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## The impact of ESG ratings on implied and historical volatility

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**Frankfurt School – Working Paper Series**

**No. 230**

**The Impact of ESG Ratings on  
Implied and Historical Volatility**

by Eric Burger, Fabian Grba, Thomas Heidorn

March 2022



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## **Abstract**

The economic and political developments of the past years show an increasing importance of a possible risk-reducing of the company due to good ESG performance. Our work contributes by examining the impact of relatively better ESG performance of companies on their implied and historical share volatility. Our regressions show a clear relationship between the volatilities and the ESG ratings of the market-leading agencies (Bloomberg, Refinitiv, Sustainalytics and MSCI) and our combined score. A better ESG performance measured by the company's ESG rating(s) has a risk-reducing effect in the form of lower stock volatility. However, our combined rating has the strongest impact.

Key words:

Environmental, Social and Governance (ESG)

ESG Ratings

ESG Rating Filter

Equity Volatility

Historical Volatility

Implied Volatility

Company Risk Performance

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# 1 Introduction

ESG compliant behavior aims to ensure a company's responsibility to not only its internal stakeholders but to a far broader alignment. As ESG addresses the whole society as conglomerate, harmful developments have retroactive effects on each individual. Therefore, it is certainly not astonishing to find a wider stakeholder orientation, which is in line with Freeman's approach of modern corporate management (cf. Freeman, 1994). However, the evidence indicates that the stakeholder view does not exclude the shareholder approach by Milton Friedman (cf. Friedman, 1970), (cf. Zumente and Bistрова, 2021: 3f.). In markets the number of shareholders, who judge the performance of a company also with respect to ESG components, typically increases (cf. Christensen, Serafeim and Sikochi, 2021: 1). Furthermore, the phenomenon of ESG has aroused remarkable interest of managers, regulators, academia and especially financial institutions (cf. Dorfleitner, Halbritter and Nguyen, 2015: 451; cf. Escrig-Olmedo *et al.*, 2019: 1). Hence, not only investors should be interested in the assessment of a company's ESG performance, but also the company itself.

This working paper investigates how different ESG ratings influence the risk of a company. Unfortunately, a clear definition of ESG does not exist. Therefore, our paper is based on ratings issued by Bloomberg, Refinitiv, Sustainalytics and MSCI because these firms are the major vendors of ESG data. We discuss the impact on historical stock price and implied volatility by using individual and combined ESG ratings, which we derived from the options market.

We find that a better ESG performance leads to lower volatility of the respective stock price. This effect could be attributed to the risk-averse mindset of investors because high ESG performance lowers the risk of ESG-related incidents.

This paper shows an inverse relationship between the overall and the historical ESG rating as well as the implied volatility of a company's equity prices. If better individual ESG ratings are assigned, both volatilities decrease. Moreover, we find that on average the stock prices of ESG Leaders are characterized by lower volatilities and are less likely to be subject to extreme variations.

## 1.1 Structure of the Paper

This introduction is followed by a literature review. The second chapter starts with an overview of the ESG rating agencies and an in-depth analysis of their rating processes. In part 2.3 we describe the selection of the ESG data and the construction of our combined ESG rating. Chapter 3 explains the data and the choice of our model.

Chapter 4 starts with characteristics, descriptive statistics and correlation of the data. An OLS regression with robust standard errors shows a negative impact on all ESG ratings on both volatilities for all chosen maturities. Finally, a comparison during pre and post COVID shows lower volatilities for ESG leaders in the respective timeframe. Chapter 5 finalizes the paper by discussing the results and pointing out possible limitations and future research.

## 1.2 Literature Review

A broad body of literature on ESG and CSR (Corporate Social Responsibility) is already available. The majority of studies cover the US market (cf. Gibson *et al.*, 2021; cf. Glossner, 2021), while fewer include or cover Europe (cf. Sassen, Hinze and Hardeck, 2016; Barth, Hübel and Scholz, 2021) or emerging markets (cf. Wong *et al.*, 2021). In addition to academic research, the activities of public and multinational organizations form an extensive part of the literature on ESG (e.g. United Nations, 2004; Allianz Global Investors, 2016; United Nations Environment Programme, 2020).

One of the most investigated impacts of ESG and CSR is the relationship to overall corporate performance and value (cf. Gillan, Koch and Starks, 2021). Studies like Glossner (2021) or Fatemi, Glaum and Kaiser (2018) found a positive overall impact of good ESG performance on corporate value. This is further suggested by other studies (cf. Benabou and Tirole, 2010: 12ff.; Albuquerque, Koskinen and Zhang, 2019: 4461ff.). Other researchers evaluate the relationship more critically; Di Giuli and Kostovetsky (2014,) Naffa and Fain (2021) or Humphrey, Lee and Shen (2012) do not find a significant impact.

The effect of ESG performance and firm's risk has been discussed in several investigations. Sassen, Hinze and Hardeck (2016) analyze the relationship between total, idiosyncratic and systematic risk of European stocks impacted by corporate social performance. They find that higher ESG performance is advantageous, because it reduces volatility (cf. Sassen, Hinze and Hardeck, 2016: 878ff.). Further, Ng and Rezaee (2020) research the relationship between ESG performance and stock price informativeness, which is proxied by volatility. Again, their findings state an advantage for high ESG performance. Clayman (2016: 38) finds a strong positive correlation between ESG and risk-adjusted return and a negative correlation in respect to volatility. His results are stronger in phases of high market volatility. Ding *et al.* (2020) analyze the performance of companies pre and during the COVID-19 downturn and state that the related stock price is even less severe for companies with prior advanced ESG/CSR performance. Lajili Jarjir, Nasreddine and Desban (2020) find a risk premium for non-financial ratings, which has been positive for ESG underperforming companies, but does not always have significantly negative effects for ESG Leaders.

Literature on ESG and corporate performance mostly find a risk lowering linkage. However, this relationship is not always clearly demonstrated. Most studies only include the US market and solely one ESG rating. However, there is a lack of literature analyzing the relationship of ESG on more than one historical volatility or on implied volatility. Therefore, this paper examines the relationship between ESG Ratings from more than one agency on historical and implied volatilities for European equities during different time frames.



## 2 ESG Ratings

On the one hand, there is a general agreement on the importance of ESG. On the other hand, ESG ratings differ substantially for the same company. Therefore, the applied ESG filter draws on four ratings, which are available for investors without additional cost.

### 2.1 ESG Rating Agencies

ESG rating agencies (cf. Döpfner, 2016: 55; Mooij, 2017: 334) primarily aim to evaluate the ESG performance of large companies listed in well-known stock indices (cf. Liang and Renneboog, 2020: 9). However, also private companies (cf. Huber and Comstock, 2017) and even states can receive ESG ratings (cf. Stüttgen and Mattmann, 2018: 41). Since ESG scores are assigned to a wide range of companies, they allow to draw comparisons of a company's ESG performance over multiple periods, as well as a comparison of a company's performance with other companies (cf. Huber and Comstock, 2017). Most of the major rating agencies are based in Europe, as i.e. Refinitiv and FTSE Russell (United Kingdom) or Sustainalytics (Netherlands), while others like MSCI or Bloomberg are based in the US (e.g., Billio et. al, 2020; Pitchbook, 2021a).

ESG rating agencies act as a collector, interpreter, aggregator and distributor of corporate ESG data (cf. Liang and Renneboog, 2020: 9; Christensen, Serafeim and Sikochi, 2021: 8). Often these ratings are also referred to as non-financial (cf. Gibson et al., 2021: 1), because they are usually not or only partially based on financial data (cf. Dorfleitner, Halbritter and Nguyen, 2015: 454; Escrig-Olmedo, et al., 2019: 3). This extra-financial information can have a material financial impact (cf. Bassen and Kovács, 2008: 183ff.). It is important to notice that the business model of ESG rating agencies does not only focus on generating ratings. Instead, they engage in the provision of information like the construction of sector or industry specific research reports, in investment research and the creation of company profiles, but also in proxy voting services as well as in benchmark and sustainability index creation (cf. Escrig-Olmedo, Muñoz-Torres and Fernández-Izquierdo, 2010: 456f.). Another difference to credit ratings is the remuneration of the agencies. In this case the users have to pay the fee instead of the rated company (cf. Kopp, Heidrun, 2016: 2; Berg, Koelbel and Rigobon, 2020: 7). On the one hand, this reduces the risk of conflict of interest (cf. Christensen, Serafeim and Sikochi, 2021: 9), but on the other hand, it is more difficult and costly for an investor to access the data.

### 2.2 ESG Rating Process

In general, ESG rating agencies do not disclose information on their entire rating process, hence they can be considered opaque (cf. Escrig-Olmedo, Muñoz-Torres and Fernández-Izquierdo, 2010: 443). Each rating agency applies its own methodology to generate an overall ESG score for a company by using varying inputs (such as the sources of information), the ESG issues covered and the weighting (cf. Escrig-Olmedo, Muñoz-Torres and Fernández-Izquierdo, 2010: 450ff.; Liang and Renneboog, 2020: 10; Matos, 2020: 51). Escrig-Olmedo et al. (2019: 14)

note that rating methodologies change over time, as several ESG rating agencies have updated their approach to better reflect a company's ESG performance. Most often the information, which the agencies analyze are either published by the rated company (e.g., company disclosures, sustainability reports), by third-party sources (e.g., NGO reports or websites, media), or through direct interaction between ESG rating agencies and the rated company (cf. Escrig-Olmedo et al., 2019: 3; Billio et al., 2020: 10; Liang and Renneboog, 2020: 9; Matos, 2020: 50). Overall, the information used is diverse but mostly publicly available with some exceptions (cf. Stüttgen and Mattmann, 2018: 43).

ESG approaches can be divided into backward-looking indicators, which evaluate past ESG performance, and forward-looking indicators, which evaluate a company's efforts to avoid future ESG risks (cf. Utz, 2019: 483ff.). Rating agencies must consider the fact that companies are not affected to the same extent by the ESG criteria assessed. As a result, the necessary prioritization is already carried out at a granular level for individual criteria or at a semi-aggregated level of scores by multiplying them with the respective weighting factors. (cf. Stüttgen and Mattmann, 2018: 46f.) The result of the ESG assessment process is a company-specific, aggregated ESG score. This score can be subdivided in multiple sub-scores, which may also be published (cf. Liang and Renneboog, 2020: 9; Matos, 2020: 51). However, these sub-dimensional scores are not limited to 'E', 'S' and 'G' only, since raters theoretically could incorporate additional sub-dimensional scores (cf. Chatterji et al., 2016: 1599f.). Often the ratings are industry-adjusted, as ESG issues differ from industry to industry and it is therefore useful to compare them within the peer group (cf. Kotsantonis and Serafeim, 2019: 52f.; Liang and Renneboog, 2020: 9).

The communication of ratings differs (cf. Matos, 2020: 51); some raters publish a numerical scale, while others use an alphabetical approach (the latter is similar to credit rating agencies) (cf. Mooij, 2017: 341). The rating scale usually ranges from the lowest to the highest achievable score, whereby the ESG score of a particular company depends on its individual ESG performance, but often also on ESG performance compared to its peer group. Accordingly, top and low performers can be identified. (cf. Kotsantonis and Serafeim, 2019: 52; MSCI Inc., 2020a: 6)<sup>1</sup> Once the ESG rating agency has assigned an ESG score to a company, it often reviews the rating on an annual basis by reanalyzing the data. Therefore, score adjustments in the past lead to difficulties in assessing the predictive power of ESG ratings on financial performance (cf. Eccles and Strohle, 2018: 5). It is important to realize that an ESG rating is based on a large amount of information, but end-users are often only confronted with highly aggregated figures, leading to a substantial loss of information (cf. Mooij, 2017: 347; Stüttgen and Mattmann, 2018: 48).

We used ESG ratings from Bloomberg, Refinitiv, Sustainalytics and MSCI for this paper. The ratings were selected based on the availability of time series data via the Bloomberg Terminal (Bloomberg, Sustainalytics) and Refinitiv EIKON (Refinitiv) and public websites (MSCI). More information on the retrieval process will be provided in chapter 3. The following table 1 provides an overview of the four ESG ratings considered.

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<sup>1</sup> In this paper, following other, e.g., MSCI Inc. (2020a), the group of ESG high-performers is referred to as ESG Leaders, whereas the group of ESG low-performers is referred to as ESG Laggards.

	Bloomberg ESG Disclosure Score	Refinitiv ESG Score	Sustainalytics ESG Risk Rating	MSCI ESG Rating
Issuing Company	Bloomberg L.P., US	Refinitiv, UK	Sustainalytics, NL	MSCI ESG Research LLC, US
Parent Company	Bloomberg Inc., US	London Stock Exchange Group, UK	Morningstar Inc., US	MSCI Inc., US
Availability of Company ESG Ratings since	2006	2002	2018	1999 / 2007
Company Coverage	~11,800	~10,000	~12,000	~8,700
Rating Approach	Assessment of ESG data transparency measured by the amount of ESG data disclosed by a company	Assessment of capacity, effectiveness, engagement, reporting transparency and practices regarding material ESG criteria to identify a company's strengths and weaknesses	Assessment of exposure to and management of ESG risks deemed to affect a company's economic value and the investment decisions of reasonable investors	Assessment of exposure to and management of financially relevant medium/long-term ESG risks and opportunities
Rating Scale (Best-Worst)	100-0	100-0	100-0	AAA-CCC
Data Sources	Public Data & Direct Contact	Public data	Public Data & Direct Contact	Public data
Rating Updates	Annually	Weekly	Annually	Annually

*Table 1: Main Characteristics of selected ESG-Rating Agencies;*

*Source: Own Illustration based on data from Billio et al. (2020), Bloomberg Intelligence (2021), Bloomberg Professional Services (2021), Huber and Comstock (2017), Mendelez (2016), MSCI (2020a, b), MSCI ESG Research LLC (2021), Pitchbook (2021a, b, c, d, e), Refinitiv (2021a, b, c, d), Sustainalytics (2020), Sustainalytics (2021a, b, c)*

Please note that we reversed the Sustainalytics rating scale from the original (100 worst) for this paper in order to get a better comparison to the other approaches.

There are major differences between the ESG rating provided by Bloomberg and Refinitiv in comparison to the two other agencies. Bloomberg's scoring method does not refer to the management of ESG risks or their impact on a company's value but ranks the companies only in terms of their ESG disclosure (cf. Bloomberg L.P., 2021a). In contrast to the ESG ratings provided by Sustainalytics and MSCI, Refinitiv concentrates on a company's ESG strengths and weaknesses but does not explicitly link those to a company's economic value or its financial relevance. It is noticeable that Refinitiv may change ESG ratings assigned in the past (cf. Refinitiv, 2021a: 5). The option to modify of retrospective ratings ends at the end of the fifth fiscal year after the rating was assigned (cf. Refinitiv, 2021a: 5).

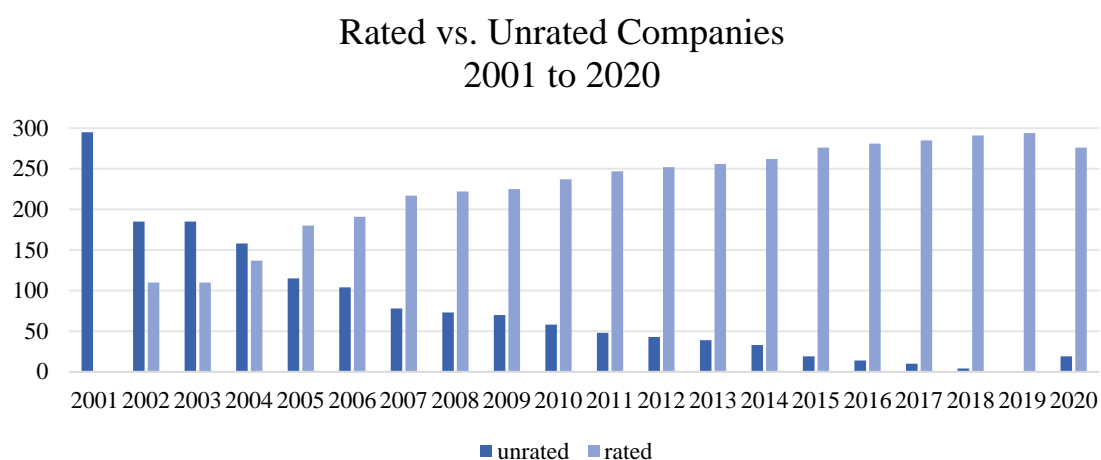
The four rating agencies use public data in the rating process; only Bloomberg and Sustainalytics obtain additional information through direct contact with the company. The rating update frequencies shown in the table appear to be relatively long, but all four rating providers may give updates in the case of special events. (cf. Bloomberg L.P., 2021a; Huber and Comstock, 2017; MSCI Inc., 2020b; Refinitiv, 2021a; Sustainalytics, 2021b).

### 2.3 ESG Data

The ratings are published and revised at different points in time during the year. We assume one rating value per agency per year to be able to compare the approaches. If several ratings of the same rating agency are published in one year, we calculate the overall annual mean. This

results in a total of 9,580 individual ratings for the 295 members of the EURO STOXX<sup>2</sup> from 2001 to 2020. As the ratings follow different methodologies and scales, we developed a certain methodology to ensure comparability. Respectively we assigned each rating a metric value between 0.00 and 2.00 according to their scale. The ESG ratings from Bloomberg, Refinitiv and Sustainalytics (100 represents the highest and 0 the lowest rating) were converted to the metric scale between 0.00 and 2.00. A rating of 100 corresponds to a metric value of 2.00, a rating of 50 corresponds to a value of 1.00 and a rating of 0 equals a metric value of 0.00 (with steps of 0.02 in between). In comparison, the MSCI rating was assigned a value of 2.00 for AAA, 1.00 for BBB and 0.00 for CCC.

Figure 1 shows the relationship between rated and unrated companies over time.



*Figure 1: EURO STOXX Rated vs. Unrated Companies 2001 to 2020;  
Source: Own Illustration*

The figure shows that the number of rated companies rises sharply, which reflects the importance of ESG ratings and market coverage.<sup>3</sup> Interesting to note is an increase on averaged rating value over time. This suggests that the importance of ESG performance also steadily increases on the corporate side and that companies are paying more attention to their behavior with regards to ESG topics. While the mean of all ratings in the data set was 0.78 in 2003, it already rose to 0.90 by 2010. The mean of 2019, which is the year with the highest number of companies in the sample, reached a high of 1.25. This finding is in line with prior literature, e.g. Lajili Jarjir, Nasreddine and Desban (2020: 4), who also find an average increase of the Refinitiv score over time.

<sup>2</sup> Member base of EURO STOXX will be described in chapter 3.1

<sup>3</sup> The bias in 2020, in terms of a small increase in the number of unrated companies, is due to the fact that some agencies published their ratings late and thus not at the time of data collection, and therefore does not represent a deviation from the general trend.

Due to today’s broad market coverage of ESG ratings (in 2019 only one of the 295 member companies of the EURO STOXX did not have an ESG rating) the sub-sample of “unrated” equities in this paper is defined as a company, which was not rated by at least three of the four rating agencies in that fiscal year. This reflects the view of investors, who tend to prefer a large number of ratings in order to form a broader and more well-founded opinion.

In order to create a score to facilitate the comparisons of ratings, in our paper we calculate an overall rating for all rated equities. To compute the rating, we take the sum of the underlying Bloomberg, Refinitiv, Sustainalytics and MSCI metric scores and divide it by the number of ratings in the reviewed year. Table 2 provides a simplified overview of the metric scale and includes a calculation example for Anheuser-Busch’s stock.

Rating Provider		Appraisal										
		ESG Leaders					ESG Laggards					
Bloomberg, Refinitiv, Sustainalytics	Original Score	100	99	98	. . .	51	50	49	. . .	2	1	0
	Metric Score	2.00	1.98	1.96	. . .	1.02	1.00	0.98	. . .	0.04	0.02	0.00
MSCI	Original Score	AAA	AA	A		BBB	BB	B		CCC		
	Metric Score	2.00	1.67	1.33		1.00	0.67	0.33		0.00		

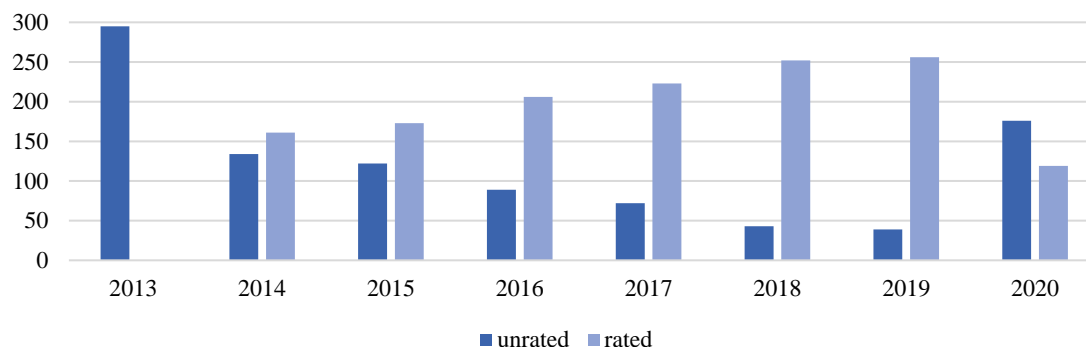
Anheuser-Busch InBev  
(ABBI BB Equity)

Year	Original Score		Metric Score	
	2019	2020	2019	2020
Bloomberg	46.28	46.28	0.92	0.92
Refinitiv	82.42		1.64	
Sustainalytics	69.13	55.77	1.38	1.12
MSCI	AA	AA	1.67	1.67
<b>Overall Metric Rating</b>	=SUM(Bloomberg + Refinitiv + Sustainalytics + MSCI) / COUNT(Bloomberg + Refinitiv + Sustainalytics + MSCI)		<b>1.40</b>	<b>1.24</b>

Table 2: Simplified Metric ESG-Rating Scale and Combined Rating;  
Source: Own Illustration

Figure 2 shows the relationship between rated (at least three ratings) and unrated equities for the data sample. Note that since 2014 there were four ratings per equity possible due to the entry of Sustainalytics into the ESG rating market.

