in the ESG controversies is also a strong effect for the entire sample period 2002-2023.

The controversy momentum is defined as:

$$ESG\ mom_{t-1} = \frac{ESG\ Controversies\ Score_{t-1}}{ESG\ Controversies\ Score_{t-24}} - 1 \quad (2)$$

The TRF Controversies Score accounts for differences between industries and companies' size because big companies tend to attract more media attention. In our sample, it is also expected that heterogeneity in countries, possibly in countries and sectors, would be significant. In this direction, we calculate the univariate sorted portfolios hedging for country and sector returns. Hedging is applied to the holding returns by subtracting from the monthly stock return, the mean return of all stocks incorporated in the same industry and country.

Figure 3 presents the value of 1 dollar invested in a value-weighted GMB Controversies Momentum Portfolio, using 10 univariate sorted Portfolios on Controversies Momentum.

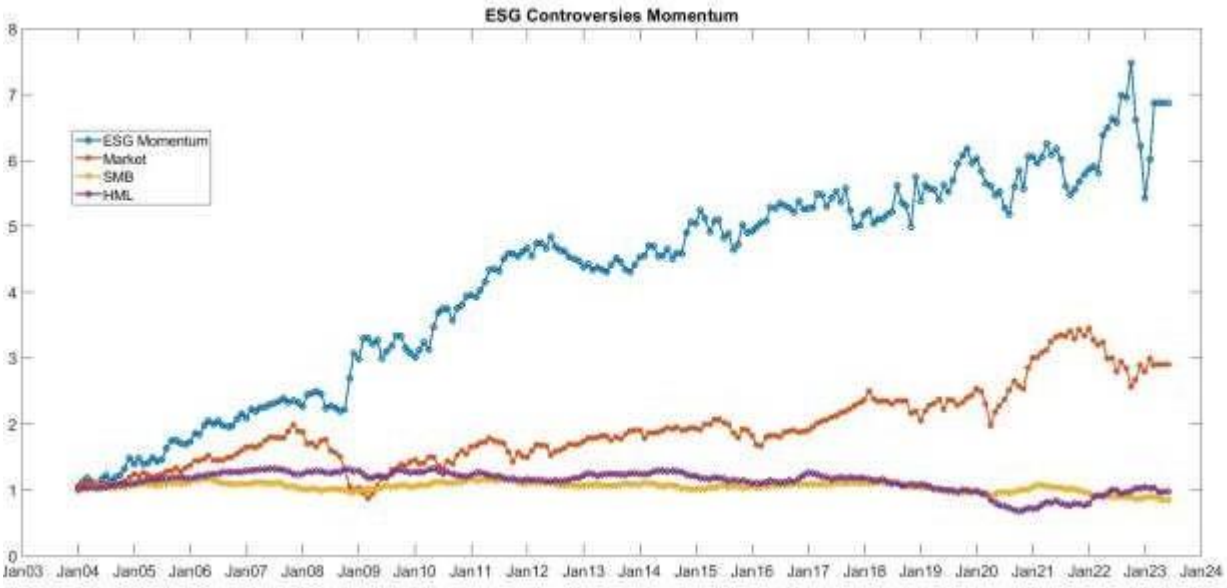

Figure 3 ESG Controversies Momentum

The GMB strategy has an average monthly return of 0.26% with a Newey-West t statistic is equal to 3.58.

To account for both effects, the combined Factor is calculated using the sum of the two scores, that is:

$$ESG\ Combined\ Score_{t-1} = ESG\ \ Score_{t-1} + ESG\ Controversies\ Score_{t-1} \quad (3)$$

The Combined ESG scores are normalized to [0,100].

Figure 4 presents the decile GMB value-weighted performance, again hedged against the stock's country and market. The portfolio has an average return equal to 0.0028, a t-stat equal to 2.66, and an annualized Sharpe ratio equal to 0.55.