## Rated vs. Unrated Companies 2013 to 2020



*Figure 2: Rated vs. Unrated Companies 2013 to 2020;  
Source: Own Illustration*

### 3 Model

The following section describes the data sample and the model set up.

#### 3.1 Data Sample

To understand the relation between the ESG ratings of European equities and their historical and implied volatility we chose the EURO STOXX Index. It is available with the Bloomberg ticker ‘SXXE’. This index comprises roughly 300 European listed companies and thus represents a large part of the European market capitalization (cf. Bloomberg L.P., 2021b; Qontigo, 2021; STOXX 2021: 38ff.). We analyze the members as individual stocks by using the composition as of December 31, 2020. The 295 share tickers were used to assign the corresponding data. We formed two subsets of rated and unrated companies (defined as having less than three ratings) out of this population.

Due to availability of data, we selected the period from 2018 to 2020, which includes high- and low-volatility phases. In 2018 the 295 companies’ sample includes 43 non-ESG-rated companies. In 2019 the number of unrated equities is lowest at 39. In 2020 there are 119 rated and 176 unrated companies, because unfortunately they were partially published with delay.

If one observes the distribution of synthetic ratings for the years 2018 to 2020, one can find that most ratings are in the 1.0 to 1.5 range. This again gives an insight into the fact that the ratings, as mentioned in chapter 2.3, became more positive over time and the companies performed better with regard to ESG criteria. The quartile and percentile distribution for the ratings are shown in the following figure 3.

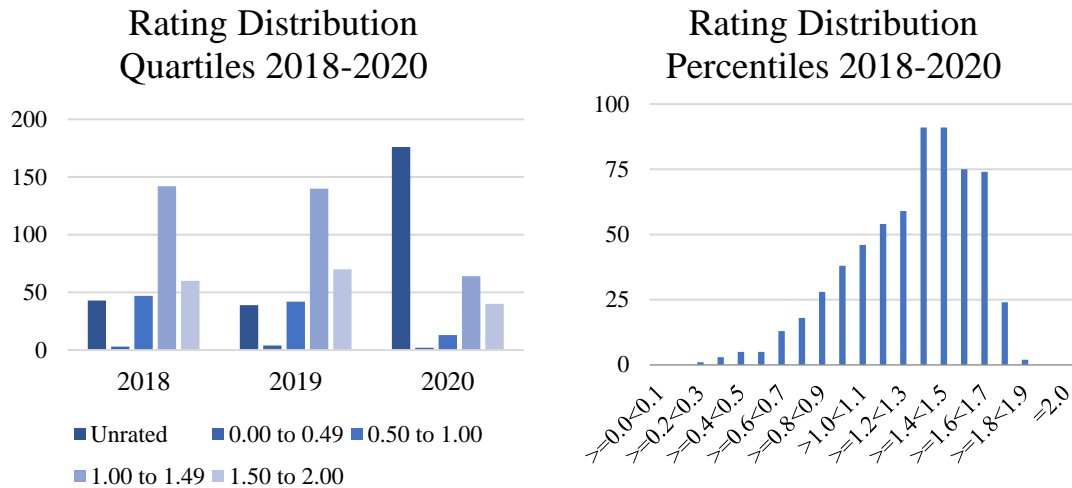


Figure 3: Rating Distribution for min. three Ratings 2018 to 2020;  
Source: Own Illustration

Based on these figures, two comparison groups were formed. The first comparison group incorporates equities that were consistently assigned at least three of the four ratings in the period of 2018 to 2020. The second group comprises all shares that were never assigned more than two ratings. The rated group consists of 117 of the 295 equities and the unrated group of 36 members. Equities with one or more gaps in the assigned data were filtered out. Therefore, the sample with at least three ratings (group one) was reduced by ten, but the sample of unrated equities was filtered to a much greater extent. It should be noted that the original data sample also includes companies that went public in 2020. Also, the availability of implied volatilities is significantly lower in percentage terms in the unrated group. This led to a considerable shortening to only 15 unrated companies. Also, we filtered those companies, which did a stock split or reverse stock split during the period, because the volatility and stock price data is significantly biased during the respective period. Hence, we analyze three data sets (all 122 stocks, 107 rated, 15 unrated).

### 3.2 Regression Variables

ESG ratings were assigned as independent variables for all 295 stocks, if they could be retrieved without additional charges either via Bloomberg, Refinitiv Eikon or from the internet via the corresponding rating agency websites. The rating data was initially retrieved from 2001 to 2021.

As the paper studies the impact of ESG ratings on historical (HV) and implied volatility (IV), these dependent variables are regressed for different time frames. Historical volatility implies to use data from exactly that timeframe (cf. Hilpold and Kaiser, 2010: 60f.; Schmidt, 2014: 45; Bruns and Meyer-Bullerdiek, 2020: 11). We chose the historical daily log-return volatility because this complies with the approach for implied volatility. To calculate them we used a Merton-type-model, which implies a normal return distribution (Heidorn 2009: 150). The method

for calculating return volatilities can be found e.g., in Bloss and Ernst (2008: 41) or Bruns and Meyer-Bullerdiel (2020: 11). In contrast to the historical volatility, the implied volatility is not backward looking, but forward oriented (cf. Hull, 2015: 364f.; Deutsch and Beinker, 2019: 701). Given observable option prices, it is possible to solve the option pricing formula for the implied (implicit) volatility. The implied volatility can be seen as an expectation about future volatility for given time intervals (cf. Lehman and McMillan, 2011: 172; Hull, 2015: 341).

The implied volatility data was retrieved from Bloomberg. In order to be able to examine the differences, data for both volatilities with a time frame of 10, 30, 90, 180 and 360 trading days (10D, etc.) was chosen. The data was retrieved for each stock from January 1, 2014 to December 31, 2020 via their respective Bloomberg fields.<sup>4</sup> Bloomberg uses its Listed Implied Volatility Engine to calculate implied volatilities; which applies the same procedure as the Black-Scholes-Merton Model (QA Bloomberg L.P., 2019: 11, 27, 33; Bloomberg L.P., 2021c: 4).

Since the volatilities can show significant outliers, we calculated the moving average over a window of 30 days. This approach is applied in prior literature as well as in practice (cf. Marra, 2015: 5ff.; Avramov, Kaplanski and Subrahmanyam, 2018: 1ff.). We executed the calculation in Excel and used the Data Analysis function. Finally, we generated a data sample of 295 equities with their corresponding moving-average historical and implied volatilities.

### 3.3 Control Variables

As the size of a company can also have an effect on volatility, we use market capitalization as one control variable. The negative correlation between company size and its idiosyncratic risk has been discussed frequently in research literature (e.g., cf. Benlemlih *et al.*, 2018: 613ff.; cf. Shakil, 2020: 3f.).

As studies like Lamoureux and Lastrapes (1990: 224ff.) find a significant relation of trading volume on stock volatility, we choose it as a control variable. Since this paper is based on daily volatilities of different time windows, we take the trading volumes per stock on a daily basis for the period considered.

As the EURO STOXX is the benchmark for the data sample, we identified some characteristics of the index as additional control variables. Hence, we take the index market capitalization and its returns into account as control variables. We calculate logarithmically from daily price changes of the index. Since no implied volatilities for the EURO STOXX were accessible, we choose the 10D historical volatility as control variable. The 10D historical volatility was retrieved on a daily basis from Bloomberg. Note again that the moving average of 30 days is the base for the control variable (compare e.g. cf. Dai *et al.*, 2020: 5).

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<sup>4</sup> The fields we used are VOLATILITY\_10D, VOLATILITY\_30D, VOLATILITY\_90D, VOLATILITY\_180D, VOLATILITY\_360D, CALL\_IMP\_VOL\_10D, CALL\_IMP\_VOL\_30D, 3MO\_CALL\_IMP\_VOL, 6MO\_CALL\_IMP\_VOL and 12MO\_CALL\_IMP\_VOL.



## 4 The Impact of ESG Ratings on Stock Volatility

As we want to identify the linkage between the ESG ratings of European listed companies and their equity volatility, a multiple linear regression model<sup>5</sup> is the best approach. As the sample is set up as panel data<sup>6</sup>, the choice of an appropriate regression model is not straightforward, however we find alternatives as less valid (see 4.3).

We want to investigate historical (HV) and implied volatility (IV) for periods of 10 days (D), 30D, 90D, 180D and 360D. The independent ESG related variable is our combined ESG Score (ESG) from chapter 2.3, but also alternatively, we consider single scores by Bloomberg ESG Disclosure (Bloomberg), Refinitiv ESG (Refinitiv), Sustainalytics ESG Risk Rating (Sustainalytics) and MSCI ESG Rating (MSCI). We use the control variables that we introduced in chapter 3.3, which are market capitalization (EMC), trading volume (ELIQ), EURO STOXX market capitalization (STOXXMC), EURO STOXX return (STOXXRT) and EURO STOXX 10D historical volatility (STOXXHV).

$$IV_i = \beta_0 + \beta_1 \mathbf{ESG\_Rating}_i + \beta_2 EMC_i + \beta_3 ELIQ_i + \beta_4 STOXXMC_i + \beta_5 STOXXRT_i + \beta_6 STOXXHV_i + \varepsilon_i$$

*Equation 1: Regression Model;*

*Source: Own Illustration*

This approach is similar to Sassen, Hinze and Hardeck (2016), who discuss the relationship between ESG performance and company risk by using control variables like company size, liquidity, ROA etc. (cf. Sassen, Hinze and Hardeck, 2016: 882). They only include one ESG score, therefore, this paper enhances the model by looking at four different ESG ratings and our combined score. Good ESG ratings should reflect lower risk for the company, which leads to lower HV and IV.

### 4.1 Descriptive Statistics

The “Data Sample All” (2018 to 2020) includes the entire portfolio of equities. It is characterized by 95,526 data points per variable, which is basically 783 days multiplied by 122 equities (107 rated, 15 unrated). Thereby 83,781 data points correspond to the sample of rated and 11,745 to the sample of unrated equities.<sup>7</sup>

The average market capitalization in the rated sample (€28.4 billion) is significantly larger compared to the unrated sample (€3.5 billion). The rated equities are also characterized by a

<sup>5</sup> For a definition, please see Marill, 2004: 94f. or Tranmer *et al.*, 2020: 1, 28.

<sup>6</sup> For a definition, please see Baltagi, 2005: 1.

<sup>7</sup> For the calculation of Descriptive Statistics, please refer to tables 10 in appendix.

higher price and a higher trading volume. On average, rated equities are traded at €69.91 with a daily trading volume of 4.61 million shares, unrated companies trade at €44.68 with a daily trading volume of 2.12 million shares. The median price for both samples also differs significantly, as €36.58 for unrated is considerably lower compared to €43.53 for rated equities. The trading volume also deviates from the mean for the unrated sample with 208,244 shares per day and 877,477 shares per day in the sample of rated equities. These deviations between mean and median indicate that there are some significant outliers based on size, price and trading volume in the set of rated equities. For the sake of accuracy, we did not winsorize the comparative variables for the purpose of this paper.

The historical volatilities of the different data samples are lower for the rated equities in both mean and median for all time frames evaluated. In terms of the average value of 10D, 30D, 90D, 180D and 360D HV, the rated sample is significantly lower with a mean of 29.62 (HV) compared to unrated equities to 31.82 (HV). If we consider the median, the picture is similar (25.38 (HV) for rated versus 27.26 (HV) for unrated). However, the comparison for implied volatility (IV) is more homogeneous in for mean and median. While the rated sample shows a mean of 27.92 (IV) and a median of 25.49 (IV), the unrated equities are only slightly lower in the mean with 27.38 (IV) and in the median with 23.42 (IV). A glance at the skewness of the HV shows that both rated and unrated equities are highly positively skewed and accordingly right tailed.

On average, the five different HV that we consider have a skewness of 2.69 (HV) for rated and 1.46 (HV) for unrated. Thus, the unrated equities are less skewed and more evenly distributed. Turning to kurtosis, the samples are quite different. While the rated equities have an average kurtosis of 16.36 (HV), the unrated show a value of 2.75 (HV). By analyzing these figures, it is important to keep in mind that the average skewness for rated stocks is significantly influenced by the historical 360D volatility, which provides a skewness of 53.67 (HV) for the analyzed period. The data shows that both samples are leptokurtically distributed, with the rated sample being extremely positive in kurtosis.

Implied volatility also shows a right-tailed distribution with a skewness of 1.57 (IV) for the rated and 1.19 (IV) for the unrated equities, which is well below the HV skewness. The kurtosis values of 3.45 (IV) for rated and 1.24 (IV) for unrated equities are also well below the HV skewness. This suggests that the IV is closer to a normal distribution than the HV. One reason for these differences is in the higher maximum value for HV (209,11) compared to IV (98,26) and the wider range for HV (195,72) compared to IV (88,79).

Rated equities show an ESG rating of 1.3473 on average, while the unrated equities only account for 0.9580. Due to a mean value close to 1 with less than three ratings at one time, we assigned the unrated companies as neutral with an ESG measure of 1.0000. The average for the whole sample is 1.3071.

For some analyses we divided the sample of rated equities into four groups. We formed these according to the percentage rank of the average ratings for 2018 to 2020. The first group contains the 25% equities with the highest ESG rating (rank 1) and the fourth group contains the 25% with the relatively lowest ESG rating (rank 4).

Some initial patterns between the rating and volatility can be identified. The ranking of the companies by size from large to small leads to a similar distribution, however with rank 2 and rank 3 changing positions. On average rank 1 is worth €34.42 billion and rank 4 €22.53 billion. If one looks at the average trading price, this is €83.13 per share in rank 1, €50.78 in rank 2, €52.20 in rank 3 and €92.88 in rank 4. In terms of trading volume, this results in an arrangement in which rank 2 is ahead of rank 1 and 3, while rank 4 has the smallest average daily trading volume. The average ESG ratings of the four groups are 1.63 for rank 1, 1.45 for rank 2, 1.31 for rank 3 and 0.98 for rank 4. One can deduce that HV rises along the rank distribution, with rank 1 being lowest in terms of HV at 27.64 on average. Group 2 and 3 show just a slight difference on average (29.02 (HV) for rank 2, 29.54 (HV) for rank 3 and rank 4 is considerably higher 32.25 (HV)). The median shows the same ascending order of volatility. The picture is similar for IV. Here rank 1 is the lowest (25.84 IV), followed by rank 2 (27.31 IV), rank 3 (28.43 IV) and rank 4 (30.13). The median values follow the same order.

## 4.2 Correlation

The first step is to examine the correlation matrices<sup>8</sup> between the variables.

We find that all ESG ratings have negative coefficients in relation to all historical (HV) and implied volatilities (IV), with only one exception of the 360D HV correlation with Refinitiv ESG rating. Therefore, it is likely that higher ESG scores lead to lower volatility.

STOXXHV exhibits the highest positive correlation with HV and IV. It is evident that the choice of 10D historical volatility of the EURO STOXX as control variable means that the correlation decreases if the volatility periods increase for both the HV and the IV. The correlation between STOXXMC and volatility has a similar profile, but with a negative correlation. Therefore, larger firms seem to be less risky compared to smaller companies. The rank correlations show an ambiguous picture and lead to additional insight.

The matrix of the independent variables shows a strong negative correlation between the historical 10D index volatility (STOXXHV) and the market capitalization (STOXXMC). Also, we find a substantially positive correlation between STOXXMC and the index return (STOXXRT). The ratings show mostly only low correlations with the control variables.

## 4.3 Robustness

Although we analyze panel data, we find that the best approach is Ordinary Least Square (OLS). The fixed effects (FE) model or the random effects (RE) model is usually suggested for panel data. On the base of a Durbin-Wu-Hausmann test we rejected the RE model. Since the data contains daily values for volatility and control variables, but only one value per year for ESG ratings, it is generally not possible to analyze the impact of ESG rating changes on

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<sup>8</sup> The Correlation Matrices are shown in tables 11 in appendix.

individual equity. This can lead to a bias in the assumption of the FE approach. On the base of a ESG data variance analysis<sup>9</sup>, we find that the demeaning of the rating data causes almost all data points to drop to zero, which makes a FE analysis practically unfeasible (cf. Studenmund, 2014: 526ff.) and leads to biased estimates.

The OLS multiple and linear regressions show a significant negative relationship between the ten dependent volatility variables and the explanatory variables. As this is true for all individual ratings, we find the most pronounced effect when we apply our combined approach. All control variables are statistically significant and show the expected sign. Dropping all control variables leads just to a small increase of the negative ESG impact on volatility and stays statistically significant. Table 3 shows one example of the full regressions for 10 day historical volatility.

Dependent Variable	10D HV									
<b>Independent Variables</b>										
<b>ESG</b>	<b>-0.145***</b>	<b>-0.187***</b>								
	(0.00449)	(0.00593)								
<b>Bloomberg</b>			<b>-0.0821***</b>	<b>-0.115***</b>						
			(0.00450)	(0.00619)						
<b>Refinitiv</b>					<b>-0.0103***</b>	<b>-0.0474***</b>				
					(0.00184)	(0.00265)				
<b>Sustainalytics</b>							<b>-0.0719***</b>	<b>-0.112***</b>		
							(0.00291)	(0.00392)		
<b>MSCI</b>									<b>-0.0382***</b>	<b>-0.0293***</b>
									(0.00111)	(0.00161)
<b>Control Variables</b>										
<b>EMC</b>	<b>-0.0951***</b>	<b>-0.101***</b>	<b>-0.106***</b>	<b>-0.0984***</b>	<b>-0.107***</b>					
	(0.00105)	(0.00103)	(0.00100)	(0.00105)	(0.000997)					
<b>ELIQ</b>	<b>0.0546***</b>	<b>0.0522***</b>	<b>0.0509***</b>	<b>0.0529***</b>	<b>0.0519***</b>					
	(0.000675)	(0.000672)	(0.000669)	(0.000672)	(0.000664)					
<b>STOXXMC</b>	<b>-0.0289***</b>	<b>-0.0286***</b>	<b>-0.0299***</b>	<b>-0.0295***</b>	<b>-0.0279***</b>					
	(0.00853)	(0.00856)	(0.00857)	(0.00854)	(0.00852)					
<b>STOXXHV</b>	<b>0.667***</b>	<b>0.666***</b>	<b>0.664***</b>	<b>0.666***</b>	<b>0.666***</b>					
	(0.00240)	(0.00241)	(0.00242)	(0.00241)	(0.00240)					
<b>STOXXRT</b>	<b>0.0172***</b>	<b>0.0170***</b>	<b>0.0176***</b>	<b>0.0174***</b>	<b>0.0166***</b>					
	(0.00635)	(0.00638)	(0.00639)	(0.00637)	(0.00635)					
<b>Constant</b>	<b>2.102***</b>	<b>3.285***</b>	<b>2.157***</b>	<b>3.240***</b>	<b>2.247***</b>	<b>3.246***</b>	<b>2.158***</b>	<b>3.279***</b>	<b>2.213***</b>	<b>3.247***</b>
	(0.135)	(0.00204)	(0.136)	(0.00148)	(0.136)	(0.00151)	(0.136)	(0.00200)	(0.135)	(0.00151)
<b>Observations</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>	<b>95,526</b>
<b>R<sup>2</sup></b>	<b>0.531</b>	<b>0.010</b>	<b>0.528</b>	<b>0.004</b>	<b>0.526</b>	<b>0.003</b>	<b>0.529</b>	<b>0.009</b>	<b>0.532</b>	<b>0.003</b>
<b>Adj. R<sup>2</sup></b>	<b>0.531</b>	<b>0.0103</b>	<b>0.527</b>	<b>0.00359</b>	<b>0.526</b>	<b>0.00333</b>	<b>0.529</b>	<b>0.00851</b>	<b>0.532</b>	<b>0.00342</b>

Table 3: Preliminary Regression Results OLS Regression for 10D HV Data Sample All;  
Source: Own Illustration, calculated in Stata

The Jarque-Bera-Test indicates that the regression residuals are not normally distributed at the 5% level (cf. Auer and Rottmann, 2020: 474). However, residual histograms show that the distribution is very similar to normal.<sup>10</sup> Considering our large sample, we accept the assumption

<sup>9</sup> For the calculation of equity variance, please refer to table 12 in appendix.

<sup>10</sup> Exemplary histograms for regressions based on 10D HV as dependent variable are shown in figure 4 in appendix.

of asymptotic normal distribution with respect to the residuals (cf. Auer and Rottmann, 2020: 474ff.).<sup>11</sup>

In order to test for multicollinearity, we introduced the variance inflation factor (VIF). Our data shows a low collinearity with no value bigger than 1.94. This indicates that there is no likelihood of multicollinearity issues (cf. Akinwande, Dikko and Samson, 2015: 755f.).<sup>12</sup>

On the base of a Breusch-Pagan-Test we find cross sectional heteroskedasticity in the regression (cf. Halunga, Orme and Yamagata, 2017: 209).<sup>13</sup> Therefore we can infer that the coefficients in the OLS/ multiple linear regression model are reasonable and consistent, but estimated standard errors are biased (cf. Long and Ervin, 2000: 2). However, robust standard errors are valid (cf. Angrist and Pischke, 2008: 221ff.). Hence, we can conclude that the chosen model is an OLS multiple linear regression model with robust standard errors. Table 4 shows the full regression for historical 10D volatility.

Dependent Variable	10D HV									
Independent Variables										
ESG	<b>-0.145***</b> (0.00479)	<b>-0.187***</b> (0.00605)								
Bloomberg			<b>-0.0821***</b> (0.00450)	<b>-0.115***</b> (0.00640)						
Refinitiv					<b>-0.0103***</b> (0.00184)	<b>-0.0474***</b> (0.00271)				
Sustainalytics							<b>-0.0719***</b> (0.00291)	<b>-0.112***</b> (0.00449)		
MSCI									<b>-0.0382***</b> (0.00111)	<b>-0.0293***</b> (0.00149)
Control Variables										
EMC	<b>-0.0951***</b> (0.00105)	<b>-0.101***</b> (0.00105)	<b>-0.106***</b> (0.00101)	<b>-0.0984***</b> (0.00105)	<b>-0.107***</b> (0.00101)					
ELIQ	<b>0.0546***</b> (0.000628)	<b>0.0522***</b> (0.000627)	<b>0.0509***</b> (0.000624)	<b>0.0529***</b> (0.000625)	<b>0.0519***</b> (0.000620)					
STOXXMC	<b>-0.0289***</b> (0.00925)	<b>-0.0286***</b> (0.00927)	<b>-0.0299***</b> (0.00932)	<b>-0.0295***</b> (0.00926)	<b>-0.0279***</b> (0.00932)					
STOXXHV	<b>0.667***</b> (0.00244)	<b>0.666***</b> (0.00245)	<b>0.664***</b> (0.00247)	<b>0.666***</b> (0.00245)	<b>0.666***</b> (0.00244)					
STOXXRT	<b>0.0172**</b> (0.00699)	<b>0.0170**</b> (0.00701)	<b>0.0176**</b> (0.00704)	<b>0.0174**</b> (0.00700)	<b>0.0166**</b> (0.00705)					
Constant	<b>2.102***</b> (0.147)	<b>3.285***</b> (0.00212)	<b>2.157***</b> (0.147)	<b>3.240***</b> (0.00148)	<b>2.247***</b> (0.148)	<b>3.246***</b> (0.00154)	<b>-0.0719***</b> (0.00352)	<b>3.279***</b> (0.00224)	<b>2.213***</b> (0.148)	<b>3.247***</b> (0.00150)
Observations	95,526	95,526	95,526	95,526	95,526	95,526	95,526	95,526	95,526	95,526
R <sup>2</sup>	0.531	0.010	0.528	0.004	0.526	0.003	0.529	0.009	0.532	0.003
Adj. R <sup>2</sup>	0.531	0.0103	0.527	0.00359	0.526	0.00333	0.529	0.00851	0.532	0.00342

Table 4: Final Regression Results OLS Regression with Robust Standard-Errors for 10D HV Data Sample All; Source: Own Illustration, calculated in Stata

<sup>11</sup> For the result of the Jarque-Bera Test on 10D HV, please refer to table 13 in appendix.

<sup>12</sup> For the result of the VIF-Test on 10D HV, please refer to table 13 in appendix.

<sup>13</sup> For the result of the Breusch-Pagan-Test on 10D HV, please refer to table 13 in appendix.

Due to a lack of conclusive findings in the regression results for rank 1-4, we base the volatility analysis regressions on the samples “All” and “Rated”.

#### 4.4 Historical Volatility

When we apply multivariate regressions for the full data sample, we find better ESG ratings that significantly reduce historical volatility for all maturities (see Table 5).<sup>14</sup>

	10D HV	30D HV	90D HV	180D HV	360D HV
<b>incl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.145***	-0.147***	-0.123***	-0.0966***	-0.101***
<b>Bloomberg</b>	-0.0821***	-0.0892***	-0.0773***	-0.0662***	-0.0770***
<b>Refinitiv</b>	-0.0103***	-0.00988***	-0.0153***	-0.0153***	0.00291*
<b>Sustainalytics</b>	-0.0719***	-0.0739***	-0.0689***	-0.0577***	-0.0597***
<b>MSCI</b>	-0.0382***	-0.0380***	-0.0356***	-0.0344***	-0.0368***
<b>incl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.531	0.495	0.368	0.301	0.260
<b>Bloomberg</b>	0.528	0.492	0.365	0.300	0.259
<b>Refinitiv</b>	0.526	0.490	0.364	0.299	0.257
<b>Sustainalytics</b>	0.529	0.493	0.367	0.301	0.260
<b>MSCI</b>	0.532	0.496	0.369	0.304	0.265

	10D HV	30D HV	90D HV	180D HV	360D HV
<b>excl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.187***	-0.201***	-0.196***	-0.190***	-0.200***
<b>Bloomberg</b>	-0.115***	-0.132***	-0.135***	-0.139***	-0.157***
<b>Refinitiv</b>	-0.0474***	-0.0464***	-0.0447***	-0.0410***	-0.0147***
<b>Sustainalytics</b>	-0.112***	-0.121***	-0.124***	-0.123***	-0.128***
<b>MSCI</b>	-0.0293***	-0.0295***	-0.0280***	-0.0277***	-0.0304***
<b>exl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.010	0.012	0.013	0.013	0.018
<b>Bloomberg</b>	0.004	0.005	0.006	0.006	0.010
<b>Refinitiv</b>	0.003	0.003	0.003	0.003	0.001
<b>Sustainalytics</b>	0.009	0.010	0.012	0.012	0.017
<b>MSCI</b>	0.003	0.004	0.004	0.004	0.006

*Table 5: Regression Results for HV Data Sample All;  
Source: Own Illustration, calculated in Stata*

The regressions that include the control variables show that the R<sup>2</sup> ranges from 0.53 for the 10 days to 0.26 for 360 days. Dropping the control variables leads to larger coefficients for the rating effect, which are all statistically significant but show a low R<sup>2</sup>. This is in line with usual explanations of market variables, because one single variable has typically very small

<sup>14</sup> All results are shown in tables 14 in appendix.

explanatory power (Roll, 1988). Therefore, we concentrate on the approach with control variables (CV) with considerably higher  $R^2$ . However, for the approach without control variables our combined rating shows the highest  $R^2$  followed by Sustainalytics, Bloomberg, Refinitiv and MSCI.

If we turn to the approach that includes control variables, we can emphasize that the high  $R^2$  is mostly driven by the 10 day historical volatility of the index (STOXXHV). This variable controls the general shifts in volatility; therefore, our results suggest that better ESG ratings lead to a relative reduction of volatility. Due to the 10 day maturity of the control variable, we find a descending order of explanatory power with longer maturities. At the same time the coefficient of the ESG impact on historical volatility is slightly reduced.

Our combined rating clearly shows the largest coefficient for the volatility reducing effect in conjunction with the largest  $R^2$ . Considering the individual ratings, Bloomberg has the largest coefficient followed by Sustainalytics, MSCI and Refinitiv. This suggests that if one uses solely Bloomberg, the rating seems to have the largest impact on volatility, however, Sustainalytics is comparatively close. This is surprising as Bloomberg only measures the availability of information. Furthermore, the coefficients for MSCI and Refinitiv are considerably lower. These results are plausible because Refinitiv does follow a financial impact approach. All ESG ratings have a significant (1% level) negative impact on HV; the only exception is the single rating by Refinitiv for 360 days with a significance level of 10%. Our general findings on the impact of ESG ratings on historical volatility is in accordance to literature (e.g., Clayman, 2016; Sassen, Hinze and Hardeck, 2016; Shakil, 2020, 2021). However, their methodologies differ considerably from our approach.

After we analyzed the full sample, we now turn to the sub sample of rated companies (see table 6, e.g., with at least three ratings).

	10D HV	30D HV	90D HV	180D HV	360D HV
<b>incl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.167***	-0.169***	-0.147***	-0.119***	-0.119***
<b>Bloomberg</b>	-0.0608***	-0.0667***	-0.0496***	-0.0352***	-0.0485***
<b>Refinitiv</b>	-0.0106***	-0.0103***	-0.0162***	-0.0161***	0.00273
<b>Sustainalytics</b>	-0.0862***	-0.0892***	-0.0857***	-0.0734***	-0.0731***
<b>MSCI</b>	-0.0401***	-0.0400***	-0.0379***	-0.0368***	-0.0388***
<b>incl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.546	0.511	0.380	0.315	0.273
<b>Bloomberg</b>	0.540	0.505	0.374	0.310	0.268
<b>Refinitiv</b>	0.539	0.504	0.374	0.311	0.267
<b>Sustainalytics</b>	0.544	0.509	0.379	0.314	0.272
<b>MSCI</b>	0.546	0.511	0.381	0.318	0.278

	10D HV	30D HV	90D HV	180D HV	360D HV
<b>excl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.190***	-0.202***	-0.196***	-0.183***	-0.187***
<b>Bloomberg</b>	-0.116***	-0.132***	-0.136***	-0.140***	-0.158***
<b>Refinitiv</b>	-0.0455***	-0.0442***	-0.0425***	-0.0382***	-0.0111***
<b>Sustainalytics</b>	-0.112***	-0.119***	-0.123***	-0.117***	-0.118***
<b>MSCI</b>	-0.0282***	-0.0282***	-0.0267***	-0.0260***	-0.0283***
<b>exl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.011	0.012	0.013	0.012	0.017
<b>Bloomberg</b>	0.004	0.006	0.007	0.008	0.013
<b>Refinitiv</b>	0.004	0.003	0.003	0.003	0.000
<b>Sustainalytics</b>	0.009	0.010	0.012	0.012	0.015
<b>MSCI</b>	0.004	0.004	0.004	0.004	0.006

*Table 6: Regression Results for HV Data Sample Rated;  
Source: Own Illustration, calculated in Stata*

Analyzing the subset, which includes control variables, shows that the same coefficients stay significant, nonetheless there is a slide increase of R<sup>2</sup>. Again, the combined rating shows the largest coefficient of Sustainalytics and Bloomberg swap places. The coefficients of MSCI and Refinitiv increase only slightly. However, dropping the control variable shows hardly any difference to our complete data set.

Overall, also for the rated sample, all rating coefficients are strongly significantly negatively correlated with the HV (except of Refinitiv 360D). The same holds if we incorporate control variables.

In summary we find a strong negative impact of ESG ratings on all historical volatilities. The impact slightly decreases with the length of the time period. The combined rating shows the largest coefficient. Moreover, for single ratings we find the largest impact by Sustainalytics and Bloomberg. The ratings by MSCI and Refinitiv are also statistically significant but with considerably lower coefficients.



## 4.5 Implied Volatility

Table 7 shows the impact of ESG ratings on implied volatility for the total sample; we use the same approach as above. Also, we use the same time spans as in historical volatility for the option maturities. It is important to note that the historical volatilities are backward-looking while the implied are forward-looking.

	10D IV	30D IV	90D IV	180D IV	360D IV
<b>incl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.122***	-0.119***	-0.127***	-0.128***	-0.129***
<b>Bloomberg</b>	-0.0976***	-0.102***	-0.108***	-0.109***	-0.110***
<b>Refinitiv</b>	-0.0113***	-0.0101***	-0.00967***	-0.00971***	-0.00771***
<b>Sustainalytics</b>	-0.0552***	-0.0535***	-0.0586***	-0.0589***	-0.0588***
<b>MSCI</b>	-0.0374***	-0.0360***	-0.0349***	-0.0331***	-0.0314***
<b>incl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.569	0.549	0.485	0.438	0.393
<b>Bloomberg</b>	0.567	0.547	0.482	0.436	0.390
<b>Refinitiv</b>	0.564	0.544	0.477	0.429	0.382
<b>Sustainalytics</b>	0.566	0.546	0.481	0.434	0.388
<b>MSCI</b>	0.572	0.551	0.486	0.439	0.393

	10D IV	30D IV	90D IV	180D IV	360D IV
<b>excl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.112***	-0.119***	-0.135***	-0.143***	-0.152***
<b>Bloomberg</b>	-0.0870***	-0.0979***	-0.112***	-0.120***	-0.129***
<b>Refinitiv</b>	-0.0338***	-0.0313***	-0.0280***	-0.0255***	-0.0204***
<b>Sustainalytics</b>	-0.0656***	-0.0683***	-0.0766***	-0.0806***	-0.0844***
<b>MSCI</b>	-0.0270***	-0.0262***	-0.0266***	-0.0257***	-0.0246***
<b>exl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.005	0.007	0.011	0.014	0.019
<b>Bloomberg</b>	0.003	0.004	0.007	0.009	0.012
<b>Refinitiv</b>	0.002	0.002	0.002	0.002	0.002
<b>Sustainalytics</b>	0.004	0.005	0.008	0.010	0.013
<b>MSCI</b>	0.004	0.004	0.006	0.006	0.007

*Table 7: Regression Results for IV Data Sample All;  
Source: Own Illustration, calculated in Stata*

Compared to historical volatility we find increased  $R^2$  especially for the longer maturities. Also, we find here that the impact on volatility is significantly negative on the 1% level for all ESG rating types. Again, our combined rating has the strongest impact followed by Bloomberg and Sustainalytics. MSCI and Refinitiv have the lowest impact. In this case the coefficients are comparatively stable over different maturities. As the impact of ratings on historical volatilities decreases over time, the coefficients for implied volatility are smaller for 10 and 30 days and larger for 180 und 360 days.

The sub sample of rated equities shows the same effects with slightly larger coefficients and  $R^2$  (Table 8).

	10D IV	30D IV	90D IV	180D IV	360D IV
<b>incl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.161***	-0.158***	-0.163***	-0.161***	-0.158***
<b>Bloomberg</b>	-0.0528***	-0.0562***	-0.0644***	-0.0670***	-0.0709***
<b>Refinitiv</b>	-0.0147***	-0.0135***	-0.0125***	-0.0123***	-0.0101***
<b>Sustainalytics</b>	-0.0813***	-0.0794***	-0.0824***	-0.0813***	-0.0791***
<b>MSCI</b>	-0.0416***	-0.0403***	-0.0388***	-0.0367***	-0.0346***
<b>incl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.597	0.581	0.522	0.478	0.434
<b>Bloomberg</b>	0.588	0.571	0.509	0.463	0.417
<b>Refinitiv</b>	0.587	0.570	0.507	0.461	0.414
<b>Sustainalytics</b>	0.593	0.576	0.516	0.471	0.425
<b>MSCI</b>	0.598	0.582	0.521	0.475	0.430

	10D IV	30D IV	90D IV	180D IV	360D IV
<b>excl. CV</b>	<b>Coefficient</b>				
<b>ESG</b>	-0.164***	-0.168***	-0.181***	-0.185***	-0.187***
<b>Bloomberg</b>	-0.0861***	-0.0971***	-0.112***	-0.120***	-0.128***
<b>Refinitiv</b>	-0.0371***	-0.0343***	-0.0304***	-0.0274***	-0.0217***
<b>Sustainalytics</b>	-0.0959***	-0.0973***	-0.103***	-0.104***	-0.104***
<b>MSCI</b>	-0.0290***	-0.0281***	-0.0282***	-0.0270***	-0.0255***
<b>exl. CV</b>	<b>R<sup>2</sup></b>				
<b>ESG</b>	0.012	0.014	0.020	0.025	0.031
<b>Bloomberg</b>	0.003	0.005	0.008	0.011	0.016
<b>Refinitiv</b>	0.003	0.003	0.003	0.003	0.002
<b>Sustainalytics</b>	0.009	0.011	0.015	0.018	0.022
<b>MSCI</b>	0.006	0.006	0.008	0.008	0.009

Table 8: Regression Results for IV Data Sample Rated;  
Source: Own Illustration, calculated in Stata

#### 4.6 Comparison Pre- and Post-COVID-19 Outbreak

The reference period of this paper coincides with the outbreak of the coronavirus epidemic. This chapter focuses on the differences of the general equity behaviour before and after the outbreak of the virus. The subdivision of the “Data Set All” is in accordance with the classification of the pandemic as the highest WHO alert level (cf. World Health Organization, 2021). The sample “Pre-COVID-19 Outbreak” represents the period from February 27, 2019 to January 29, 2020. The “Post-COVID-19 Outbreak” sample represents the period from January 30, 2020 to December 31, 2020. Both periods cover 241 trading days to ensure comparability.

In order to identify differences, we compare the historical, the implied volatilities and the maximum draw down (MDD) of all equities. We find that historical volatilities increased by 13.87 percentage point (start at 24.23 % Pre-COVID-19 and rise to 38.10 % after the outbreak). The implied volatilities show the same picture, here the Pre-COVID-19 period volatilities increased

by 10.28 percentage points from an average of 23.84 to an average value of 34.14. Hence, we can deduce that the outbreak of the virus forced the market into a higher volatility phase. This leads to the question whether good ESG ratings can dampen this effect. On the base of the four different ranks that we created, we find that both implied and historical volatilities are lowest for rank 1 and highest for rank 4 in both periods. Therefore, we conclude that on the one hand good ESG ratings tend to result in lower volatilities on average, but on the other hand the percentage raise of volatilities is rather less significant for the lower rated. This leads to an ambivalent picture.

Maximum draw down gives additional evidence for the risk reduction of better ESG ratings. Rank 1 took the lowest drawdown for both periods, followed by rank 2, 3 and 4. Table 9 gives a detailed look on the MDD and average values for historical and implied volatility.

	Pre-COVID-19 Outbreak	Post-COVID-19 Outbreak	Absolute Change	Percentage Change
<b>MDD</b>				
All	20.08 %	43.13 %	23.05	114.79 %
Rate d	20.14 %	42.94 %	22.81	113.21 %
Rank 1	18.28 %	42.34 %	24.06	131.62 %
Rank 2	19.54 %	42.79 %	23.25	118.99 %
Rank 3	21.47 %	43.22 %	21.75	101.30 %
Rank 4	21.30 %	43.43 %	22.13	103.90 %
Unrated	19.69 %	44.47 %	24.78	125.85 %
<b>Historical Volatility</b>				
All	24.23 %	38.10 %	13.87	57.23 %
Rate d	23.98 %	38.11 %	14.12	58.89 %
Rank 1	22.21 %	35.84 %	13.62	61.33 %
Rank 2	23.00 %	37.19 %	14.19	61.67 %
Rank 3	24.28 %	38.79 %	14.51	59.74 %
Rank 4	26.68 %	40.91 %	14.23	53.34 %
<b>Implied Volatility</b>				
All	23.85 %	34.14 %	10.29	43.14 %
Rate d	24.03 %	34.43 %	10.39	43.25 %
Rank 1	21.88 %	31.98 %	10.11	46.21 %
Rank 2	23.20 %	33.81 %	10.61	45.74 %
Rank 3	24.55 %	35.53 %	10.97	44.69 %
Rank 4	26.79 %	36.61 %	9.82	36.66 %

Table 9: Volatility and MDD Data Pre- and Post-COVID-19;  
Source: Own Illustration, calculated in Stata

## 5 Conclusion

### 5.1 Discussion

In the last decade we experienced an increasing importance of ESG ratings. This paper examines four ratings, which are available on Bloomberg, Eikon-Reuters or on various websites free of additional charge.

Nearly all of the approximately 300 index members of the EURO STOXX have at least one ESG rating. However, we define a rated company as having at least three of the possible four ratings. These companies have a larger market capitalization (€38.4 billion) compared to unrated companies (€22.5 billion). This effect can also be observed by quartile-clustering according to their overall ESG scores. The average market capitalization of ESG Leaders (ESG 1.63; €34.4 billion) exceeds ESG laggards (ESG 0.98; €22.5 billion). Therefore, we find evidence that larger firms tend to have a better ESG performance.

We measure risk by historical (HV) and implied volatility (IV). The OLS regressions display rising risk for lower ESG scores. This implies a negative relation between the ESG performance and equity historical and implied volatility. Further analyses also imply more extreme variations in volatility for lower ESG rated companies, even though the maximum values, mostly reached during the COVID-19 downturn in 2020, do not differ significantly.

Our OLS regressions almost always show statistically significant negative coefficients (1% level) for the impact of ESG ratings on historical and implied volatilities (10, 30, 90, 180, 360D). The combined ratings of Sustainalytics, Bloomberg, Refinitiv and MSCI show the largest coefficient. We find a predictive advantage of the Bloomberg ESG Disclosure Score and the Sustainalytics ESG Risk Rating in comparison to the Refinitiv and MSCI ratings.

ESG ratings significantly reduce volatility on a standalone basis, however with low  $R^2$ . To check the results for robustness we introduce 5 control variables that are a company's market capitalization (EMC), trading volume (ELIQ), EURO STOXX market capitalization (STOXXMC), EURO STOXX return (STOXXRT) and EURO STOXX 10D historical volatility (STOXXHV). For all of them we find statistically significant results and we find that  $R^2$  increases to levels around 0.5. Also, the most predictive power shows the 10 day EURO STOXX volatility. As this variable catches the effect of the volatility level, our results show the impact of ESG ratings on the relative volatility changes. Our general findings are in line with prior literature (i.e., Sassen, Hinze and Hardeck (2016)).