Figure 4 Combined ESG Momentum Effect

Figure 5 presents a double-sorted Factor ESG Momentum Mimicking portfolio based on the 90% breakpoint for Size and [30,70] breakpoints for the Combined ESG Momentum. Factor has a significant average return of 12bs (t-stat = 2.42) and an annualized Sharpe ratio equal to 0.53. A Fama Mac Beth (FMB) cross-sectional regression, where the holding period returns for all stocks are regressed to the combined ESG momentum signals, yields an FMB beta equal to 0.01%, with a hac robust t-stat of 4.1.

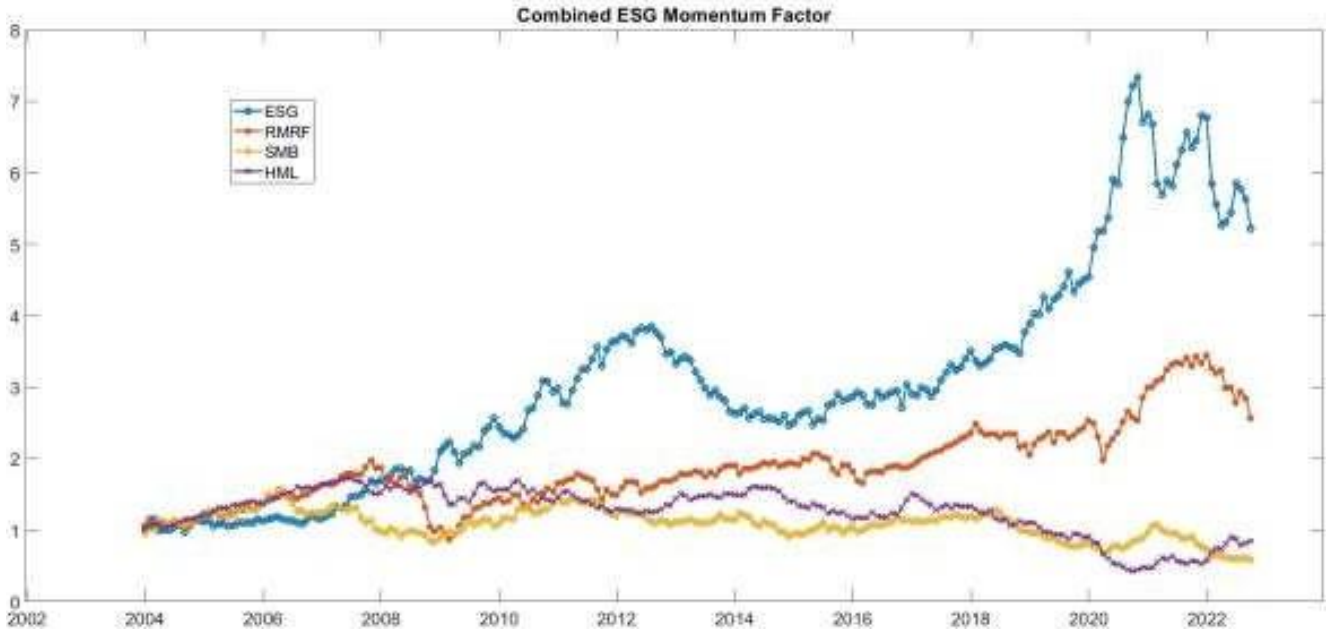

Figure 5 Combined ESG Momentum Factor

In the same direction as Henriksson et al. (2018), we find that the returns continue to increase and be significant

for at least 12 months after portfolio formation. **Table 3** reports the results from FMB cross-sectional regressions of future returns (t+1 to t+12) to ESG Momentum Signals (based on periods t-24 to t-1).

Table 3 ESG Momentum Future Returns

Holding Period	***Beta***	***HAC se***	***HAC t-stat***
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

To provide an example of the applicability of our factors, we calculate 20 portfolios univariate sorted on ESG Momentum Controversy, the FF three-factor model produces an average absolute alpha of 0.0015 and a GRS test for all portfolios equal to 2.73 (p-value 0.0035), while a 4-factor model expanded to include our Combined ESG Momentum factor exhibits an average absolute alpha of 0.0010 and a GRS test of 2.05 (p-value=0.012).