ESG equity investors often focus on medium- and long-term performance. Therefore, the effect of historical volatility reduction (compare cf. Boffo and Patalano, 2020: 14) improves the risk adjusted performance of their portfolios. On the one hand, one can attribute the effect of the volatility reduction to the presumably better risk profile of the strong ESG companies. On the other hand, investors might overestimate the widely studied positive correlation between high ESG performance and financial stability. Furthermore, our study shows that for the investigation of the corona epidemic time span we find a similar relationship, which is again reflected by the lower volatility of ESG leaders compared to laggards.

For volatility long strategies, which indicate larger implied than realized volatilities, we find some evidence that the application of ESG filters tends to perform better for short-term options. The impact of ESG ratings is very similar for the different maturities of implied volatility but decrease in size for historical volatilities. Therefore, the impact for implied volatility is larger for 10 and 30 days compared to historical volatility and smaller for 180 and 360 days. The key risk of these strategies is an extreme negative event. Here the evidence is mixed, because ESG leaders have lower volatilities during the crisis time, however the increase in percentage terms is larger compared to ESG laggards.

Unfortunately, our regressions on different ESG-quartiles do not lead to conclusive findings. By looking at the individual ranks, we find negative relations between the overall rating and the groups and only few positive coefficients for some cases. Hence, we excluded rank regressions from this paper.

## 5.2 Limitations and Future Research

The ESG-rating data is available on a yearly basis and constantly improves in quality (review of the rating approach). Thus, our data base covers a comparatively short time span. In our studies we compare only one rating value per year with daily volatility data because of the characteristics of the rating and for comparability reasons. Unfortunately, this led us to challenges in the choice of the regression model. This might be one important reason why rank regression leads to ambiguous results. We chose the EURO STOXX as investment universe, which lead to a liquid sample, but also caused that the group of non-ESG-rated companies was very small. Therefore, the comparative analysis of ESG-rated to non-rated companies is very limited in our approach, which is also partly due to the fact that the data on implied volatility is very scarce for this group.

Further analyzes could focus on two separate regression models in order to investigate the relationship of ESG performance on historical compared to implied volatility. Especially the choice of control variables might be specific to the particular volatility under consideration.

# Appendix

Table 10: Descriptive Statistics for different Data Samples;  
Source: Own Illustration, calculated in Excel

Data Sample All												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
<b>10D HV</b>	28.6563	0.0516	24.2240	15.9347	253.9139	8.1298	2.3486	155.1650	5.5467	160.7117	95,526	0.1010
<b>30D HV</b>	30.2034	0.0544	25.2884	16.8138	282.7052	7.5256	2.3095	156.2388	8.6865	164.9253	95,526	0.1066
<b>90D HV</b>	30.8337	0.0506	26.1333	15.6515	244.9701	5.9739	1.9508	180.5969	9.7476	190.3446	95,526	0.0993
<b>180D HV</b>	30.8959	0.0471	26.6996	14.5579	211.9338	4.2082	1.6314	123.8734	12.0931	135.9664	95,526	0.0923
<b>360D HV</b>	28.8427	0.0431	25.5651	13.3122	177.2145	45.3678	4.3339	195.7222	13.3885	209.1107	95,526	0.0844
<b>10D IV</b>	29.7747	0.0425	26.3091	13.1268	172.3139	4.3584	1.7986	104.3150	9.4770	113.7920	95,526	0.0832
<b>30D IV</b>	28.6175	0.0382	25.5579	11.8156	139.6089	3.6364	1.6559	88.6998	9.5334	98.2332	95,526	0.0749
<b>90D IV</b>	27.6127	0.0323	25.0952	9.9729	99.4597	2.8133	1.4583	78.6342	10.1311	88.7653	95,526	0.0632
<b>180D IV</b>	26.9896	0.0287	24.9214	8.8807	78.8669	2.2865	1.3302	67.8693	10.9098	78.7791	95,526	0.0563
<b>360D IV</b>	26.2842	0.0254	24.5760	7.8659	61.8724	2.2424	1.2798	61.5463	11.4148	72.9611	95,526	0.0499
<b>EMC</b>	25.3084085	101.7045	12.864.9395	31,434.0851	988,101,705.0937	8.0150	2.5635	258,471.4749	519.5157	258,990.9906	95,526	199.3396
<b>PX_LAST</b>	66.8096	0.2771	42.3100	85.6420	7,334.5551	21.0822	3.9125	883.7454	0.2546	884.0000	95,526	0.5431
<b>ELIQ</b>	4,305,187.7199	45,650.3936	749,432.0000	14,109,295.2930	199,072,213,666,245.0000	161.1252	10.0838	471,131,653.0000	5,263.0000	471,136,916.0000	95,526	89,474.2611
<b>STOXXMC</b>	5,694,091.5043	1,392.0478	5,730,114.7100	430,244.1351	185,110,015,813.1810	36.7434	-3.3468	6,484,145.1800	84,146.9700	6,568,292.1500	95,526	2,728.3982
<b>STOXXHV</b>	16.3540	0.0389	13.5700	12.0155	144.3721	13.8095	3.1413	100.0700	3.1700	103.2400	95,526	0.0762
<b>STOXXRT</b>	0.0001	0.0007	0.0007	0.2154	0.0464	385.8129	-0.0159	8.5096	-4.2558	4.2538	95,526	0.0014
<b>Bloomberg</b>	1.0038	0.0008	1.0400	0.2267	0.0514	0.8920	-1.0136	1.1600	0.2600	1.4200	85,589	0.0015
<b>MSCI</b>	1.5519	0.0017	1.6667	0.4209	0.1772	1.7848	-1.2165	2.0000	0.0000	2.0000	64,209	0.0033
<b>Refinitiv</b>	1.3142	0.0016	1.4400	0.4529	0.2051	1.3599	-1.4162	1.8000	0.0800	1.8800	76,664	0.0032
<b>Sustainalytics</b>	1.5698	0.0014	1.7200	0.4140	0.1714	0.7965	-1.2017	1.8400	0.1600	2.0000	82,998	0.0028
<b>Overall</b>	1.3071	0.0010	1.3483	0.3060	0.0936	0.8557	-0.9388	1.6833	0.1900	1.8733	93,430	0.0020
<b>ESG</b>	1.3473	0.0010	1.3867	0.2785	0.0776	0.5752	-0.8850	1.4467	0.4267	1.8733	83,781	0.0019

This table shows the descriptive statistics for Data Sample All. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of 1st return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Rated												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
<b>10D HV</b>	28.4509	0.0546	24.0692	15.8013	249.6805	8.6914	2.4223	155.1650	5.5467	160.7117	83,781	0.1070
<b>30D HV</b>	29.9637	0.0575	25.1021	16.6392	276.8627	7.8402	2.3600	156.2388	8.6865	164.9253	83,781	0.1127
<b>90D HV</b>	30.5837	0.0536	25.9678	15.5020	240.3124	6.6533	2.0343	180.5969	9.7476	190.3446	83,781	0.1050
<b>180D HV</b>	30.5898	0.0496	26.4176	14.3581	206.1563	4.9327	1.7267	123.8734	12.0931	135.9664	83,781	0.0972
<b>360D HV</b>	28.4889	0.0457	25.3372	13.2169	174.6877	53.6736	4.9031	195.7222	13.3885	209.1107	83,781	0.0895
<b>10D IV</b>	29.9215	0.0449	26.5399	13.0079	169.2043	4.6560	1.8543	104.0869	9.7050	113.7920	83,781	0.0881
<b>30D IV</b>	28.7397	0.0403	25.7706	11.6760	136.3283	3.9538	1.7175	88.1346	10.0986	98.2332	83,781	0.0791
<b>90D IV</b>	27.6858	0.0337	25.2873	9.7624	95.3053	3.2443	1.5374	76.0717	12.6936	88.7653	83,781	0.0661
<b>180D IV</b>	27.0151	0.0296	25.1180	8.5743	73.5188	2.7184	1.4018	64.5544	14.2247	78.7791	83,781	0.0581
<b>360D IV</b>	26.2497	0.0257	24.7234	7.4422	55.3870	2.6530	1.3333	58.4598	14.5014	72.9611	83,781	0.0504
<b>EMC</b>	28,369.6339	111.9610	15,151.9908	32,407.0459	1,050,216,621.0274	7.1177	2.4264	257,558.3654	1,432.6252	258,990.9906	83,781	219.4426
<b>PX_LAST</b>	69.9121	0.3109	43.5300	89.9967	8,099.4000	18.9805	3.7484	883.7454	0.2546	884.0000	83,781	0.6094
<b>ELIQ</b>	4,610,845.5029	51,014.3916	877,477.0000	14,766,088.9929	218,037,384,146,081.0000	151.8667	9.8839	471,130,580.0000	6,336.0000	471,136,916.0000	83,781	99,987.8148
<b>STOXXMC</b>	5,694,091.5043	1,486.4233	5,730,114.7100	430,244.4508	185,110,287,470.2380	36.7437	-3.3468	6,484,145.1800	84,146.9700	6,568,292.1500	83,781	2,913.3782
<b>STOXXHV</b>	16.3540	0.0415	13.5700	12.0155	144.3723	13.8096	3.1413	100.0700	3.1700	103.2400	83,781	0.0814
<b>STOXXRT</b>	0.0001	0.0007	0.0007	0.2154	0.0464	385.8158	-0.0159	8.5096	-4.2558	4.2538	83,781	0.0015
<b>Bloomberg</b>	1.0219	0.0008	1.0600	0.2169	0.0470	1.1425	-1.0576	1.1600	0.2600	1.4200	77,766	0.0015
<b>MSCI</b>	1.5519	0.0017	1.6667	0.4209	0.1772	1.7848	-1.2165	2.0000	0.0000	2.0000	64,209	0.0033
<b>Refinitiv</b>	1.3466	0.0017	1.4600	0.4454	0.1984	1.7139	-1.5328	1.7800	0.1000	1.8800	68,325	0.0033
<b>Sustainalytics</b>	1.5734	0.0014	1.7200	0.4142	0.1716	0.8600	-1.2293	1.8400	0.1600	2.0000	82,215	0.0028
<b>Overall</b>	1.3473	0.0010	1.3867	0.2785	0.0776	0.5752	-0.8850	1.4467	0.4267	1.8733	83,781	0.0019
<b>ESG</b>	1.3473	0.0010	1.3867	0.2785	0.0776	0.5752	-0.8850	1.4467	0.4267	1.8733	83,781	0.0019

This table shows the descriptive statistics for Data Sample Rated. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of 1st return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Unrated												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
<b>10D HV</b>	30.1214	0.1549	25.3652	16.7836	281.6885	5.0244	1.8990	128.0145	8.1105	136.1250	11,745	0.3036
<b>30D HV</b>	31.9131	0.1653	26.3878	17.9186	321.0751	5.7738	1.9997	139.8858	9.4776	149.3634	11,745	0.3241
<b>90D HV</b>	32.6169	0.1529	27.5527	16.5708	274.5925	2.3679	1.4476	94.5377	11.6437	106.1814	11,745	0.2997
<b>180D HV</b>	33.0800	0.1452	29.0319	15.7394	247.7283	0.7226	1.0768	71.1991	13.0686	84.2678	11,745	0.2847
<b>360D HV</b>	31.3665	0.1265	27.9692	13.7110	187.9919	-0.1438	0.8878	53.8801	14.0584	67.9385	11,745	0.2480
<b>10D IV</b>	28.7272	0.1283	24.0490	13.9018	193.2607	2.6763	1.5088	88.7874	9.4770	98.2644	11,745	0.2514
<b>30D IV</b>	27.7459	0.1175	23.4928	12.7341	162.1584	1.9260	1.3479	77.0313	9.5334	86.5647	11,745	0.2303
<b>90D IV</b>	27.0911	0.1047	23.3233	11.3488	128.7948	0.8167	1.1046	63.7750	10.1311	73.9061	11,745	0.2053
<b>180D IV</b>	26.8074	0.0998	23.1556	10.8161	116.9880	0.4528	1.0260	61.7543	10.9098	72.6641	11,745	0.1956
<b>360D IV</b>	26.5308	0.0959	23.0893	10.3959	108.0745	0.3343	0.9853	61.2493	11.4148	72.6641	11,745	0.1880
<b>EMC</b>	3,471.6670	10.6424	3,501.0863	1,153.3606	1,330,240.6916	0.2159	0.0026	6,991.4843	519.5157	7,511.0000	11,745	20.8608
<b>PX_LAST</b>	44.6786	0.3353	36.5800	36.3373	1,320.3972	1.0785	1.2301	159.4570	1.0430	160.5000	11,745	0.6572
<b>ELIQ</b>	2,124,828.8679	70,498.7446	208,244.0000	7,640,255.7124	58,373,507,350,668.6000	33.2302	5.2263	93,883,786.0000	5,263.0000	93,889,049.0000	11,745	138,189.2426
<b>STOXXMC</b>	5,694,091.5043	3,970.1294	5,730,114.7100	430,260.2003	185,123,839,943.5970	36.7575	-3.3472	6,484,145.1800	84,146.9700	6,568,292.1500	11,745	7,782.1127
<b>STOXXHV</b>	16.3540	0.1109	13.5700	12.0159	144.3829	13.8151	3.1417	100.0700	3.1700	103.2400	11,745	0.2173
<b>STOXXRT</b>	0.0001	0.0020	0.0007	0.2154	0.0464	385.9575	-0.0159	8.5096	-4.2558	4.2538	11,745	0.0039
<b>Bloomberg</b>	0.8241	0.0028	0.9000	0.2437	0.0594	-0.5006	-0.6659	0.8600	0.3000	1.1600	7,823	0.0054
<b>MSCI</b>	-	65.535.0000	-	-	-	-	-	0.0000	0.0000	0.0000	0	-
<b>Refinitiv</b>	-	0.0047	1.1600	0.4255	0.1810	0.5791	-1.2358	1.4600	0.0800	1.5400	8,339	0.0091
<b>Sustainalytics</b>	1.1869	0.0034	1.1200	0.0944	0.0089	-1.5105	0.7024	0.2000	1.1200	1.3200	783	0.0066
<b>Overall</b>	0.9580	0.0032	1.0200	0.3119	0.0973	0.1986	-1.0497	1.1300	0.1900	1.3200	9,649	0.0062
<b>ESG</b>	-	65.535.0000	-	-	-	-	-	0.0000	0.0000	0.0000	0	-

This table shows the descriptive statistics for Data Sample Unrated. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of its return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Rank 1												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
<b>10D HV</b>	26.5595	0.1041	22.2875	15.1294	228.8996	10.4043	2.6362	149.5694	7.6864	157.2558	21,141	0.2040
<b>30D HV</b>	28.0591	0.1121	23.1237	16.2979	265.6206	9.6729	2.6105	152.7308	9.1255	161.8563	21,141	0.2197
<b>90D HV</b>	28.7081	0.1021	23.5801	14.8414	220.2662	4.5851	1.9356	100.2719	11.3930	111.6649	21,141	0.2001
<b>180D HV</b>	28.6675	0.0914	23.9493	13.2918	176.6707	1.9983	1.4450	71.1923	12.3433	83.5557	21,141	0.1792
<b>360D HV</b>	26.2206	0.0671	23.5927	9.7631	95.3187	1.3906	1.3008	47.8876	14.2571	62.1447	21,141	0.1316
<b>10D IV</b>	27.4863	0.0834	24.4114	12.1268	147.0602	5.6691	2.0874	90.5750	12.1353	102.7103	21,141	0.1635
<b>30D IV</b>	26.5338	0.0748	23.8389	10.8810	118.3970	4.7472	1.9074	82.0763	11.6430	93.7193	21,141	0.1467
<b>90D IV</b>	25.6991	0.0624	23.6450	9.0731	82.3209	4.1946	1.7311	76.0717	12.6936	88.7653	21,141	0.1223
<b>180D IV</b>	25.0965	0.0541	23.3740	7.8725	61.9763	3.3158	1.5521	60.4491	14.4099	74.8589	21,141	0.1061
<b>360D IV</b>	24.4054	0.0463	22.9682	6.7299	45.2915	3.3021	1.4839	52.6947	14.5014	67.1961	21,141	0.0907
<b>EMC</b>	34,424.8508	248.2092	20,070.2217	36,089.4883	1,302,451,167.6580	2.2406	1.7697	175,824.0024	2,624.8901	178,448.8925	21,141	486.5090
<b>PX_LAST</b>	83.1332	0.7107	39.3300	103.3296	10,676.9963	7.0500	2.4519	621.8300	1.6700	623.5000	21,141	1.3929
<b>ELIQ</b>	3,587,848.3970	52,833.3392	1,046,286.0000	7,681,938.4497	59,012,178,345,595.1000	48.7621	5.2823	171,868,082.0000	7,467.0000	171,875,549.0000	21,141	103,557.3711
<b>STOXXMC</b>	5,694,091.5043	2,959.1038	5,730,114.7100	430,252.0590	185,116,834,311.0570	36.7504	-3.3470	6,484,145.1800	84,146.9700	6,568,292.1500	21,141	5,800.0689
<b>STOXXHV</b>	16.3540	0.0826	13.5700	12.0157	144.3774	13.8123	3.1415	100.0700	3.1700	103.2400	21,141	0.1620
<b>STOXXRT</b>	0.0001	0.0015	0.0007	0.2154	0.0464	385.8842	-0.0159	8.5096	-4.2558	4.2538	21,141	0.0029
<b>Bloomberg</b>	1.1782	0.0009	1.2000	0.1262	0.0159	-0.5282	-0.4916	0.5200	0.8400	1.3600	19,570	0.0018
<b>MSCI</b>	1.8786	0.0012	2.0000	0.1777	0.0316	0.1660	-1.1082	0.6667	1.3333	2.0000	21,141	0.0024
<b>Refinitiv</b>	1.5565	0.0026	1.6500	0.3422	0.1171	9.6487	-3.0268	1.7200	0.1600	1.8800	16,688	0.0052
<b>Sustainalytics</b>	1.8673	0.0008	1.9200	0.1232	0.0152	-0.1744	-0.9534	0.5000	1.5000	2.0000	21,141	0.0017
<b>Overall</b>	1.6303	0.0007	1.6467	0.1018	0.0104	4.1068	-1.4236	0.6667	1.2067	1.8733	21,141	0.0014
<b>ESG</b>	1.6303	0.0007	1.6467	0.1018	0.0104	4.1068	-1.4236	0.6667	1.2067	1.8733	21,141	0.0014

This table shows the descriptive statistics for Data Sample Rank 1. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of its return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Rank 2												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
<b>10D HV</b>	27.6543	0.1025	23.5678	14.9091	222.2825	9.9224	2.5240	151.0879	8.8337	159.9216	21,141	0.2010
<b>30D HV</b>	28.9184	0.1068	24.4725	15.5248	241.0208	8.5667	2.4354	142.4531	9.6379	152.0911	21,141	0.2093
<b>90D HV</b>	29.6064	0.1080	24.9701	15.7101	246.8058	15.3002	2.8896	178.9258	11.4188	190.3446	21,141	0.2118
<b>180D HV</b>	29.8554	0.1070	25.6116	15.5613	242.1528	11.5959	2.6605	123.8734	12.0931	135.9664	21,141	0.2098
<b>360D HV</b>	29.0841	0.1332	24.7658	19.3626	374.9090	44.1867	5.6312	195.7222	13.3885	209.1107	21,141	0.2610
<b>10D IV</b>	29.6803	0.0905	26.2682	13.1525	172.9890	4.7168	1.8859	97.9632	9.7050	107.6683	21,141	0.1773
<b>30D IV</b>	28.2744	0.0788	25.3398	11.4557	131.2332	3.5953	1.6870	82.4691	10.0986	92.5677	21,141	0.1544
<b>90D IV</b>	26.8843	0.0634	24.7213	9.2189	84.9877	2.4657	1.4361	63.2543	12.9840	76.2383	21,141	0.1243
<b>180D IV</b>	26.1954	0.0556	24.4098	8.0794	65.2760	2.0969	1.3254	51.7691	14.2996	66.0687	21,141	0.1089
<b>360D IV</b>	25.5179	0.0491	23.9594	7.1412	50.9961	2.7302	1.3755	49.1451	14.6561	63.8012	21,141	0.0963
<b>EMC</b>	26,183.6830	158.8547	17,607.6165	23,097.3847	533,489,182.0003	2.7207	1.7139	116,808.6557	1,629.3786	118,438.0343	21,141	311.3673
<b>PX_LAST</b>	50.7780	0.3701	34.3200	53.8192	2,896.5051	4.1304	1.8260	315.7593	0.2907	316.0500	21,141	0.7255
<b>ELIQ</b>	9,354,912.4047	173,994.9943	960,070.0000	25,298,776.4419	640,028,089,455,730.0000	54.2295	6.1936	423,034,496.0000	8,887.0000	423,043,383.0000	21,141	341,043.4487
<b>STOXXMC</b>	5,694,091.5043	2,959.1038	5,730,114.7100	430,252.0590	185,116,834,311.0570	36.7504	-3.3470	6,484,145.1800	84,146.9700	6,568,292.1500	21,141	5,800.0689
<b>STOXXHV</b>	16.3540	0.0826	13.5700	12.0157	144.3774	13.8123	3.1415	100.0700	3.1700	103.2400	21,141	0.1620
<b>STOXXRT</b>	0.0001	0.0015	0.0007	0.2154	0.0464	385.8842	-0.0159	8.5096	-4.2558	4.2538	21,141	0.0029
<b>Bloomberg</b>	1.0461	0.0007	1.0400	0.0961	0.0092	-0.2941	0.2303	0.4400	0.8600	1.3000	19,835	0.0013
<b>MSCI</b>	1.6633	0.0021	1.6667	0.2678	0.0717	1.3616	-0.7931	1.3333	0.6667	2.0000	16,965	0.0040
<b>Refinitiv</b>	1.3984	0.0032	1.4800	0.4123	0.1700	3.6693	-1.9920	1.7200	0.1400	1.8600	16,425	0.0063
<b>Sustainalytics</b>	1.7807	0.0013	1.8200	0.1879	0.0353	0.8331	-1.1450	0.8000	1.2000	2.0000	21,141	0.0025
<b>Overall</b>	1.4587	0.0007	1.4717	0.1055	0.0111	1.3712	-0.8395	0.6067	1.0800	1.6867	21,141	0.0014
<b>ESG</b>	1.4587	0.0007	1.4717	0.1055	0.0111	1.3712	-0.8395	0.6067	1.0800	1.6867	21,141	0.0014

This table shows the descriptive statistics for Data Sample Rank 2. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of its return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Rank 3												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
10D HV	28.6391	0.1125	24.0769	16.0564	257.8081	8.8208	2.5685	142.1077	7.7224	149.8301	20,358	0.2206
30D HV	30.1310	0.1171	25.2650	16.7052	279.0641	7.7608	2.4667	140.6077	9.2256	149.8334	20,358	0.2295
90D HV	30.6461	0.1065	25.9340	15.2023	231.1114	4.2470	1.9452	100.1729	9.7476	109.9206	20,358	0.2088
180D HV	30.4664	0.0950	26.3112	13.5536	183.6995	1.9453	1.4704	72.2678	12.5459	84.8137	20,358	0.1862
360D HV	27.8134	0.0671	25.1678	9.5742	91.6660	1.2305	1.2305	51.0446	14.8136	65.8581	20,358	0.1315
10D IV	30.6355	0.0911	27.1444	12.9992	168.9779	5.8627	2.0900	101.3434	12.4486	113.7920	20,358	0.1786
30D IV	29.2751	0.0804	26.1795	11.4719	131.6038	4.8121	1.9192	84.1381	13.2760	97.4140	20,358	0.1576
90D IV	28.1679	0.0666	25.5769	9.5088	90.4168	3.7723	1.7197	70.3931	14.8067	85.1998	20,358	0.1306
180D IV	27.4668	0.0577	25.4550	8.2305	67.7408	3.0687	1.5684	57.8724	15.6758	73.5482	20,358	0.1131
360D IV	26.5855	0.0477	25.1961	6.8042	46.2972	2.4990	1.3918	45.5505	16.3351	61.8855	20,358	0.0935
EMC	30.413.0468	220.6539	16.568.9515	31,483.2270	991,193.584.5885	6.1073	2.2202	190,973.7530	2,328.2811	193,302.0341	20,358	432.4995
PX_LAST	52.2023	0.2714	44.3000	38.7167	1,498.9845	1.7364	1.1342	249.7780	1.5220	251.3000	20,358	0.5319
ELIQ	3,161,727.0448	45,633.0667	1,275,397.0000	6,510,992.7392	42,393,026,449,704.8000	270.7250	10.9794	272,493,319.0000	62,254.0000	272,555,573.0000	20,358	89,444.4854
STOXXMC	5,694,091.5043	3,015.4755	5,730,114.7100	430,252.4504	185,117,171,108.1810	36.7507	-3.3470	6,484,145.1800	84,146.9700	6,568,292.1500	20,358	5,910.5747
STOXXHV	16.3540	0.0842	13.5700	12.0157	144.3777	13.8124	3.1415	100.0700	3.1700	103.2400	20,358	0.1651
STOXXRT	0.0001	0.0015	0.0007	0.2154	0.0464	385.8877	-0.0159	8.5096	-4.2558	4.2538	20,358	0.0030
Bloomberg	1.0773	0.0009	1.0800	0.1243	0.0154	-0.0785	0.1574	0.6200	0.8000	1.4200	19,051	0.0018
MSCI	1.3968	0.0018	1.3333	0.2146	0.0460	2.6923	-0.9419	1.0000	0.6667	1.6667	14,356	0.0035
Refinitiv	1.3278	0.0031	1.3800	0.4061	0.1649	2.7857	-1.7129	1.7200	0.1400	1.8600	16,952	0.0061
Sustainalytics	1.5557	0.0018	1.6000	0.2603	0.0677	-0.9959	-0.2752	1.0600	0.9400	2.0000	20,358	0.0036
Overall	1.3167	0.0008	1.3350	0.1071	0.0115	0.5645	-0.5781	0.5394	0.9983	1.5378	20,358	0.0015
ESG	1.3167	0.0008	1.3350	0.1071	0.0115	0.5645	-0.5781	0.5394	0.9983	1.5378	20,358	0.0015

This table shows the descriptive statistics for Data Sample Rank 3. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of 1st return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.

Data Sample Rank 4												
	Mean	Standard Error	Median	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Minimum	Maximum	Count	Conf. Level (95.0%)
10D HV	30.9578	0.1150	27.0345	16.7194	279.5367	6.8000	2.0803	155.1650	5.5467	160.7117	21,141	0.2254
30D HV	32.7525	0.1210	28.6091	17.5881	309.3413	6.3140	2.0475	156.2388	8.6865	164.9253	21,141	0.2371
90D HV	33.3765	0.1088	29.8441	15.8266	250.4825	2.5464	1.4459	99.6119	10.6726	110.2845	21,141	0.2134
180D HV	33.3653	0.0995	29.9459	14.4688	209.3466	0.9098	1.0479	71.8450	12.3579	84.2029	21,141	0.1950
360D HV	30.8125	0.0761	28.4557	11.0666	122.4687	0.1719	0.7687	54.4186	13.5633	67.9819	21,141	0.1492
10D IV	31.9106	0.0916	28.9438	13.3180	177.3692	3.2391	1.4988	94.5017	10.9101	105.4118	21,141	0.1795
30D IV	30.8952	0.0853	28.0219	12.4064	153.9181	3.2355	1.4768	86.9911	11.2421	98.2332	21,141	0.1672
90D IV	30.0099	0.0731	27.7555	10.6355	113.1135	2.7356	1.3328	70.1582	13.2518	83.4100	21,141	0.1434
180D IV	29.3187	0.0649	27.5169	9.4352	89.0221	2.3475	1.2058	64.5544	14.2247	78.7791	21,141	0.1272
360D IV	28.5024	0.0573	27.1846	8.3375	69.5132	2.1119	1.1143	58.1185	14.8426	72.9611	21,141	0.1124
EMC	22,532.6370	247.2263	8,118.0126	35,946.5747	1,292,156,230.4657	12.2099	3.2913	257,558.3654	1,432.6252	258,990.9906	21,141	484.5825
PX_LAST	92.8788	0.8621	60.2000	125.3448	15,711.3241	12.0468	3.3060	883.7454	0.2546	884.0000	21,141	1.6897
ELIQ	2,285,223.1111	66,416.6884	513,912.0000	9,656,949.9516	93,256,682,368.227.2000	368.8542	13.6947	471,130,580.0000	6,336.0000	471,136,916.0000	21,141	130,181.7708
STOXXMC	5,694,091.5043	2,959.1038	5,730,114.7100	430,252.0590	185,116,834,311.0570	36.7504	-3.3470	6,484,145.1800	84,146.9700	6,568,292.1500	21,141	5,800.0689
STOXXHV	16.3540	0.0826	13.5700	12.0157	144.3774	13.8123	3.1415	100.0700	3.1700	103.2400	21,141	0.1620
STOXXRT	0.0001	0.0015	0.0007	0.2154	0.0464	385.8842	-0.0159	8.5096	-4.2558	4.2538	21,141	0.0029
Bloomberg	0.7841	0.0018	0.7800	0.2522	0.0636	-0.8247	0.0656	1.0200	0.2600	1.2800	19,310	0.0036
MSCI	0.9928	0.0041	1.3333	0.4471	0.1999	-0.6804	-0.7342	1.6667	0.0000	1.6667	11,747	0.0081
Refinitiv	1.1257	0.0036	1.1800	0.4875	0.2377	-0.4125	-0.7496	1.7000	0.1000	1.8000	18,260	0.0071
Sustainalytics	1.0506	0.0031	1.0200	0.4269	0.1822	-0.5884	0.0723	1.7800	0.1600	1.9400	19,575	0.0060
Overall	0.9825	0.0015	1.0333	0.2199	0.0484	0.0312	-0.6235	1.0467	0.4267	1.4733	21,141	0.0030
ESG	0.9825	0.0015	1.0333	0.2199	0.0484	0.0312	-0.6235	1.0467	0.4267	1.4733	21,141	0.0030

This table shows the descriptive statistics for Data Sample Rank 4. Hereby all dependent variables, independent variables and control variables are shown. Notice: PX\_Last was excluded in the regressions since, HV is a direct function of 1st return. Overall accounts for the individual average of ESG Ratings for each Equity, even though less than three Ratings are assigned. ESG is the average Rating for at least three assigned Ratings.



Table 11: Correlation Matrices for different Data Sample All;  
Source: Own Illustration, calculated in Excel

Data Sample All																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 10D HV	1.0000																				
2 30D HV	0.9956	1.0000																			
3 90D HV	0.7204	0.8107	1.0000																		
4 180D HV	0.5959	0.6511	0.8310	1.0000																	
5 360D HV	0.4711	0.5073	0.6294	0.7675	1.0000																
6 10D IV	0.8891	0.8535	0.7964	0.6421	0.5206	1.0000															
7 30D IV	0.8783	0.8581	0.7851	0.6810	0.5555	0.9388	1.0000														
8 90D IV	0.8466	0.8469	0.8048	0.7382	0.6085	0.9518	0.9766	1.0000													
9 180D IV	0.8170	0.8307	0.8167	0.7599	0.6934	0.9229	0.9528	0.9913	1.0000												
10 360D IV	0.7787	0.7982	0.7965	0.7528	0.6417	0.8849	0.9189	0.9687	0.9896	1.0000											
11 EMC	-0.1481	-0.1510	-0.1699	-0.1789	-0.1859	-0.1656	-0.1784	-0.1856	-0.1972	-0.2138	1.0000										
12 FX_LAST	-0.1146	-0.1147	-0.1159	-0.1141	-0.1232	-0.1537	-0.1538	-0.1480	-0.1457	-0.1470	0.4780	1.0000									
13 LIQ	0.0868	0.0869	0.0801	0.0693	0.0785	0.2082	0.2048	0.1825	0.1715	0.1718	-0.0142	-0.1851	1.0000								
14 STOXXMC	-0.4207	-0.3752	-0.2235	-0.1121	-0.0531	-0.4246	-0.3960	-0.3400	-0.2985	-0.2567	0.0503	0.0423	-0.0947	1.0000							
15 STOXXHV	0.5000	0.4079	0.2698	0.2023	0.1462	0.5270	0.4882	0.4229	0.3785	0.3383	-0.0410	-0.0254	0.0547	-0.6163	1.0000						
16 STOXXRT	0.0030	0.0031	0.0027	0.0023	0.0014	0.0028	0.0029	0.0029	0.0028	0.0025	0.0004	0.0004	-0.0013	0.3471	-0.0016	1.0000					
17 Bloomberg	-0.0200	-0.0270	-0.0267	-0.0310	-0.0475	0.0007	-0.0118	-0.0282	-0.0410	-0.0597	0.2800	0.0101	0.0609	-0.0035	0.0266	0.0001	1.0000				
18 MSCI	-0.0592	-0.0619	-0.0712	-0.0884	-0.1288	-0.0852	-0.0961	-0.1186	-0.1305	-0.1444	0.0707	0.0337	0.0648	-0.0024	0.0130	0.0000	0.2274	1.0000			
19 Refinitiv	-0.0181	-0.0188	-0.0093	-0.0048	0.0483	-0.0126	-0.0154	-0.0141	-0.0100	-0.0106	0.1020	-0.0400	0.1094	0.0097	-0.0169	0.0002	0.3436	0.1701	1.0000		
20 Sustainalytics	-0.1140	-0.1153	-0.1246	-0.1298	-0.1295	-0.1166	-0.1290	-0.1454	-0.1718	-0.1881	0.1524	-0.0268	0.0725	0.0012	-0.0050	0.0000	0.5655	0.5802	0.2165	1.0000	
21 ESG	-0.0940	-0.0967	-0.1019	-0.1059	-0.1114	-0.1035	-0.1168	-0.1440	-0.1625	-0.1834	0.1614	-0.0822	0.0538	0.0006	0.0101	0.0001	0.6749	0.7778	0.6064	0.8203	1.0000

This table shows the Correlation Matrix for Data Sample All. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Rated																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 10D HV	1.0000																				
2 30D HV	0.9953	1.0000																			
3 90D HV	0.7139	0.8056	1.0000																		
4 180D HV	0.5875	0.6441	0.8306	1.0000																	
5 360D HV	0.4477	0.4945	0.6095	0.7475	1.0000																
6 10D IV	0.8931	0.8562	0.7930	0.6387	0.5015	1.0000															
7 30D IV	0.8823	0.8614	0.7830	0.6795	0.5373	0.9380	1.0000														
8 90D IV	0.8513	0.8544	0.8042	0.7387	0.5892	0.9500	0.9758	1.0000													
9 180D IV	0.8197	0.8345	0.8174	0.7621	0.6140	0.9205	0.9518	0.9913	1.0000												
10 360D IV	0.7785	0.7968	0.7961	0.7554	0.6224	0.8818	0.9177	0.9689	0.9898	1.0000											
11 EMC	-0.1533	-0.1558	-0.1687	-0.1827	-0.1852	-0.1915	-0.2057	-0.2192	-0.2259	-0.2489	1.0000										
12 FX_LAST	-0.1119	-0.1117	-0.1119	-0.1093	-0.1171	-0.1611	-0.1637	-0.1552	-0.1527	-0.1537	0.4756	1.0000									
13 LIQ	0.0891	0.0890	0.0769	0.0651	0.0790	0.1988	0.2005	0.1794	0.1650	0.1683	-0.0506	-0.1839	1.0000								
14 STOXXMC	-0.4255	-0.3787	-0.2242	-0.1134	-0.0543	-0.4292	-0.4004	-0.3467	-0.3041	-0.2599	0.0546	0.0421	-0.0865	1.0000							
15 STOXXHV	0.5118	0.4179	0.2778	0.2102	0.1493	0.5375	0.4983	0.4357	0.3913	0.3509	-0.0447	-0.0249	0.0571	-0.6163	1.0000						
16 STOXXRT	0.0031	0.0032	0.0027	0.0023	0.0015	0.0029	0.0030	0.0030	0.0029	0.0026	0.0004	0.0004	-0.0012	0.3471	-0.0016	1.0000					
17 Bloomberg	-0.0592	-0.0646	-0.0700	-0.0802	-0.0935	-0.0580	-0.0727	-0.0948	-0.1116	-0.1345	0.2516	0.0043	0.0492	-0.0001	0.0109	0.0001	1.0000				
18 MSCI	-0.0592	-0.0619	-0.0712	-0.0884	-0.1288	-0.0852	-0.0961	-0.1186	-0.1305	-0.1444	0.0707	0.0337	0.0648	-0.0024	0.0130	0.0000	0.2274	1.0000			
19 Refinitiv	-0.0483	-0.0492	-0.0378	-0.0240	0.0813	-0.0362	-0.0391	-0.0362	-0.0409	-0.0400	0.0583	-0.0416	0.0606	0.0144	-0.0388	0.0002	0.2448	0.1701	1.0000		
20 Sustainalytics	-0.1035	-0.1050	-0.1134	-0.1178	-0.1184	-0.1060	-0.1176	-0.1425	-0.1577	-0.1790	0.1466	-0.0239	0.0702	0.0015	-0.0061	0.0000	0.5655	0.5802	0.2122	1.0000	
21 ESG	-0.0940	-0.0967	-0.1019	-0.1059	-0.1114	-0.1035	-0.1168	-0.1440	-0.1625	-0.1834	0.1614	-0.0822	0.0538	0.0006	0.0101	0.0001	0.6749	0.7778	0.6064	0.8203	1.0000

This table shows the Correlation Matrix for Data Sample Rated. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Unrated																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
1 10D HV	1.0000																						
2 30D HV	0.9369	1.0000																					
3 90D HV	0.7588	0.8401	1.0000																				
4 180D HV	0.6434	0.6886	0.8310	1.0000																			
5 360D HV	0.6153	0.6454	0.7511	0.8879	1.0000																		
6 10D IV	0.8786	0.8523	0.7741	0.6846	0.6715	1.0000																	
7 30D IV	0.8667	0.8523	0.7937	0.7102	0.6974	0.9936	1.0000																
8 90D IV	0.8314	0.8357	0.8222	0.7527	0.7469	0.9650	0.9827	1.0000															
9 180D IV	0.8179	0.8253	0.8292	0.7650	0.7631	0.9476	0.9675	0.9942	1.0000														
10 360D IV	0.8046	0.8110	0.8223	0.7620	0.7650	0.9308	0.9517	0.9836	0.9959	1.0000													
11 EMC	-0.3569	-0.3535	-0.3591	-0.2828	-0.2665	-0.3883	-0.3848	-0.3748	-0.3698	-0.3624	1.0000												
12 FX_LAST	-0.1639	-0.1650	-0.1748	-0.1652	-0.1710	-0.1719	-0.1659	-0.1668	-0.1667	-0.1711	0.4809	1.0000											
13 LIQ	0.1740	0.1674	0.1877	0.1886	0.2347	0.2932	0.2981	0.3141	0.3068	0.2984	-0.1237	-0.3009	1.0000										
14 STOXXMC	-0.3913	-0.3552	-0.2207	-0.1058	-0.0460	-0.3963	-0.3694	-0.3029	-0.2737	-0.2526	0.1976	0.0672	-0.0180	1.0000									
15 STOXXHV	0.4242	0.3451	0.2189	0.1541	0.1278	0.4596	0.4248	0.3489	0.3144	0.2903	-0.1320	-0.0478	0.0348	-0.6163	1.0000								
16 STOXXRT	0.0023	0.0025	0.0025	0.0019	0.0011	0.0023	0.0024	0.0022	0.0021	0.0011	0.0014	0.0007	-0.0035	0.3471	-0.0016	1.0000							
17 Bloomberg	0.2659	0.2722	0.3080	0.3486	0.3842	0.3364	0.3300	0.3397	0.3437	0.3426	-0.3692	-0.3849	0.1375	-0.0067	0.0714	0.0002	1.0000						
18 MSCI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0000					
19 Refinitiv	0.2237	0.2311	0.2560	0.2781	0.3010	0.3027	0.3001	0.3015	0.2941	0.2913	-0.2886	-0.4811	0.2789	-0.0066	0.0928	0.0002	0.8092	-	1.0000				
20 Sustainalytics	0.0645	0.0927	0.1735	0.5504	0.7047	0.1429	0.1552	0.1237	0.0707	-0.0260	-0.1831	-0.1831	-0.3187	-0.1222	0.5009	-0.0006	-	-	0.0000	1.0000			
21 ESG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0000		

This table shows the Correlation Matrix for Data Sample Unrated. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Rank 1																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
1 10D HV	1.0000																				
2 30D HV	0.9285	1.0000																			
3 90D HV	0.7183	0.8177	1.0000																		
4 180D HV	0.6128	0.6741	0.8569	1.0000																	
5 360D HV	0.5891	0.6423	0.8056	0.9567	1.0000																
6 10D IV	0.9115	0.8654	0.7665	0.6909	0.6832	1.0000															
7 30D IV	0.8981	0.8726	0.8008	0.7375	0.7297	0.9896	1.0000														
8 90D IV	0.8673	0.8696	0.8444	0.8027	0.7975	0.9555	0.9791	1.0000													
9 180D IV	0.8322	0.8480	0.8632	0.8317	0.8332	0.9249	0.9553	0.9911	1.0000												
10 360D IV	0.7915	0.8123	0.8467	0.8311	0.8468	0.8826	0.9187	0.9683	0.9894	1.0000											
11 EMC	-0.1506	-0.1469	-0.1609	-0.1781	-0.2273	-0.1964	-0.2119	-0.2225	-0.2333	-0.2493	1.0000										
12 PX_LAST	-0.0644	-0.0654	-0.0639	-0.0617	-0.0745	-0.1023	-0.1095	-0.1015	-0.0921	-0.0858	0.4614	1.0000									
13 LIQ	0.0632	0.0560	0.0584	0.0515	0.0581	0.1225	0.1207	0.1151	0.1122	0.1112	0.0658	-0.2700	1.0000								
14 STOXXMC	-0.4282	-0.3778	-0.2333	-0.1257	-0.0812	-0.4595	-0.4288	-0.3750	-0.3294	-0.2740	0.0511	0.0443	-0.0643	1.0000							
15 STOXXHV	0.5157	0.4121	0.2832	0.2280	0.2235	0.5729	0.5272	0.4600	0.4118	0.3597	-0.0326	-0.0247	0.1028	-0.6163	1.0000						
16 STOXXRT	0.0035	0.0033	0.0029	0.0025	0.0020	0.0029	0.0032	0.0032	0.0031	0.0028	0.0003	0.0000	-0.0080	0.3471	-0.0016	1.0000					
17 Bloomberg	0.0774	0.0675	0.0802	0.1025	0.1316	0.0839	0.0872	0.0830	0.0782	0.0652	-0.1334	-0.0144	0.1445	-0.0067	0.0437	0.0001	1.0000				
18 MSCI	-0.0395	-0.0405	-0.0396	-0.0406	-0.0524	-0.0568	-0.0518	-0.0462	-0.0464	-0.0510	0.2481	-0.0492	-0.1350	0.0118	-0.0301	0.0002	-0.2731	1.0000			
19 Refinitiv	-0.1619	-0.1591	-0.1980	-0.2230	-0.2100	-0.2003	-0.1950	-0.1938	-0.1864	-0.1707	0.1669	0.1063	-0.2198	0.0120	-0.0498	0.0001	-0.0593	-0.0174	1.0000		
20 Sustainalytics	-0.0671	-0.0651	-0.0809	-0.0994	-0.0729	-0.0638	-0.0657	-0.0527	-0.0399	-0.0360	0.0578	0.2075	-0.1507	0.0082	-0.0599	-0.0002	-0.2742	0.1917	0.1061	1.0000	
21 Overall	-0.0338	-0.0347	-0.0457	-0.0445	-0.0165	-0.0384	-0.0289	-0.0196	-0.0118	-0.0084	0.1558	0.0675	-0.1774	-0.0050	0.0281	0.0000	0.0861	0.4202	0.8238	0.3432	1.0000
21 ESG	-0.0338	-0.0347	-0.0457	-0.0445	-0.0165	-0.0384	-0.0289	-0.0196	-0.0118	-0.0084	0.1558	0.0675	-0.1774	-0.0050	0.0281	0.0000	0.0861	0.4202	0.8238	0.3432	1.0000