Integrate Sustainable Development Goals

Since the Late 2000 ESG integration focused primarily on assessing the ESG policies and processes of companies to evaluate the companies best managing these issues, and which issues were material to the financial prospects of the company, then overweighting or underweighting the companies accordingly.

With the launch of the United Nations SDGs in 2015, this started to change. Endorsed by 193 countries, the SDGs address topics including poverty, hunger, health, education, climate change, gender equality, water, sanitation, energy, environment, and social justice. Achieving the goals requires an estimated investment of USD 5 trillion to USD 7 trillion per year until 2030. For every year that passes, the investment needed to fulfill these goals increases, highlighting the urgency of mobilizing capital. Since 2015, the SDGs have been gaining ground as a reference point

for investors to align investments and impact goals. This has not only added a layer of analysis on top of the traditional exclusion and ESG but underlines the need for the creation of a suite of additional attractive investment opportunities that are 'impact-aligned' to the SDGs. Agenda 2030 and the Sustainable Development Goals (SDGs), adopted by all member states of the United Nations in 2015, describe a universal agenda that applies to and must be implemented by all countries and all stakeholders at a local level and in any instance of economic activities. Sound metrics and data are critical for turning the SDGs into practical tools for problem-solving. UN SDSN partners with a variety of organizations to assess progress toward SDG achievement at the national level and the local level. Both official and unofficial metrics are used to measure the distance to targets for each of the SDGs to identify priorities for action, understand key implementation challenges, track progress, ensure accountability, and identify gaps that must be closed to achieve the SDGs by 2030. The SDSN methodology (Sachs et al., 2020) was audited by the EU JRC in July 2019.

Sachs et al. (2019) suggest an approach to making the SDGs operational for governments and policymakers, based on Six Transformational themes, while Koundouri et al. (2021, 2022) propose a methodology to map European Green Deal policy documents to the SDGs. Further, Koundouri et al. (2022) presents a methodology to assess the degree to the National Recovery and Resilience Plans (NRRPs) of the NextGenerationEU program, support the SDGs, and apply it to the NRRPs of 7 European countries. Koundouri et al. (2023b) provide a holistic three-step approach for the integration of the Sustainable Development Goals into the sustainability reporting of companies. The process requires the use of an extended set of sector-specific and generic Environmental, Social, and Governance Key Performance Indicators (KPIs) based on a series of accounting standards and frameworks, measured across the value chain of the company.

The above framework can be integrated in the portfolio construction, to provide meaningful implications related to the exposure of financial assets to SDGs. **Table 4** presents the Pillars, and the Material categories used in the TRF metrics.

Table 4 TRF ESG Categories

ESG Categories	Material Issues / Categories
Environmental	Emissions
	Environmental Innovation
	Resource Use
	Biodiversity
	Workforce
	Human Rights

Social	Community
	Product Responsibility
Governance	Management
	Shareholders
	CSR

Following a similar methodology to Koundouri et al. (2022), we map the ESG categories to SDGs. The mapping methodology refers to mapping individual key performance indicators to specific SDG indicators using the most updated list of the 169 indicators for the 17 SDGs.

Consider i=1, ….,17 refers to the 17 SDGs. Also consider k=1, to K refers to the Individual KPIs in analysis. Then, the raw SDG weights for each KPI are calculated as follows:

$$W_{i,k}^{SDG} = \frac{\sum SDG\ Indicators\ mapped\ to\ KPI_k\ under\ SDG_i}{\sum Indicators\ under\ SDG_i} \quad (4)$$

Raw weights are normalized so that the sum of weights to sum to one:

$$\widetilde{W_{i,k}^{SDG}} = \frac{W_{i,k}^{SDG}}{\sum_{k=1}^{K} W_{i,k}^{SDG}} \quad (5)$$

Note that:

$$\sum_{k=1}^{K} \widetilde{W_{i,k}^{SDG}} = 1 \quad (6)$$

The holistic interdependence relationship between the 3 Pillars and the 17 Sustainable development goals (SDGs) is presented using a Sankey diagram in Figure 6.7. The SDG weights for each category/ pillar are calculated as the average weight of all KPIs used in each material issue category/ pillar. Analysis in the SDG context is more holistic and reveals the interconnections between the ESG KPIs, where the most common ESG-related scores are agnostic. Koundouri et al. (2023) provide an extended set of examples as well as robustness checks for the above methodology.

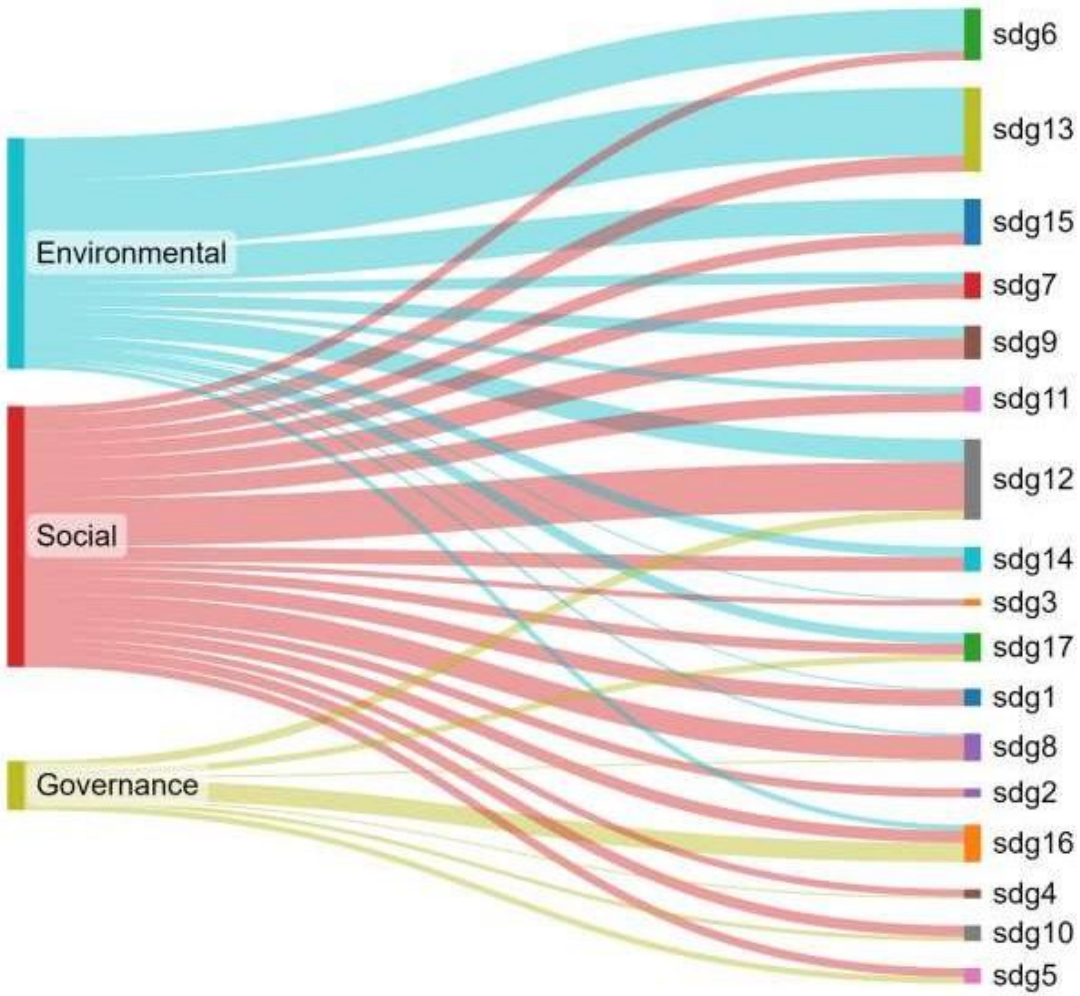

Figure 6 ESG Pillars Map to SDGs

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

$$Score_i^{SDG} = \sum_{p=1}^{3} \widetilde{W_{i,p}^{SDG}}\ Pillar\ Score_p \quad (7)$$