This table shows the Correlation Matrix for Data Sample Rank 1. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Rank 2																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
1 10D HV	1.0000																				
2 30D HV	0.9440	1.0000																			
3 90D HV	0.6479	0.7310	1.0000																		
4 180D HV	0.5152	0.5629	0.7798	1.0000																	
5 360D HV	0.2893	0.3080	0.4058	0.5374	1.0000																
6 10D IV	0.8667	0.8347	0.6349	0.5155	0.2929	1.0000															
7 30D IV	0.8586	0.8416	0.6678	0.5578	0.3266	0.9813	1.0000														
8 90D IV	0.8456	0.8513	0.7239	0.6240	0.3726	0.9413	0.9728	1.0000													
9 180D IV	0.8277	0.8421	0.7435	0.6520	0.3959	0.9140	0.9487	0.9900	1.0000												
10 360D IV	0.7938	0.8115	0.7268	0.6470	0.4080	0.8762	0.9154	0.9657	0.9877	1.0000											
11 EMC	-0.2035	-0.2062	-0.2254	-0.2493	-0.1646	-0.2410	-0.2554	-0.2626	-0.2803	-0.2999	1.0000										
12 PX_LAST	-0.1316	-0.1277	-0.1094	-0.0930	-0.0956	-0.2307	-0.2349	-0.2219	-0.2209	-0.2291	0.3245	1.0000									
13 LIQ	0.1142	0.1090	0.0849	0.0630	0.0512	0.2618	0.2746	0.2426	0.2263	0.2354	-0.0664	-0.2935	1.0000								
14 STOXXMC	-0.4321	-0.3841	-0.1957	-0.0803	-0.0254	-0.4166	-0.3886	-0.3453	-0.3078	-0.2669	0.0639	0.0480	-0.0395	1.0000							
15 STOXXHV	0.5237	0.4327	0.2482	0.1607	0.0558	0.5294	0.4919	0.4292	0.3900	0.3502	-0.0578	-0.0300	0.0576	-0.6163	1.0000						
16 STOXXRT	0.0031	0.0034	0.0027	0.0021	0.0009	0.0030	0.0030	0.0031	0.0031	0.0029	0.0005	0.0006	-0.0008	0.3471	-0.0016	1.0000					
17 Bloomberg	0.0200	0.0136	0.0377	-0.0075	-0.0191	0.0837	0.0527	0.0464	0.0469	0.0322	-0.3603	-0.1599	0.1042	0.0009	0.0018	0.0000	1.0000				
18 MSCI	-0.0057	-0.0040	-0.0417	-0.1252	-0.2036	0.0274	0.0159	0.0134	0.0089	0.0036	-0.1072	0.1695	-0.0083	0.0002	0.0386	0.0003	-0.2088	1.0000			
19 Refinitiv	0.1025	0.1121	0.1326	0.1666	0.2086	0.1022	0.1229	0.1470	0.1549	0.1718	-0.0476	-0.1092	0.0852	0.0072	-0.0171	0.0001	-0.1965	-0.3723	1.0000		
20 Sustainalytics	-0.0511	-0.0494	-0.0602	-0.0626	-0.1294	-0.0448	-0.0392	-0.0640	-0.0758	-0.0733	0.0881	-0.1010	0.0869	0.0006	0.0011	0.0000	-0.0102	-0.3646	0.0188	1.0000	
21 ESG	0.0753	0.0794	0.0779	0.0666	-0.0425	0.0918	0.0777	0.0943	0.0934	0.0815	-0.0236	0.0136	-0.1059	-0.0097	0.0736	0.0002	-0.0388	0.1764	0.6966	0.2297	1.0000

This table shows the Correlation Matrix for Data Sample Rank 2. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Rank 3																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
1 10D HV	1.0000																				
2 30D HV	0.9415	1.0000																			
3 90D HV	0.7474	0.8381	1.0000																		
4 180D HV	0.6194	0.6790	0.8589	1.0000																	
5 360D HV	0.6040	0.6583	0.8180	0.9655	1.0000																
6 10D IV	0.9296	0.8890	0.7721	0.6846	0.6741	1.0000															
7 30D IV	0.9208	0.8980	0.8065	0.7294	0.7176	0.9912	1.0000														
8 90D IV	0.8901	0.8903	0.8473	0.7913	0.7807	0.9604	0.9823	1.0000													
9 180D IV	0.8609	0.8737	0.8640	0.8168	0.8095	0.9350	0.9628	0.9928	1.0000												
10 360D IV	0.8205	0.8375	0.8441	0.8128	0.8168	0.8999	0.9310	0.9699	0.9883	1.0000											
11 EMC	-0.1097	-0.1098	-0.1124	-0.1149	-0.1483	-0.1383	-0.1469	-0.1469	-0.1603	-0.1862	1.0000										
12 PX_LAST	-0.2179	-0.2186	-0.2314	-0.2422	-0.2962	-0.2753	-0.2759	-0.2805	-0.2924	-0.3178	0.4498	1.0000									
13 LIQ	0.1647	0.1435	0.1212	0.1159	0.1624	0.2527	0.2355	0.2264	0.2292	0.2401	-0.0250	-0.3278	1.0000								
14 STOXXMC	-0.4460	-0.3995	-0.2471	-0.1302	-0.0798	-0.4553	-0.4321	-0.3813	-0.3428	-0.3042	0.0755	0.0881	-0.0734	1.0000							
15 STOXXHV	0.5443	0.4439	0.3049	0.2429	0.2360	0.5746	0.5421	0.4848	0.4450	0.4127	-0.0820	-0.0955	0.1028	-0.6163	1.0000						
16 STOXXRT	0.0033	0.0032	0.0029	0.0026	0.0022	0.0030	0.0031	0.0033	0.0032	0.0030	0.0003	0.0005	-0.0032	0.3471	-0.0016	1.0000					
17 Bloomberg	0.0272	0.0324	0.0337	0.0295	0.0401	0.0281	0.0462	0.0469	0.0392	0.0291	-0.0112	0.0524	-0.1035	0.0004	0.0069	0.0001	1.0000				
18 MSCI	-0.0044	-0.0013	0.0018	0.0015	-0.0197	-0.0056	-0.0228	-0.0303	-0.0174	0.0062	0.0165	-0.1590	-0.0373	-0.0061	-0.0021	-0.0003	-0.6116	1.0000			
19 Refinitiv	0.1286	0.1332	0.1463	0.1471	0.1685	0.1345	0.1480	0.1736	0.1813	0.1848	0.1759	-0.0311	0.1249	0.0143	-0.0090	0.0004	0.0519	-0.2254	1.0000		
20 Sustainalytics	-0.1721	-0.1758	-0.2123	-0.2457	-0.2719	-0.1417	-0.1504	-0.1620	-0.1669	-0.1659	0.0680	0.3078	-0.1068	0.0178	-0.0954	-0.0001	0.0660	-0.0414	-0.2665	1.0000	
21 ESG	-0.1153	-0.1080	-0.1248	-0.1459	-0.1562	-0.1074	-0.1112	-0.1223	-0.1266	-0.1258	-0.1370	0.0749	-0.0520	0.0156	-0.0429	0.0002	-0.1389	0.1462	0.6751	0.3683	1.0000

This table shows the Correlation Matrix for Data Sample Rank 3. Hereby all dependent variables, independent variables and control variables are shown.

Data Sample Rank 4																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
1 10D HV	1.0000																				
2 30D HV	0.9267	1.0000																			
3 90D HV	0.7291	0.8266	1.0000																		
4 180D HV	0.5972	0.6589	0.8321	1.0000																	
5 360D HV	0.5461	0.5960	0.7420	0.9058	1.0000																
6 10D IV	0.8691	0.8388	0.7558	0.6716	0.6504	1.0000															
7 30D IV	0.8544	0.8354	0.7728	0.6999	0.6797	0.9913	1.0000														
8 90D IV	0.8099	0.8139	0.8009	0.7474	0.7359	0.9499	0.9718	1.0000													
9 180D IV	0.7708	0.7877	0.8063	0.7650	0.7609	0.9179	0.9454	0.9913	1.0000												
10 360D IV	0.7289	0.7480	0.7830	0.7559	0.7649	0.8822	0.9132	0.9722	0.9917	1.0000											
11 EMC	-0.1354	-0.1453	-0.1595	-0.1697	-0.2203	-0.1708	-0.1853	-0.1919	-0.1998	-0.2089	1.0000										
12 PX_LAST	-0.1615	-0.1659	-0.1786	-0.1814	-0.2127	-0.1967	-0.2032	-0.2024	-0.2045	-0.2059	0.6419	1.0000									
13 LIQ	-0.1790	-0.1627	-0.1738	-0.1619	-0.1551	-0.2838	-0.3012	-0.2916	-0.2834	-0.2743	-0.0768	-0.1390	1.0000								
14 STOXXMC	-0.4085	-0.3652	-0.2286	-0.1266	-0.0745	-0.4036	-0.3737	-0.3138	-0.2689	-0.2305	-0.0392	-0.0366	-0.0188	1.0000							
15 STOXXHV	0.4797	0.3970	0.2843	0.2253	0.2153	0.4962	0.4593	0.4032	0.3581	0.3265	-0.0206	-0.0091	0.0468	-0.6163	1.0000						
16 STOXXRT	0.0026	0.0029	0.0026	0.0023	0.0017	0.0027	0.0027	0.0026	0.0025	0.0022	0.0005	0.0006	0.0033	0.3471	-0.0016	1.0000					
17 Bloomberg	-0.0488	-0.0534	-0.0599	-0.0755	-0.1138	-0.0354	-0.0426	-0.0497	-0.0576	-0.0668	0.4469	0.1549	-0.0323	0.0040	0.0083	0.0002	1.0000				
18 MSCI	0.0959	0.0974	0.1269	0.1565	0.1447	0.0519	0.0662	0.0706	0.0815	0.0821	0.0231	0.0901	-0.0942	-0.0085	0.0570	0.0001	-0.3107	1.0000			
19 Refinitiv	-0.0187	-0.0269	-0.0163	0.0033	0.0290	0.0464	0.0470	0.0348	0.0254	0.0212	-0.1328	-0.0977	0.2075	0.0146	-0.0329	0.0003	0.1489	-0.1569	1.0000		
20 Sustainalytics	0.0190	0.0220	0.0314	0.0495	0.0330	-0.0083	-0.0052	-0.0040	-0.0092	-0.0213	0.1869	0.0732	-0.0464	-0.0081	0.0536	0.0001	0.3239	0.2699	-0.0173	1.0000	
21 ESG	0.0078	0.0038	0.0153	0.0348	0.0149	0.0140	0.0159	0.0037	-0.0061	-0.0211	0.1611	0.0710	0.0956	0.0029	0.0223	0.0003	0.5011	0.5433	0.5763	0.6999	1.0000

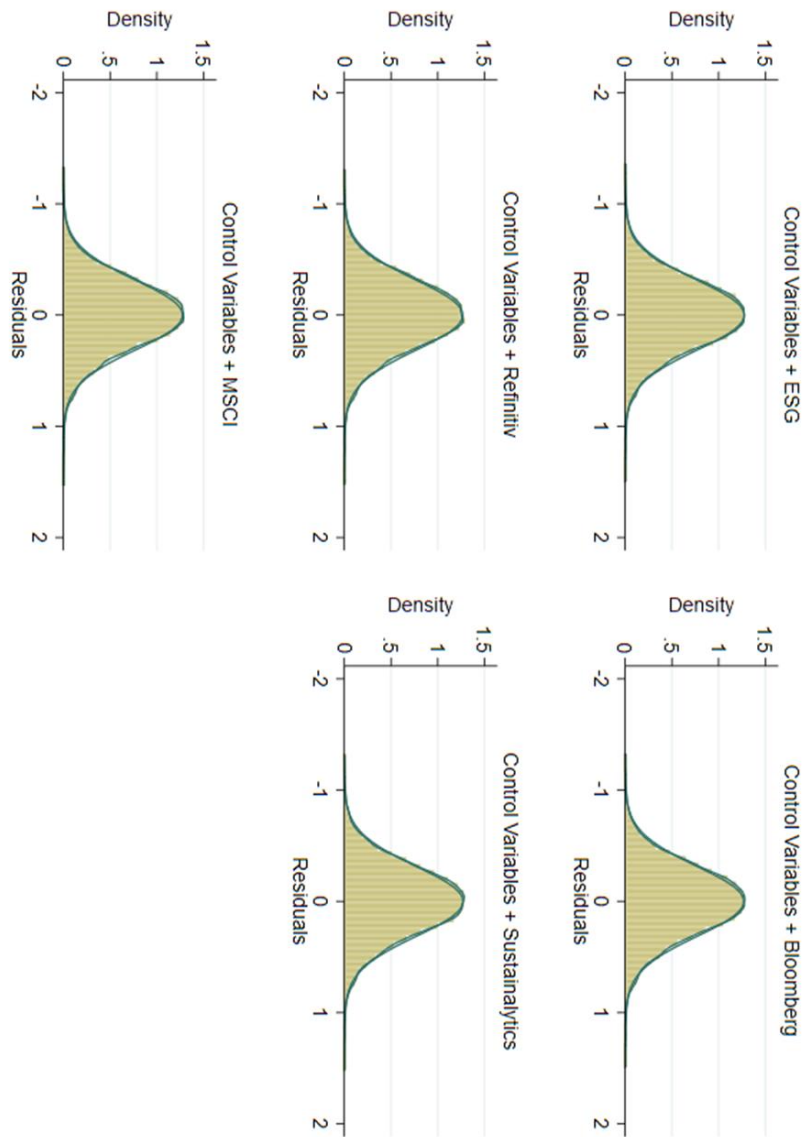
This table shows the Correlation Matrix for Data Sample Rank 4. Hereby all dependent variables, independent variables and control variables are shown.

Table 12: Variance Test;  
Source: Own Illustration, calculated in Excel

Ticker	Company Name	ESG 2018	ESG 2019	ESG 2020	Absolute ESG Change	Variance
MC FP Equity	LVMH Moet Hennessy Louis Vuitton SE	1.05	1.47	1.09	0.8022	0.036024
SY1 GY Equity	Symrise AG	1.37	1.08	1.54	0.7444	0.035393
OR FP Equity	L'Oreal SA	1.65	1.66	1.65	0.0217	0.000038
SIE GY Equity	Siemens AG	1.70	1.71	1.69	0.0213	0.000025
WAF GY Equity	Siltronic AG	-	-	-	0.0000	0.000000

This table shows the variance in five equities of the data sample. Thereby two equities (MC FP Equity, SY1 GY Equity) with high absolute ESG Rating changes between 2018-2020 are considered, as well as two equities (OR FP Equity, SIE GY Equity) with low absolute ESG Rating

Figure 4: Asymptotic Normal Distribution of Regression Residuals,  
Source: Stata



*Table 13: Robustness Tests;  
Source: Own Illustration, calculated in Stata*

Dependent Variable		10D HV									
<b>VIF</b>	<b>Independent Variables</b>										
	<b>ESG</b>	1.21	1.00								
	<b>Bloomberg</b>			1.11	1.00						
	<b>Refinitiv</b>					1.02	1.00				
	<b>Sustainalytics</b>							1.16	1.00		
	<b>MSCI</b>									1.00	1.00
	<b>Control Variables</b>										
	<b>EMC</b>	1.24		1.18		1.11		1.21		1.11	
	<b>ELIQ</b>	1.15		1.13		1.12		1.13		1.11	
	<b>STOXXMC</b>	1.94		1.94		1.94		1.94		1.94	
	<b>STOXXHV</b>	1.13		1.13		1.13		1.13		1.13	
<b>STOXXRT</b>	1.82		1.82		1.82		1.82		1.82		
<b>Jarque Bera</b>	<b>P-Value</b>	1.e-159	0.00000	4.e-160	0.00000	5.e-151	0.00000	4.e-167	0.00000	3.e-180	0.00000
<b>Breusch-Pagan</b>	<b>P-Value</b>	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4507

This table shows the calculated robustness tests VIF, Jarque Bera, Breusch-Pagan for the regression on dependent variable 10D HV. As stated in chapter 5, the VIF values do not exceed 1.94. The Jarque Bera p-values are very close to zero, if not exactly zero, what implies not-normality. The Breusch-Pagan p-values are exactly zero for most regressions, this states for heteroscedasticity in the data sample.



Dependent Variables	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	
ESG	-0.127*** (0.00358)	-0.119*** (0.00348)	-0.127*** (0.00337)	-0.128*** (0.00312)	-0.129*** (0.00297)	-0.0976*** (0.00398)	-0.103*** (0.00393)	-0.108*** (0.00373)	-0.109*** (0.00358)	-0.110*** (0.00342)	-0.0113*** (0.00131)	-0.001*** (0.00120)	-0.0067*** (0.00122)	-0.0071*** (0.00114)	-0.0852*** (0.00250)	-0.0515*** (0.00241)	-0.0586*** (0.00228)	-0.0599*** (0.00219)	-0.0589*** (0.00209)	-0.0747*** (0.00250)	-0.0773*** (0.00231)	-0.0952*** (0.00250)	-0.0952*** (0.00241)	-0.0973*** (0.00228)	-0.0984*** (0.00219)	-0.0843*** (0.00209)
Bloomberg																										
Realtivity																										
Standardlytics																										
MSCI																										
Constant	3.347*** (0.00179)	3.311*** (0.00172)	3.294*** (0.00150)	3.283*** (0.00146)	3.265*** (0.00136)	3.114*** (0.00130)	3.283*** (0.00118)	3.261*** (0.00105)	3.247*** (0.00097)	3.228*** (0.00088)	3.190*** (0.00129)	3.287*** (0.00112)	3.266*** (0.00110)	3.251*** (0.00102)	3.232*** (0.00092)	3.337*** (0.00081)	3.307*** (0.00175)	3.288*** (0.00160)	3.276*** (0.00150)	3.258*** (0.00140)	3.239*** (0.00130)	3.288*** (0.00120)	3.267*** (0.00107)	3.251*** (0.00099)	3.234*** (0.00091)	3.214*** (0.00082)
Observations	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536
R <sup>2</sup>	0.005	0.007	0.011	0.014	0.019	0.003	0.004	0.007	0.009	0.012	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	0.004	0.006	0.006	0.007
Adj. R <sup>2</sup>	0.00531	0.00653	0.00805	0.01039	0.01385	0.00292	0.00410	0.00674	0.00904	0.01233	0.00242	0.00229	0.00228	0.00221	0.00169	0.00212	0.00229	0.00228	0.00221	0.00169	0.00415	0.00433	0.00557	0.00607	0.00662	0.00662
ESG	-0.112*** (0.00503)	-0.119*** (0.00482)	-0.135*** (0.00432)	-0.143*** (0.00400)	-0.152*** (0.00368)	-0.0970*** (0.00523)	-0.0979*** (0.00507)	-0.112*** (0.00457)	-0.120*** (0.00423)	-0.129*** (0.00389)	-0.0338*** (0.00221)	-0.0313*** (0.00210)	-0.0280*** (0.00189)	-0.0258*** (0.00174)	-0.0234*** (0.00155)	-0.0656*** (0.00351)	-0.0683*** (0.00338)	-0.0766*** (0.00308)	-0.0806*** (0.00288)	-0.0844*** (0.00268)	-0.0844*** (0.00258)	-0.0790*** (0.00313)	-0.0762*** (0.00301)	-0.0727*** (0.00284)	-0.0686*** (0.00268)	-0.0646*** (0.00250)
Bloomberg																										
Realtivity																										
Standardlytics																										
MSCI																										
Constant	3.407*** (0.105)	1.999*** (0.108)	1.475*** (0.118)	1.853*** (0.123)	1.333*** (0.122)	2.427*** (0.106)	2.013*** (0.109)	1.490*** (0.119)	1.607*** (0.123)	1.348*** (0.123)	2.523*** (0.107)	2.131*** (0.109)	1.603*** (0.119)	1.481*** (0.123)	1.460*** (0.122)	2.460*** (0.106)	2.052*** (0.109)	1.529*** (0.118)	1.406*** (0.123)	1.388*** (0.122)	2.498*** (0.106)	2.088*** (0.109)	1.572*** (0.119)	1.451*** (0.123)	1.433*** (0.123)	
Observations	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536
R <sup>2</sup>	0.569	0.549	0.485	0.438	0.393	0.567	0.547	0.482	0.436	0.390	0.564	0.544	0.477	0.429	0.382	0.566	0.546	0.481	0.434	0.388	0.572	0.551	0.480	0.439	0.393	
Adj. R <sup>2</sup>	0.569	0.549	0.485	0.438	0.393	0.567	0.547	0.482	0.436	0.390	0.564	0.544	0.477	0.429	0.382	0.566	0.546	0.481	0.434	0.388	0.572	0.551	0.480	0.439	0.393	
ESG																										
Bloomberg																										
Realtivity																										
Standardlytics																										
MSCI																										
Constant	2.407*** (0.105)	1.999*** (0.108)	1.475*** (0.118)	1.853*** (0.123)	1.333*** (0.122)	2.427*** (0.106)	2.013*** (0.109)	1.490*** (0.119)	1.607*** (0.123)	1.348*** (0.123)	2.523*** (0.107)	2.131*** (0.109)	1.603*** (0.119)	1.481*** (0.123)	1.460*** (0.122)	2.460*** (0.106)	2.052*** (0.109)	1.529*** (0.118)	1.406*** (0.123)	1.388*** (0.122)	2.498*** (0.106)	2.088*** (0.109)	1.572*** (0.119)	1.451*** (0.123)	1.433*** (0.123)	
Observations	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536	95,536
R <sup>2</sup>	0.569	0.549	0.485	0.438	0.393	0.567	0.547	0.482	0.436	0.390	0.564	0.544	0.477	0.429	0.382	0.566	0.546	0.481	0.434	0.388	0.572	0.551	0.480	0.439	0.393	
Adj. R <sup>2</sup>	0.569	0.549	0.485	0.438	0.393	0.567	0.547	0.482	0.436	0.390	0.564	0.544	0.477	0.429	0.382	0.566	0.546	0.481	0.434	0.388	0.572	0.551	0.480	0.439	0.393	

Independent Variables	10D HV	30D HV	90D HV	180D HV	360D HV	10D HV	30D HV	90D HV	180D HV	360D HV	10D HV	30D HV	90D HV	180D HV	360D HV	10D HV	30D HV	90D HV	180D HV	360D HV	10D HV	30D HV	90D HV	180D HV	360D HV		
ESG	-0.167*** (0.0096)	-0.149*** (0.0096)	-0.147*** (0.00507)	-0.119*** (0.00838)	-0.119*** (0.00438)	-0.068*** (0.00535)	-0.0667*** (0.00525)	-0.0696*** (0.00557)	-0.052*** (0.00524)	-0.0485*** (0.00460)	-0.016*** (0.00171)	-0.003*** (0.00178)	-0.0162*** (0.00196)	-0.0161*** (0.00200)	0.0023 (0.00172)	-0.0862*** (0.00373)	-0.0892*** (0.00571)	-0.0857*** (0.00387)	-0.0714*** (0.00380)	-0.0731*** (0.00238)	-0.113*** (0.00713)	-0.116*** (0.00571)	-0.120*** (0.00380)	-0.128*** (0.00387)	-0.138*** (0.00481)	-0.138*** (0.00517)	
Bloomberg																											
ReidIn																											
Standardlytics																											
MSCI																											
Constant	3.287*** (0.00211)	3.432*** (0.00271)	3.374*** (0.00230)	3.380*** (0.00217)	3.339*** (0.00188)	3.234*** (0.00150)	3.287*** (0.00155)	3.329*** (0.00177)	3.329*** (0.00142)	3.274*** (0.00123)	3.241*** (0.00164)	3.294*** (0.00166)	3.327*** (0.00150)	3.345*** (0.00150)	3.279*** (0.00138)	3.279*** (0.00253)	3.334*** (0.00253)	3.369*** (0.00212)	3.376*** (0.00235)	3.324*** (0.00201)	3.324*** (0.00159)	3.324*** (0.00159)	3.327*** (0.00159)	3.337*** (0.00159)	3.336*** (0.00145)	3.324*** (0.00127)	
Observations	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	
R <sup>2</sup>	0.01	0.012	0.013	0.012	0.017	0.004	0.006	0.007	0.008	0.013	0.004	0.005	0.007	0.008	0.013	0.004	0.005	0.007	0.008	0.013	0.004	0.005	0.007	0.008	0.013	0.006	
Adj. R <sup>2</sup>	0.0108	0.0124	0.0129	0.0122	0.0167	0.00422	0.00561	0.00658	0.00752	0.0125	0.00355	0.00340	0.00388	0.00433	0.006325	0.00355	0.00340	0.00388	0.00433	0.006325	0.00355	0.00340	0.00388	0.00433	0.006325	0.00589	
ESG	-0.190*** (0.0064)	-0.210*** (0.00638)	-0.196*** (0.00640)	-0.183*** (0.00833)	-0.187*** (0.00500)	-0.116*** (0.00640)	-0.113*** (0.00624)	-0.136*** (0.00588)	-0.140*** (0.00570)	-0.158*** (0.00500)	-0.045*** (0.00272)	-0.042*** (0.00276)	-0.0425*** (0.00267)	-0.0382*** (0.00250)	-0.0111*** (0.00223)	-0.112*** (0.00487)	-0.119*** (0.00479)	-0.123*** (0.00462)	-0.117*** (0.00450)	-0.118*** (0.00381)	-0.128*** (0.00381)	-0.128*** (0.00253)	-0.128*** (0.00253)	-0.128*** (0.00253)	-0.128*** (0.00253)	-0.128*** (0.00253)	
Bloomberg																											
ReidIn																											
Standardlytics																											
MSCI																											
Constant	3.244*** (0.152)	1.639*** (0.155)	-0.575** (0.251)	-1.758*** (0.344)	-1.282*** (0.309)	2.286*** (0.153)	1.672*** (0.150)	-0.433** (0.250)	-1.772*** (0.344)	-1.259*** (0.308)	2.285*** (0.153)	1.722*** (0.150)	-0.440** (0.249)	-1.642*** (0.342)	-1.198*** (0.308)	2.284*** (0.152)	1.699*** (0.155)	-0.530** (0.250)	-1.723*** (0.343)	-1.288*** (0.308)	2.284*** (0.153)	1.706*** (0.157)	-0.471** (0.251)	-1.672*** (0.344)	-1.198*** (0.309)		
Observations	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	
R <sup>2</sup>	0.546	0.511	0.580	0.315	0.273	0.540	0.505	0.574	0.310	0.285	0.539	0.504	0.574	0.311	0.267	0.544	0.509	0.579	0.314	0.272	0.546	0.511	0.581	0.318	0.278		
Adj. R <sup>2</sup>	0.546	0.511	0.580	0.315	0.273	0.540	0.505	0.574	0.310	0.285	0.539	0.504	0.574	0.311	0.267	0.544	0.509	0.579	0.314	0.272	0.546	0.511	0.581	0.318	0.278		
ESG																											
Bloomberg																											
ReidIn																											
Standardlytics																											
MSCI																											
Constant																											
Observations	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	83,791	
R <sup>2</sup>	0.546	0.511	0.580	0.315	0.273	0.540	0.505	0.574	0.310	0.285	0.539	0.504	0.574	0.311	0.267	0.544	0.509	0.579	0.314	0.272	0.546	0.511	0.581	0.318	0.278		
Adj. R <sup>2</sup>	0.546	0.511	0.580	0.315	0.273	0.540	0.505	0.574	0.310	0.285	0.539	0.504	0.574	0.311	0.267	0.544	0.509	0.579	0.314	0.272	0.546	0.511	0.581	0.318	0.278		



Dependent Variables	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV
ESG	-0.161*** (0.00370)	-0.158*** (0.00338)	-0.163*** (0.00356)	-0.161*** (0.00319)	-0.158*** (0.00303)	-0.028*** (0.00392)	-0.0562*** (0.00387)	-0.0644*** (0.00365)	-0.0670*** (0.00351)	-0.0709*** (0.00336)	-0.0417*** (0.00133)	-0.0315*** (0.00130)	-0.0125*** (0.00125)	-0.0112*** (0.00112)	-0.0101*** (0.00113)	-0.0813*** (0.00271)	-0.0794*** (0.00265)	-0.0824*** (0.00251)	-0.0813*** (0.00241)	-0.0793*** (0.00210)	2.789*** (0.107)	2.882*** (0.111)	1.911*** (0.123)	1.772*** (0.127)	1.721*** (0.126)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	3.367*** (0.00177)	3.366*** (0.00190)	3.317*** (0.00170)	3.303*** (0.00150)	3.283*** (0.00143)	3.322*** (0.00129)	3.290*** (0.00122)	3.267*** (0.00109)	3.252*** (0.00099)	3.231*** (0.00089)	3.328*** (0.00155)	3.295*** (0.00138)	3.272*** (0.00114)	3.256*** (0.00104)	3.238*** (0.00091)	3.360*** (0.00206)	3.329*** (0.00199)	3.308*** (0.00181)	3.293*** (0.00168)	3.273*** (0.00155)	3.329*** (0.00131)	3.297*** (0.00125)	3.274*** (0.00111)	3.259*** (0.00101)	3.238*** (0.00091)
Observations	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781
R <sup>2</sup>	0.012	0.014	0.020	0.025	0.031	0.003	0.005	0.008	0.011	0.016	0.006	0.006	0.008	0.008	0.009	0.009	0.011	0.015	0.018	0.022	0.006	0.006	0.008	0.008	0.009
Adj. R <sup>2</sup>	0.0117	0.0137	0.0200	0.0251	0.0314	0.0034	0.00842	0.00812	0.0111	0.0157	0.00567	0.00592	0.00756	0.00824	0.00901	0.00950	0.01016	0.0151	0.0184	0.0224	0.00567	0.00592	0.00756	0.00824	0.00901
ESG	-0.164*** (0.00351)	-0.168*** (0.00359)	-0.181*** (0.00435)	-0.185*** (0.00418)	-0.187*** (0.00381)	-0.0861*** (0.00323)	-0.0971*** (0.00307)	-0.112*** (0.00427)	-0.120*** (0.00389)	-0.128*** (0.00359)	-0.037*** (0.00223)	-0.0343*** (0.00213)	-0.0304*** (0.00192)	-0.0274*** (0.00176)	-0.0277*** (0.00150)	-0.0959*** (0.00385)	-0.0973*** (0.00372)	-0.103*** (0.00340)	-0.104*** (0.00317)	-0.104*** (0.00293)	-0.0999*** (0.00385)	-0.0981*** (0.00372)	-0.0952*** (0.00340)	-0.0925*** (0.00317)	-0.0899*** (0.00293)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	3.367*** (0.00177)	3.366*** (0.00190)	3.317*** (0.00170)	3.303*** (0.00150)	3.283*** (0.00143)	3.322*** (0.00129)	3.290*** (0.00122)	3.267*** (0.00109)	3.252*** (0.00099)	3.231*** (0.00089)	3.328*** (0.00155)	3.295*** (0.00138)	3.272*** (0.00114)	3.256*** (0.00104)	3.238*** (0.00091)	3.360*** (0.00206)	3.329*** (0.00199)	3.308*** (0.00181)	3.293*** (0.00168)	3.273*** (0.00155)	3.329*** (0.00131)	3.297*** (0.00125)	3.274*** (0.00111)	3.259*** (0.00101)	3.238*** (0.00091)
Observations	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781
R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
Adj. R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
ESG	-0.104*** (0.00387)	-0.103*** (0.00379)	-0.093*** (0.00353)	-0.087*** (0.00329)	-0.086*** (0.00314)	-0.108*** (0.00389)	-0.108*** (0.00381)	-0.097*** (0.00354)	-0.093*** (0.00345)	-0.090*** (0.00329)	-0.113*** (0.00375)	-0.113*** (0.00361)	-0.103*** (0.00331)	-0.098*** (0.00318)	-0.096*** (0.00303)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	2.675*** (0.106)	2.269*** (0.110)	1.795*** (0.121)	1.656*** (0.125)	1.677*** (0.125)	2.722*** (0.109)	2.341*** (0.112)	1.829*** (0.122)	1.688*** (0.122)	1.639*** (0.126)	2.288*** (0.109)	2.408*** (0.112)	1.936*** (0.122)	1.796*** (0.127)	1.751*** (0.125)	2.273*** (0.107)	2.227*** (0.110)	1.855*** (0.120)	1.715*** (0.126)	1.676*** (0.125)	-0.0416*** (0.00354)	-0.0403*** (0.00353)	-0.0388*** (0.00319)	-0.0367*** (0.00297)	-0.0346*** (0.00269)
Observations	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781
R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
Adj. R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
ESG	-0.104*** (0.00387)	-0.103*** (0.00379)	-0.093*** (0.00353)	-0.087*** (0.00329)	-0.086*** (0.00314)	-0.108*** (0.00389)	-0.108*** (0.00381)	-0.097*** (0.00354)	-0.093*** (0.00345)	-0.090*** (0.00329)	-0.113*** (0.00375)	-0.113*** (0.00361)	-0.103*** (0.00331)	-0.098*** (0.00318)	-0.096*** (0.00303)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	2.675*** (0.106)	2.269*** (0.110)	1.795*** (0.121)	1.656*** (0.125)	1.677*** (0.125)	2.722*** (0.109)	2.341*** (0.112)	1.829*** (0.122)	1.688*** (0.122)	1.639*** (0.126)	2.288*** (0.109)	2.408*** (0.112)	1.936*** (0.122)	1.796*** (0.127)	1.751*** (0.125)	2.273*** (0.107)	2.227*** (0.110)	1.855*** (0.120)	1.715*** (0.126)	1.676*** (0.125)	-0.0416*** (0.00354)	-0.0403*** (0.00353)	-0.0388*** (0.00319)	-0.0367*** (0.00297)	-0.0346*** (0.00269)
Observations	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781	83,781
R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
Adj. R <sup>2</sup>	0.597	0.581	0.522	0.478	0.424	0.288	0.271	0.260	0.246	0.217	0.287	0.270	0.287	0.301	0.314	0.293	0.276	0.256	0.271	0.225	0.298	0.282	0.251	0.245	0.230
ESG	-0.104*** (0.00387)	-0.103*** (0.00379)	-0.093*** (0.00353)	-0.087*** (0.00329)	-0.086*** (0.00314)	-0.108*** (0.00389)	-0.108*** (0.00381)	-0.097*** (0.00354)	-0.093*** (0.00345)	-0.090*** (0.00329)	-0.113*** (0.00375)	-0.113*** (0.00361)	-0.103*** (0.00331)	-0.098*** (0.00318)	-0.096*** (0.00303)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)	-0.107*** (0.00389)	-0.107*** (0.00381)	-0.096*** (0.00352)	-0.092*** (0.00337)	-0.091*** (0.00322)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	2.675*** (0.106)	2.269*** (0.110)	1.795*** (0.121)	1.656*** (0.125)	1.677*** (0.125)	2.722*** (0.109)	2.341*** (0.112)	1.829*** (0.122)	1.688*** (0.122)	1.639*** (0.126)	2.288*** (0.109)	2.408*** (0.112)	1.936*** (0.122)	1.796*** (0.127)											



Data Sample Rank 1

Dependent Variables	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	
ESG	-0.0768*** (0.0243)	0.0654 (0.0218)	0.085*** (0.0221)	0.06*** (0.0210)	0.126*** (0.0193)	0.00956 (0.0128)	-0.000612 (0.0128)	-0.007 (0.0122)	-0.0389*** (0.0117)	-0.0724*** (0.0110)	-0.0641*** (0.0108)	-0.0610*** (0.0108)	-0.0596*** (0.00818)	-0.0515*** (0.00758)	-0.0439*** (0.00739)	0.346*** (0.0211)	0.236*** (0.0208)	0.238*** (0.0201)	0.244*** (0.0195)	0.216*** (0.0185)	0.146*** (0.0161)	0.177*** (0.0157)	0.166*** (0.0147)	0.150*** (0.0142)	0.132*** (0.0136)	
Bloomberg																										
ReidIn																										
Standardlytics																										
MSCI																										
Constant	3.356*** (0.0199)	3.294*** (0.0189)	3.243*** (0.0166)	3.200*** (0.0151)	3.181*** (0.0131)	3.256*** (0.00390)	3.210*** (0.00360)	3.195*** (0.00353)	3.188*** (0.00292)	3.171*** (0.00253)	3.299*** (0.00344)	3.288*** (0.00336)	3.245*** (0.00290)	3.224*** (0.00264)	3.197*** (0.00211)	3.409*** (0.0236)	3.375*** (0.0225)	3.376*** (0.0209)	3.398*** (0.0189)	3.244*** (0.0171)	3.206*** (0.0169)	3.367*** (0.0167)	3.318*** (0.0159)	3.285*** (0.0154)	3.263*** (0.0130)	3.242*** (0.0106)
Observations	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	
R <sup>2</sup>	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Adj. R <sup>2</sup>	0.00192	0.000972	0.000388	0.000142	8.57e-05	-1.28e-06	-2.27e-05	-4.09e-05	6.58e-05	0.000755	0.00030	0.0014	0.0005	0.00057	0.00070	0.00254	0.00260	0.00130	0.000564	0.000329	0.000308	0.000534	0.00215	0.00218	0.00218	0.00262
Independent Variables	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	
ESG	-0.239*** (0.0403)	-0.186*** (0.0385)	-0.0975*** (0.0337)	-0.0383** (0.0269)	-0.0437 (0.0268)	0.025 (0.0208)	0.0116 (0.0200)	0.00171 (0.0177)	-0.0026 (0.0161)	-0.0647*** (0.0143)	-0.202*** (0.0165)	-0.199*** (0.0162)	-0.187*** (0.0162)	-0.148*** (0.0153)	-0.119*** (0.0145)	-0.272*** (0.0389)	-0.262*** (0.0372)	-0.166*** (0.0331)	-0.101*** (0.0298)	-0.0709*** (0.0269)	-0.203*** (0.0261)	-0.169*** (0.0247)	-0.144*** (0.0210)	-0.131*** (0.0187)	-0.128*** (0.0169)	
Bloomberg																										
ReidIn																										
Standardlytics																										
MSCI																										
Constant	3.068*** (0.210)	2.569*** (0.211)	2.038*** (0.217)	1.873*** (0.223)	1.724*** (0.237)	3.038*** (0.210)	2.565*** (0.211)	2.065*** (0.216)	1.901*** (0.223)	1.807*** (0.236)	3.310*** (0.208)	2.823*** (0.202)	2.316*** (0.203)	2.125*** (0.219)	1.984*** (0.225)	2.726*** (0.209)	2.270*** (0.213)	1.739*** (0.222)	1.588*** (0.239)	1.477*** (0.243)	2.299*** (0.212)	2.457*** (0.213)	1.964*** (0.218)	1.806*** (0.236)	1.722*** (0.237)	
Observations	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	
R <sup>2</sup>	0.628	0.613	0.550	0.495	0.427	0.628	0.613	0.550	0.494	0.427	0.644	0.619	0.557	0.501	0.432	0.642	0.617	0.555	0.501	0.433	0.639	0.615	0.553	0.497	0.429	
Adj. R <sup>2</sup>	0.628	0.613	0.550	0.494	0.427	0.643	0.619	0.547	0.501	0.432	0.643	0.619	0.547	0.501	0.432	0.642	0.617	0.555	0.501	0.433	0.639	0.615	0.553	0.497	0.429	
Independent Variables	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	10D IV	30D IV	90D IV	180D IV	360D IV	
ESG	-0.115*** (0.00169)	-0.117*** (0.00166)	-0.107*** (0.00160)	-0.101*** (0.00154)	-0.0966*** (0.00146)	-0.116*** (0.00169)	-0.117*** (0.00166)	-0.106*** (0.00159)	-0.0999*** (0.00153)	-0.0925*** (0.00142)	-0.113*** (0.00162)	-0.114*** (0.00162)	-0.108*** (0.00158)	-0.0977*** (0.00150)	-0.0933*** (0.00142)	-0.119*** (0.00169)	-0.120*** (0.00165)	-0.119*** (0.00158)	-0.119*** (0.00152)	-0.103*** (0.00143)	-0.0983*** (0.00143)	-0.120*** (0.00185)	-0.121*** (0.00183)	-0.111*** (0.00176)	-0.104*** (0.00170)	-0.0996*** (0.00162)
ESG	0.0438*** (0.00118)	0.0416*** (0.00114)	0.0322*** (0.00108)	0.0309*** (0.00104)	0.0272*** (0.000988)	0.0409*** (0.00119)	0.0416*** (0.00115)	0.0389*** (0.00111)	0.0299*** (0.00106)	0.0255*** (0.00101)	0.0408*** (0.00121)	0.0385*** (0.00116)	0.0368*** (0.00111)	0.0288*** (0.00107)	0.0245*** (0.00101)	0.0469*** (0.00119)	0.0441*** (0.00112)	0.0365*** (0.00107)	0.0322*** (0.00101)	0.0292*** (0.00094)	0.0444*** (0.00118)	0.0420*** (0.00114)	0.0343*** (0.00109)	0.0299*** (0.000994)	0.0270*** (0.00094)	
ESG	-0.0512*** (0.0132)	-0.0126 (0.0133)	0.0522*** (0.0146)	0.0554*** (0.0149)	0.0732*** (0.0149)	-0.0512*** (0.0132)	-0.0126 (0.0133)	0.0522*** (0.0156)	0.0554*** (0.0159)	0.0732*** (0.0149)	-0.0649*** (0.0131)	-0.0249** (0.0127)	0.0222*** (0.0128)	0.0483*** (0.0134)	0.290*** (0.0141)	-0.0487*** (0.0131)	-0.00739 (0.0134)	0.00936*** (0.0134)	0.0101 (0.0130)	0.0733*** (0.0130)	-0.00739 (0.0130)	-0.00739 (0.0130)	-0.00739 (0.0130)	-0.00739 (0.0130)	-0.00739 (0.0130)	-0.00739 (0.0130)
ESG	0.576*** (0.00348)	0.534*** (0.00341)	0.444*** (0.00326)	0.375*** (0.00323)	0.297*** (0.00312)	0.576*** (0.00349)	0.534*** (0.00344)	0.444*** (0.00323)	0.375*** (0.00311)	0.297*** (0.00311)	0.569*** (0.00364)	0.522*** (0.00349)	0.433*** (0.00333)	0.366*** (0.00313)	0.290*** (0.00320)	0.580*** (0.00349)	0.539*** (0.00353)	0.448*** (0.00327)	0.380*** (0.00314)	0.302*** (0.00314)	0.489*** (0.00349)	0.464*** (0.00341)	0.301*** (0.00311)	0.277*** (0.00311)	0.209*** (0.00313)	
ESG	0.0278*** (0.00980)	0.00991 (0.00985)	-0.0144 (0.0101)	-0.0251** (0.0109)	-0.0342*** (0.0112)	0.0278*** (0.00982)	0.00991 (0.00985)	-0.0144 (0.0101)	-0.0251** (0.0112)	-0.0342*** (0.0112)	0.0342*** (0.00970)	0.0149 (0.00954)	-0.00863 (0.00954)	-0.0199* (0.0102)	-0.0309** (0.0106)	0.0232*** (0.00975)	0.00644 (0.00951)	-0.0170 (0.0103)	-0.0278** (0.0112)	-0.0367*** (0.0115)	0.0299*** (0.00951)	0.00714 (0.00951)	-0.015 (0.0102)	-0.0262** (0.0103)	-0.0352*** (0.0119)	
ESG	3.068*** (0.210)	2.569*** (0.211)	2.038*** (0.217)	1.873*** (0.223)	1.724*** (0.237)	3.038*** (0.210)	2.565*** (0.211)	2.065*** (0.216)	1.901*** (0.223)	1.807*** (0.236)	3.310*** (0.208)	2.823*** (0.202)	2.316*** (0.203)	2.125*** (0.219)	1.984*** (0.225)	2.726*** (0.209)	2.270*** (0.213)	1.739*** (0.222)	1.588*** (0.239)	1.477*** (0.243)	2.299*** (0.212)	2.457*** (0.213)	1.964*** (0.218)	1.806*** (0.236)	1.722*** (0.237)	
Observations	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	21,141	
R <sup>2</sup>	0.628	0.613	0.550	0.495	0.427	0.628	0.613	0.550	0.494	0.427	0.644	0.619	0.557	0.501	0.432	0.642	0.617	0.555	0.501	0.433	0.639	0.615	0.553	0.497	0.429	
Adj. R <sup>2</sup>	0.628	0.613	0.550	0.494	0.427	0.643	0.619	0.547	0.501	0.432	0.643	0.619	0.547	0.501	0.432	0.642	0.617	0.555	0.501	0.433	0.639	0.615	0.553	0.497	0.429	