We use the SDG scores to calculate SDG bivariate factors mimicking portfolios sorted on size and SDG scores, using a 90% breakpoint for the size and a [30,70] breakpoint for the SDG-related signals. **Figure 7** depicts the value of 1 dollar invested in the 17-factor mimicking portfolios, which proxy for risks related to the implementation of the 17 SDG goals.

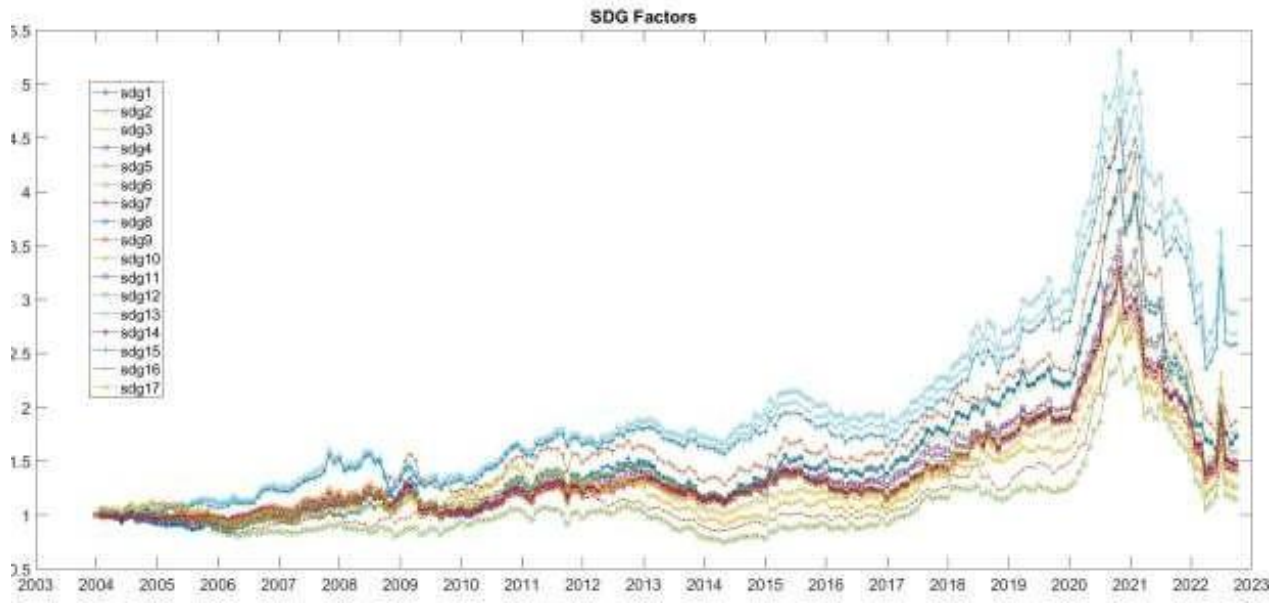

Figure 7 SDG factors

The above setup can be trivially used to calculate the SDG footprint of financial portfolios. We can use an extended version of the Fama and French 3-factor model to estimate the sensitivities of assets to the SDG-related factors.

$$r_{i,t} - r_{f,t} = \beta_0 + \beta_1\left(r_{m,t} - r_{f,t}\right) + \beta_2(SMB_t) + \beta_3(HML_t) + \sum_{i=4}^{20} \beta_i \left(SDG_{i-3,t}\right) + \varepsilon_t \quad (8)$$

Where $r_{f,t}$, denotes a risk-free rate.