Dependent Variables	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV		
ESG	-0.166*** (0.0223)	-0.112*** (0.0218)	-0.172*** (0.0275)	-0.209*** (0.0284)	-0.272*** (0.0233)	0.188*** (0.0165)	0.209*** (0.0178)	0.169*** (0.0201)	0.177*** (0.0205)	0.112*** (0.0166)	0.0550*** (0.00271)	0.0613*** (0.00294)	0.0823*** (0.00344)	0.0833*** (0.00337)	0.0833*** (0.00254)	-0.0968*** (0.0114)	-0.118*** (0.0118)	-0.237*** (0.0126)	-0.307*** (0.0127)	-0.369*** (0.0103)	-0.0836*** (0.00218)	-0.0826*** (0.00213)	-0.0834*** (0.00251)	-0.0847*** (0.00254)	-0.0863*** (0.00208)		
Bloomberg																											
ReidIn																											
StandardIn																											
MSCI																											
Constant	3.362*** (0.0125)	3.307*** (0.0124)	3.456*** (0.0119)	3.462*** (0.0115)	3.391*** (0.00952)	3.237*** (0.00313)	3.289*** (0.00347)	3.322*** (0.00231)	3.330*** (0.00294)	3.269*** (0.00217)	3.288*** (0.00122)	3.299*** (0.00191)	3.321*** (0.00010)	3.328*** (0.00266)	3.268*** (0.00229)	3.436*** (0.00861)	3.489*** (0.00852)	3.549*** (0.00798)	3.571*** (0.00746)	3.472*** (0.00699)	3.327*** (0.00131)	3.378*** (0.00127)	3.403*** (0.00103)	3.404*** (0.00081)	3.339*** (0.00115)		
Observations	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	
R <sup>2</sup>	0.007	0.005	0.006	0.010	0.014	0.001	0.002	0.001	0.000	0.001	0.006	0.007	0.007	0.005	0.007	0.036	0.033	0.049	0.062	0.070	0.030	0.029	0.028	0.027	0.027	0.038	
Adj. R <sup>2</sup>	0.00647	0.00494	0.00641	0.0102	0.0138	0.00114	0.00160	0.00106	0.000373	0.000603	0.00580	0.00697	0.00728	0.00524	0.00664	0.0316	0.0277	0.0485	0.0619	0.0699	0.0299	0.0288	0.0279	0.0272	0.0272	0.0360	
Independent Variables																											
ESG	-0.427*** (0.0122)	-0.564*** (0.0118)	-0.391*** (0.0400)	-0.469*** (0.0387)	-0.438*** (0.0321)	0.133** (0.0279)	0.155*** (0.0277)	0.129*** (0.0241)	0.0765*** (0.0218)	0.0765*** (0.0198)	0.0896*** (0.00307)	0.0635*** (0.00501)	0.0618*** (0.00417)	0.0496*** (0.00440)	0.0442*** (0.00329)	-0.445*** (0.0176)	-0.447*** (0.0174)	-0.515*** (0.0161)	-0.553*** (0.0152)	-0.472*** (0.0123)	-0.362*** (0.0145)	-0.352*** (0.0143)	-0.427*** (0.0132)	-0.308*** (0.0132)	-0.288*** (0.00869)		
Bloomberg																											
ReidIn																											
StandardIn																											
MSCI																											
Constant	1.201*** (0.241)	0.807*** (0.277)	-1.594*** (0.492)	-3.039*** (0.718)	-2.778*** (0.666)	1.123*** (0.242)	0.748*** (0.275)	-1.673*** (0.491)	-3.153*** (0.720)	-2.892*** (0.669)	1.169*** (0.239)	0.729*** (0.275)	-1.638*** (0.488)	-3.124*** (0.718)	-2.869*** (0.667)	1.279*** (0.241)	0.926*** (0.273)	-1.334*** (0.472)	-2.721*** (0.690)	-2.526*** (0.642)	1.315*** (0.236)	0.838*** (0.268)	-1.497*** (0.483)	-2.988*** (0.713)	-2.729*** (0.662)		
Observations	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	20,358	
R <sup>2</sup>	0.608	0.522	0.413	0.343	0.333	0.609	0.524	0.414	0.341	0.329	0.612	0.528	0.418	0.344	0.331	0.608	0.524	0.421	0.338	0.327	0.617	0.527	0.411	0.349	0.366		
Adj. R <sup>2</sup>	0.608	0.522	0.413	0.343	0.333	0.609	0.524	0.414	0.341	0.329	0.612	0.528	0.418	0.344	0.331	0.608	0.524	0.421	0.338	0.327	0.617	0.527	0.411	0.349	0.366		
Dependent Variables																											
ESG	-0.0758*** (0.00215)	-0.0752*** (0.00229)	-0.0758*** (0.00230)	-0.0764*** (0.00233)	-0.0758*** (0.00207)	-0.0783*** (0.00219)	-0.0776*** (0.00212)	-0.0758*** (0.00250)	-0.0797*** (0.00252)	-0.0818*** (0.00205)	-0.0764*** (0.00215)	-0.0757*** (0.00227)	-0.0759*** (0.00245)	-0.0766*** (0.00248)	-0.0807*** (0.00203)	-0.0731*** (0.00219)	-0.0714*** (0.00211)	-0.0697*** (0.00249)	-0.0652*** (0.00249)	-0.0703*** (0.00203)	-0.0733*** (0.00218)	-0.0756*** (0.00213)	-0.0814*** (0.00251)	-0.0847*** (0.00254)	-0.0863*** (0.00208)		
ESG	0.0959*** (0.00157)	0.0874*** (0.00168)	0.0890*** (0.00177)	0.0726*** (0.00173)	0.0726*** (0.00140)	0.0833*** (0.00157)	0.0877*** (0.00167)	0.0803*** (0.00176)	0.0745*** (0.00174)	0.0765*** (0.00141)	0.0916*** (0.00169)	0.0829*** (0.00170)	0.0785*** (0.00180)	0.0799*** (0.00177)	0.0737*** (0.00143)	0.0929*** (0.00169)	0.0847*** (0.00169)	0.0724*** (0.00174)	0.0669*** (0.00168)	0.0704*** (0.00137)	0.0923*** (0.00151)	0.0888*** (0.00162)	0.0776*** (0.00171)	0.0719*** (0.00137)			
ESG	-0.0210 (0.0151)	0.0095 (0.0175)	0.205*** (0.0310)	0.319*** (0.0453)	0.319*** (0.0420)	-0.0188 (0.0152)	0.00318 (0.0173)	0.207*** (0.0386)	0.322*** (0.0452)	0.323*** (0.0422)	-0.0083 (0.0150)	0.0217 (0.0173)	0.207*** (0.0386)	0.322*** (0.0452)	0.323*** (0.0420)	-0.0299 (0.0151)	0.0138 (0.0171)	0.303*** (0.0268)	0.304*** (0.0435)	0.307*** (0.0445)	-0.0186 (0.0148)	0.0212 (0.0168)	0.307*** (0.0304)	0.322*** (0.0419)	0.323*** (0.0417)		
ESG	0.681*** (0.0480)	0.646*** (0.0450)	0.526*** (0.0626)	0.450*** (0.0687)	0.321*** (0.0590)	0.683*** (0.0485)	0.647*** (0.0453)	0.528*** (0.0626)	0.453*** (0.0669)	0.324*** (0.0592)	0.686*** (0.0486)	0.651*** (0.0453)	0.532*** (0.0626)	0.455*** (0.0669)	0.326*** (0.0592)	0.678*** (0.0489)	0.642*** (0.0453)	0.518*** (0.0625)	0.440*** (0.0680)	0.313*** (0.0584)	0.682*** (0.0489)	0.647*** (0.0452)	0.528*** (0.0625)	0.452*** (0.0686)	0.324*** (0.0584)		
ESG	0.0163 (0.0112)	-0.00377 (0.0235)	-0.0963*** (0.0349)	-0.154*** (0.0326)	-0.155*** (0.0326)	0.0150 (0.0113)	-0.00479 (0.0125)	-0.0973*** (0.0333)	-0.153*** (0.0331)	-0.157*** (0.0328)	0.0146 (0.0111)	-0.00524 (0.0125)	-0.0973*** (0.0333)	-0.156*** (0.0349)	-0.157*** (0.0327)	0.0181 (0.0112)	-0.00109 (0.0124)	-0.0994*** (0.0324)	-0.147*** (0.0335)	-0.149*** (0.0314)	0.0149 (0.0110)	-0.00827 (0.0122)	-0.0974*** (0.0330)	-0.156*** (0.0347)	-0.157*** (0.0329)		
ESG	1.201*** (0.241)	0.807*** (0.277)	-1.594*** (0.492)	-3.039*** (0.718)	-2.778*** (0.666)	1.123*** (0.242)	0.748*** (0.275)	-1.673*** (0.491)	-3.153*** (0.720)	-2.892*** (0.669)	1.169*** (0.239)	0.729*** (0.275)	-1.638*** (0.488)	-3.124*** (0.718)	-2.869*** (0.667)	1.279*** (0.241)	0.926*** (0.273)	-1.334*** (0.472)	-2.721*** (0.690)	-2.526*** (0.642)	1.315*** (0.236)	0.838*** (0.268)	-1.497*** (0.483)	-2.988*** (0.713)	-2.729*** (0.662)		



Dependent Variables	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV
ESG	-0.028*** (0.0025)	-0.0271*** (0.0020)	0.08607 (0.00927)	0.0167*** (0.0024)	0.0458*** (0.00763)	0.0674*** (0.00790)	0.0697*** (0.00782)	0.0894*** (0.00776)	0.104*** (0.00766)	0.0872*** (0.00655)	-0.0265*** (0.0037)	-0.0302*** (0.00310)	-0.0241*** (0.00333)	-0.0098*** (0.00239)	0.00181 (0.00297)	0.0239*** (0.00582)	0.0184*** (0.00582)	0.0334*** (0.00601)	0.0563*** (0.00585)	0.0475*** (0.00473)	-0.0224*** (0.00954)	-0.0231*** (0.00100)	-0.0209*** (0.00177)	-0.0202*** (0.00121)	-0.0221*** (0.00941)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	3.315*** (0.00238)	3.373*** (0.00324)	3.410*** (0.00301)	3.422*** (0.00286)	3.367*** (0.00210)	3.315*** (0.00329)	3.369*** (0.00394)	3.406*** (0.00372)	3.415*** (0.00359)	3.351*** (0.00235)	3.314*** (0.00125)	3.373*** (0.00430)	3.409*** (0.00280)	3.420*** (0.00253)	3.362*** (0.00200)	3.319*** (0.00223)	3.376*** (0.00321)	3.413*** (0.00299)	3.424*** (0.00285)	3.369*** (0.00212)	3.316*** (0.00333)	3.375*** (0.00329)	3.411*** (0.00306)	3.422*** (0.00292)	3.367*** (0.00229)
Observations	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441
R <sup>2</sup>	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003	0.001	0.001	0.000	0.002	0.002	0.002	0.003	0.007	0.006	0.000	0.000	0.000	0.000	0.001	0.001
Adj. R <sup>2</sup>	3.51e-05	0.000212	-4.6e-05	0.000717	0.000272	-4.7e-05	0.000127	9.40e-05	0.000185	0.00249	0.000673	0.000818	0.000212	4.8e-05	0.00181	0.000219	0.00197	0.00239	0.00700	0.00625	-4.7e-05	-1.59e-05	0.000160	0.000439	0.000543
Independent Variables	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV
ESG	-0.0166 (0.0123)	-0.0239*** (0.0021)	-0.00108 (0.0114)	0.0143*** (0.0109)	0.0244*** (0.00907)	-0.00320 (0.00895)	-0.0176** (0.00869)	0.0148* (0.00850)	-0.0167** (0.00793)	0.0511*** (0.00647)	-0.0179*** (0.00417)	-0.0184*** (0.00484)	-0.00991** (0.00474)	0.00576 (0.00470)	0.0215*** (0.00406)	0.0463*** (0.00717)	0.0413*** (0.00733)	0.0520*** (0.00698)	0.0773*** (0.00661)	0.0589*** (0.00651)	1.96e-05 (0.00154)	0.00148 (0.00150)	0.00355* (0.00145)	0.00519** (0.00145)	0.00486** (0.00140)
Bloomberg																									
Realtivity																									
Standardlytics																									
MSCI																									
Constant	3.315*** (0.00238)	3.373*** (0.00324)	3.410*** (0.00301)	3.422*** (0.00286)	3.367*** (0.00210)	3.315*** (0.00329)	3.369*** (0.00394)	3.406*** (0.00372)	3.415*** (0.00359)	3.351*** (0.00235)	3.314*** (0.00125)	3.373*** (0.00430)	3.409*** (0.00280)	3.420*** (0.00253)	3.362*** (0.00200)	3.319*** (0.00223)	3.376*** (0.00321)	3.413*** (0.00299)	3.424*** (0.00285)	3.369*** (0.00212)	3.316*** (0.00333)	3.375*** (0.00329)	3.411*** (0.00306)	3.422*** (0.00292)	3.367*** (0.00229)
Observations	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441
R <sup>2</sup>	0.470	0.448	0.448	0.366	0.330	0.472	0.450	0.450	0.324	0.327	0.471	0.450	0.367	0.318	0.321	0.470	0.449	0.367	0.322	0.325	0.476	0.455	0.372	0.325	0.331
Adj. R <sup>2</sup>																									
Independent Variables	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV	100 HV	300 HV	900 HV	1800 HV	3600 HV
ESG	-0.115*** (0.00194)	-0.123*** (0.00199)	-0.124*** (0.00215)	-0.127*** (0.00234)	-0.133*** (0.00195)	-0.125*** (0.00211)	-0.133*** (0.00210)	-0.136*** (0.00257)	-0.140*** (0.00256)	-0.144*** (0.00211)	-0.118*** (0.00198)	-0.126*** (0.00205)	-0.127*** (0.00221)	-0.133*** (0.00214)	-0.133*** (0.00203)	-0.116*** (0.00192)	-0.124*** (0.00198)	-0.124*** (0.00214)	-0.126*** (0.00222)	-0.132*** (0.00194)	-0.137*** (0.00194)	-0.138*** (0.00216)	-0.138*** (0.00233)	-0.135*** (0.00241)	-0.137*** (0.00215)
ESG	0.085*** (0.00142)	0.042*** (0.00143)	0.038*** (0.00146)	0.025*** (0.00148)	0.023*** (0.00132)	0.043*** (0.00147)	0.039*** (0.00150)	0.024*** (0.00151)	0.018*** (0.00125)	0.016*** (0.00142)	0.042*** (0.00143)	0.038*** (0.00146)	0.025*** (0.00148)	0.023*** (0.00132)	0.043*** (0.00147)	0.039*** (0.00150)	0.024*** (0.00151)	0.018*** (0.00125)	0.016*** (0.00142)	0.016*** (0.00144)	0.042*** (0.00143)	0.038*** (0.00146)	0.025*** (0.00148)	0.023*** (0.00132)	0.043*** (0.00147)
ESG	-0.060*** (0.0238)	-0.0155 (0.0210)	0.169*** (0.0405)	0.263*** (0.0395)	0.231*** (0.0395)	-0.085*** (0.0229)	-0.0182 (0.0210)	0.166*** (0.0399)	0.240*** (0.0399)	0.279*** (0.0392)	-0.067*** (0.0218)	-0.0175 (0.0210)	0.168*** (0.0388)	0.263*** (0.0405)	0.282*** (0.0392)	-0.067*** (0.0229)	-0.0169 (0.0210)	0.168*** (0.0387)	0.251*** (0.0401)	0.279*** (0.0393)	-0.068*** (0.0228)	-0.0133 (0.0211)	0.172*** (0.0290)	0.266*** (0.0407)	0.284*** (0.0399)
ESG	0.627*** (0.0065)	0.601*** (0.00576)	0.494*** (0.00630)	0.427*** (0.00579)	0.321*** (0.00579)	0.222*** (0.00585)	0.595*** (0.00578)	0.488*** (0.00621)	0.421*** (0.00579)	0.316*** (0.00579)	0.624*** (0.00571)	0.579*** (0.00582)	0.491*** (0.00625)	0.427*** (0.00658)	0.322*** (0.00582)	0.625*** (0.00569)	0.599*** (0.00577)	0.491*** (0.00620)	0.424*** (0.00654)	0.318*** (0.00580)	0.627*** (0.00564)	0.601*** (0.00574)	0.494*** (0.00620)	0.429*** (0.00653)	0.322*** (0.00580)
ESG	0.0346** (0.0173)	0.00988 (0.0150)	-0.0821*** (0.0218)	-0.130*** (0.0312)	-0.140*** (0.0308)	0.0388** (0.0174)	0.0112 (0.0150)	-0.0807*** (0.0218)	-0.129*** (0.0308)	-0.139*** (0.0305)	0.0355** (0.0173)	0.0109 (0.0156)	-0.0814*** (0.0218)	-0.130*** (0.0313)	-0.140*** (0.0309)	0.0339** (0.0174)	0.0106 (0.0156)	-0.0812*** (0.0217)	-0.128*** (0.0310)	-0.139*** (0.0306)	0.0334* (0.0174)	0.00871 (0.0150)	-0.0833*** (0.0220)	-0.131*** (0.0315)	-0.141*** (0.0311)
ESG	3.077*** (0.362)	2.598*** (0.333)	0.119 (0.458)	-0.981 (0.640)	-0.977 (0.627)	3.269*** (0.364)	2.800*** (0.354)	0.351 (0.453)	-0.742 (0.653)	-0.697 (0.622)	3.114*** (0.362)	2.665*** (0.333)	0.154 (0.458)	-1.002 (0.643)	-0.931 (0.629)	3.109*** (0.363)	2.632*** (0.334)	0.145 (0.450)	-0.966 (0.637)	-0.884 (0.623)	3.134*** (0.363)	2.723*** (0.335)	0.211 (0.461)	-0.925 (0.646)	-0.836 (0.632)
Observations	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441	21441
R <sup>2</sup>	0.470	0.448	0.448	0.366	0.330	0.472	0.450	0.450	0.324	0.327	0.471	0.450	0.367	0.318	0.321	0.470	0.449	0.367	0.322	0.325	0.476	0.455	0.372	0.325	0.331
Adj. R <sup>2</sup>																									





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