Suppose the portfolio contains N shares with weights. a_i were

$$\sum_{i=1}^{N} a_i = 1 \quad (9)$$

The SDG Footprint of the portfolio relative to the jth SDG-factor can be calculated as the weighted sum of portfolio weights and the asset's sensitivity to factor j.

Conclusion

The findings of this study underscore the growing importance of ESG momentum in international financial markets. Our analysis reveals that companies with improved ESG performance over a two-year period achieve significant premiums, a trend observable across both large-cap and small-cap stocks. This highlights ESG momentum as a persistent and lucrative source of priced risk, with substantial implications for portfolio construction and asset management. The role of ESG controversies is another pivotal aspect of our study. Companies embroiled in ESG-related controversies experience notable short-term financial repercussions, which persist even in a globally diversified sample. This underscores the financial materiality of negative ESG shocks, serving as a cautionary note for investors and corporate decision-makers alike.

In bridging ESG performance with the broader SDG framework, our study introduces a comprehensive methodology for calculating the SDG footprint of financial portfolios. By mapping ESG key performance indicators to specific SDG targets, we provide a quantitative tool for assessing the alignment of investments with global sustainability goals. This innovation is particularly timely, given the regulatory landscape—most notably the CSRD—that increasingly demands transparency and accountability in sustainability reporting. The practical implications of our findings are multifold. For investors, integrating ESG momentum and SDG metrics into asset pricing models can enhance portfolio performance while aligning investments with long-term sustainability objectives. For policymakers, our study highlights the critical role of regulatory frameworks in fostering sustainable financial practices. Initiatives like the EU's Sustainable Finance Framework and the CSRD exemplify how policy can incentivize the integration of ESG and SDG considerations into corporate and investment strategies.

Looking ahead, several avenues for further research emerge. First, exploring the heterogeneity of ESG momentum effects across industries and regions can yield deeper insights into sector-specific dynamics. Second, extending the analysis to other asset classes, such as fixed income or alternative investments, can broaden the applicability of our findings. Finally, incorporating real-time data on ESG controversies and SDG progress can refine the predictive accuracy of our models, enabling more responsive investment strategies.

In conclusion, this study reinforces the strategic value of integrating ESG momentum and SDG metrics into financial decision-making. By demonstrating the tangible financial benefits of sustainable practices and their alignment with global developmental priorities, we pave the way for a more resilient and inclusive financial ecosystem. The nexus of ESG, SDGs, and financial performance is not only a compelling area of academic inquiry but also a critical component of the global transition toward sustainable development.

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Appendix

Table A.1 Thomson Reuters Datastream datatypes referenced in the paper.

We collect and report short definitions for all TDS datatypes referenced anywhere in the paper, summarizing the detailed definitions offered on Datastream Navigator. A detailed Worldscope data definitions guide is available on the Thompson Extranet. Following TDS datatype classification panels divide TDS datatypes between time series and descrriptive-static.

Datatype	Name	Definition
MV	Market Value	Share price multiplied by the number of ordinary shares in issue.
RI	Total Return Index	This describes the growth in value of an investment of 100 local currency units on the base date, assuming that dividends are re-invested to purchase additional units of equity or unit trust at the closing price applicable on the ex-dividend date. Ex-date detailed dividend data are available from 1988, except USA and Canada where they are available from 1973.
EXMNEM	Exchange Mnemonic	Exchange Mnemonic. TDS mnemonics are based on the ISO codes.
GEOGN	Geographical Classification of Company	Country of Incorporation.
TR3	TRBC (The Refinitiv Business Classification) Industry Group Code	TR3 returns the Industry Group code from The Refinitiv Business Classification system. Covering over 250,000 securities in 130 countries to 5 levels of granularity, The Refinitiv Business Classifications (TRBC) is the most comprehensive, detailed, and up-to-date sector and industry classification available. Dedicated, local language-speaking analysts utilize company filings, Reuters news, and our corporate actions services to assign and maintain a company's activity. The basis for our sector indices, TRBC helps you identify, monitor, and analyze companies and industries across global markets. It is the ideal tool for benchmarking, peer comparison and navigation, and building custom sector andthematic indices. TRBC consists of five levels of hierarchicalstructure. Each company is allocated an Activity that falls under anIndustry, then an Industry group, then a Business Sector, which is then part of an overall Economic Sector. For more details on the TRBCclassification system click here: https://my.refinitiv.com/content/mytr/en/product/thomson-Reuters-business-classification.html.
TR3N	TRBC (The Refinitiv Business Classification) Industry Group Name	TR3N returns the Industry Group name from The Refinitiv Business Classification system.
TRESGS	ESG Score	Refinitiv's ESG Score is an overall company score based on self-reported information in the environmental, social, and corporate governance pillars.
TRESGCCS	ESG Controversies Score	the ESG controversies category score measures a company's exposure to environmental, social, and governance controversies and negative events reflected in global media.
ENCORE	Environment Pillar Score	Refinitiv's Environment Pillar Score is the weighted average relative rating of a company based on the reported environmentalinformation and the resulting three environmental category scores.

CGSCORE	Governance Pillar Score	Refinitiv's Governance Pillar Score is the weighted average relative rating of a company based on the reported governance information And the resulting three governance category scores.
SCORE	Social Pillar Score	Refinitiv's Social Pillar Score is the weighted average relative rating of a company based on the reported social information and the Resulting in four social category scores.
TRESGENRRS	Resource Use Score	Resource use category 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 the supply chain Management.
TRESGENERS	Emissions Score	The emission category score measures a company's commitment and effectiveness towards reducing environmental emissions in the Production and operational processes.
TRESGENPIS	Environmental Innovation Score	The environmental innovation category score reflects a company's capacity to reduce the environmental costs and burdens of its customers, thereby creating new market opportunities through new environmental technologies and processes or eco-designed Products.
TRESGSOWOS	Workforce Score	The workforce category score measures a company's effectiveness towards job satisfaction, a healthy and safe workplace, and maintaining diversity and equal opportunities, and development opportunities For its workforce.
TRESGSOHRS	Human Rights Score	The human rights category score measures a company's effectiveness towards respecting the fundamental human rights conventions.
TRESGSOCOS	Community Score	The community category score measures the company's commitment towards being a good citizen, protecting public health and Respecting business ethics.
TRESGSOPRS	Product Responsibility Score	The product responsibility category score reflects a company's capacity to produce quality goods and services integrating the customer's Health and safety, integrity, and data privacy.
TRESGCGBDS	Management Score	Management category score measures a company's commitment and effectiveness towards following best practices in corporate Governance principles.
TRESGCGSRS	Shareholders Score	Shareholders category score measures a company's effectiveness towards equal treatment of shareholders and the use of anti-Takeover devices.
TRESGCGVSS	CSR Strategy Score	CSR strategy category 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.

Table 3 Number of Stocks Per Country, per Industry

Market	*#Stocks*	*Share (%)*	*Industry*	*#Stocks*	*Share (%)*
UNITED STATES	3431	30.29	Banking Services	865	7.64
CHINA	1104	9.75	Software & IT Services	722	6.37
INDIA	720	6.36	Machinery, Equipment & Components	591	5.22
UNITED KINGDOM	676	5.97	Metals & Mining	516	4.56
JAPAN	491	4.33	Biotechnology & Medical Research	487	4.30
CANADA	485	4.28	Real Estate Operations	407	3.59
AUSTRALIA	407	3.59	Food & Tobacco	394	3.48
MALAYSIA	347	3.06	Chemicals	384	3.39
SWEDEN	335	2.96	Pharmaceuticals	379	3.35
HONG KONG	309	2.73	Residential & Commercial REITs	374	3.30
GERMANY	303	2.67	Investment Banking & Investment Services	349	3.08
FRANCE	199	1.76	Professional & Commercial Services	340	3.00
SWITZERLAND	188	1.66	Healthcare Equipment & Supplies	295	2.60
THAILAND	178	1.57	Hotels & Entertainment Services	278	2.45
TAIWAN	175	1.54	Automobiles & Auto Parts	266	2.35
SOUTH KOREA	168	1.48	Oil & Gas	263	2.32
ITALY	135	1.19	Construction & Engineering	257	2.27
BRAZIL	132	1.17	Insurance	251	2.22
SOUTH AFRICA	118	1.04	Electrical Utilities & IPPs	249	2.20
TURKEY	99	0.87	Specialty Retailers	242	2.14
MEXICO	98	0.87	Media & Publishing	217	1.92
NORWAY	95	0.84	Semiconductors & Semiconductor Equipment	211	1.86
SINGAPORE	95	0.84	Freight & Logistics Services	174	1.54
INDONESIA	83	0.73	Oil & Gas Related Equipment and Services	174	1.54
FINLAND	78	0.69	Telecommunications Services	170	1.50
SPAIN	73	0.64	Homebuilding & Construction Supplies	160	1.41
DENMARK	67	0.59	Healthcare Providers & Services	154	1.36
NEW ZEALAND	61	0.54	Textiles & Apparel	142	1.25
ARGENTINA	57	0.50	Electronic Equipment & Parts	135	1.19
NETHERLANDS	56	0.49	Food & Drug Retailing	127	1.12
BELGIUM	54	0.48	Computers, Phones & Household Electronics	111	0.98
CHILE	47	0.41	Beverages	109	0.96
RUSSIAN FEDERATION	45	0.40	Aerospace & Defense	100	0.88
POLAND	43	0.38	Diversified Retail	100	0.88
PHILIPPINES	38	0.34	Communications & Networking	99	0.87
EGYPT	35	0.31	Passenger Transportation Services	99	0.87
PERU	33	0.29	Construction Materials	92	0.81
AUSTRIA	32	0.28	Personal & Household Products & Services	90	0.79
MOROCCO	30	0.26	Transport Infrastructure	90	0.79

GREECE	27	0.24	Household Goods	88	0.78
VIETNAM	26	0.23	Collective Investments	88	0.78
IRELAND	22	0.19	Renewable Energy	76	0.67
COLOMBIA	22	0.19	Containers & Packaging	76	0.67
PORTUGAL	16	0.14	Paper & Forest Products	67	0.59
LUXEMBOURG	11	0.10	Consumer Goods Conglomerates	55	0.49
PAKISTAN	11	0.10	Leisure Products	54	0.48
ICELAND	10	0.09	Natural Gas Utilities	54	0.48
ROMANIA	10	0.09	Coal	47	0.41
HUNGARY	6	0.05	Holding Companies	41	0.36
NIGERIA	6	0.05	Multiline Utilities	40	0.35
CYPRUS	5	0.04	Water & Related Utilities	36	0.32
ISRAEL	5	0.04	Financial Technology (Fintech) & Infrastructure	34	0.30
CHANNEL ISLANDS	5	0.04	Miscellaneous Educational Service Providers	26	0.23
CZECH REPUBLIC	3	0.03	Diversified Industrial Goods Wholesalers	24	0.21
CAYMAN ISLANDS	3	0.03	Office Equipment	18	0.16
BERMUDA	3	0.03	Uranium	15	0.13
SLOVENIA	3	0.03	Professional & Business Education	12	0.11
SLOVAKIA	2	0.02	Integrated Hardware & Software	7	0.06
KAZAKHSTAN	2	0.02	School, College & University	7	0.06
UGANDA	2	0.02			
BULGARIA	1	0.01			
MALTA	1	0.01			
UKRAINE	1	0.01			
JERSEY	1	0.01			
PANAMA	1	0.01			
SRI LANKA	1	0.01			
ZIMBABWE	1	0.01			
KENYA	1	0.01			