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The effect of climate disclosure on stock market performance: Evidence from Norway

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Abstract

Increased concerns about climate change and its economic impact emphasize the necessity of sustainable investment and have become a demanded research topic. Via voluntary carbon and climate-related disclosure, companies indicate their exposure to climate change risks and how they counteract them. Investors seeking to reduce the climate risk of their portfolios can utilize this information. Using the 2010–2020 Carbon Disclosure Project scoring for companies in Norway, I formed portfolios of stocks with high, low, and no scores. These portfolios represent lower, higher, and unknown climate risks, respectively. The results suggest that a value-weighted portfolio of firms with high scores generates an extra 1.3% annualized return over the market. This portfolio steadily outperformed the market in recent years based on the information and Sortino ratios. However, after controlling for recognized risk factors, the high-score portfolio has no abnormal return unless energy stocks are excluded. In contrast, low- and no-score portfolios were penalized for bearing higher climate risk so that there is a significant climate alpha after 2016. This research highlights that a climate-aligned investment strategy is profitable while offering lower climate change risk exposure.

KEYWORDS

carbon disclosure, climate risks, portfolio investment, sustainable investment

1 | INTRODUCTION

Climate change mitigation is receiving growing attention from the public, policymakers, and investors (Bender et al., 2019; Clapp et al., 2017; Guyatt, 2011; Hunt & Weber, 2019). A transition to a low-carbon economy is a way to cope with climate change. Since this transition calls for actions on different levels by many actors, the financial market has a unique role in providing funds for their implementation. However, financial markets still lack a corresponding green structure (D'Orazio & Popoyan, 2019) to facilitate mitigation at a sufficient level even though some innovative funding tools such as green bonds are available (Horsch & Richter, 2017). There is also a horizon mismatch between climate change consequences and financial implications that must be overcome for a successful transition to a low-carbon economy (Louche et al., 2019).

Nordic countries are seen as leaders in low-carbon economy transition because they aim to be fossil fuel-free and state this in their national strategies (Sovacool, 2017). Norway is a particular case among Nordic countries due to the special role of fossil fuels in the country's development. The Oslo Stock Exchange (OSE) is oil and gas driven; companies from the energy sector make up 18% of the total OSE Benchmark Index (only the industrial sector is larger[1]). Unlike other Nordic countries, Norway's carbon emission per capita income remains high and therefore has to cut down its emissions further

(Urban & Nordensvärd, 2018). Norway actively works towards the goal of reducing its greenhouse gas (GHG) emissions. After the reached climate agreement at *Stortinget* (the Norwegian Parliament) in 2008, significant steps in addressing climate change were implemented via the Climate Change Act (2017). This act set forth Norwegian climate change goals for years 2030 and 2050. While Norwegian companies have adopted climate neutrality as a part of their corporate strategies, large investors such as Norges Bank Investment Management, which manages the Norwegian sovereign wealth fund, are interested in how the risk–return relationship will adjust to climate issues (Hong et al., 2020).

The historical importance of the oil and gas sector in Norway and Norway's active contribution to the low-carbon economy transition make Norway a unique context for studying sustainable investments. Some studies have already examined sustainable investments in Norway based on environmental, social, and governmental (ESG) ratings (Steen et al., 2020) and sustainability proxies (Fiskerstrand et al., 2020), but have not found these strategies profitable. In contrast to previous research with sustainability as an overarching focus, this article only focuses on climate change in portfolio formation. Norway's special emphasis on climate change mitigation and adaptation on the legislative level might affect the stock market and enable climate-aligned investments.

When considering climate change and its associated risks, financial markets find a disclosure on climate change risk more valuable than reporting on the absolute levels of GHG emissions (Liesen, 2015; Liesen et al., 2017). This incentivizes studying climate disclosure, data for which were obtained from the Carbon Disclosure Project (CDP) climate change reports for this article. The CDP is non-for-profit organization that assesses companies' disclosure based on the information provided annually in the questionnaire covering the topics of current carbon footprint and future adaptation and mitigation plans. The CDP database is proven to be a reliable source of disclosure information for academic research (Gasbarro et al., 2017; Kouloukoui et al., 2019; Sakhel, 2017; Schiemann & Sakhel, 2019).

This article aims to fill the gap in understanding how sustainability goals and climate change affect the stock market by studying the relationship between voluntary carbon disclosure and stock performance. The objective is to investigate whether the performance of the Norwegian exchange-traded companies varies with climate risk disclosure.

The companies are gathered in portfolios based on scores from 2010 to 2019 CDP reports to achieve this. Different risk-return measures show that the portfolio of companies with fuller disclosure performed better since 2010 and outperformed the market and sustainable indices. Controlling for common risk factors revealed that the portfolios of companies that do not disclose their carbon and climate performance have negative excess returns. This article adds to the understanding of the investors' reaction to climate change disclosure by investigating short-term investments in the stock market. The study's results show that climate risk-aligned investment is a viable investment strategy for the Norwegian stock market.

A review of existing literature and the explanation of hypothesis development are presented in the next section. The data and methodology are explained in Section 3, while Section 4 presents the empirical results, and Section 5 discusses them and makes concluding remarks.

2 | THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESIS

Climate change is a new topic in the sustainable investment literature (Daugaard, 2020). The main question is whether sustainable strategies can outperform benchmark (market portfolio) investments, whilst having a good performance based on these factors individually or combined. Thus far, research based on the aggregated ESG scores has provided evidence that neither portfolios of high-ESG-score stocks (Auer & Schuhmacher, 2016) nor sustainable stock indices (de Souza Cunha et al., 2019) outperform low-ESG-score stocks and traditional indices globally.

However, a later work of "Do Low-Carbon Investments in Emerging Economies Pay Off? Evidence from the Brazilian Stock Market" Souza Cunha et al. (2021) show that Brazilian carbon-efficient companies outperform both the market and sustainability index. Soler-Domínguez et al. (2021) provide further evidence that a location can impact the performance of the climate-efficient companies: The American and Canadian portfolios outperform the European ones in terms of annualized returns. In contrast, certified with environmental label Chinese companies perform better environmentally but not financially (He et al., 2022).

In Sweden, for example, socially responsible mutual funds have a similar performance to conventional funds (Leite et al., 2018). Previous ESG research on the Norwegian stock market also shows that ESG ranking level does not affect performance or create an abnormal risk-adjusted return for mutual funds (Steen et al., 2020). Similarly, there is no difference in the returns of high and low ESG-ranked Norwegian stocks, according to Fiskerstrand et al. (2020). Thus, the Nordic countries were considered in studies on sustainable, not climate investments.

Currently, investors have access to corporate environmental performance via companies' reports or third-party agencies (i.e., ESG ratings). Only some ratings have metrics that could potentially be used in climate performance measures (Rekker et al., 2019). Moreover, ESG ratings given to one company are often different among rating providers (Berg et al., 2020). This decreases opportunities for implementing climate-aligned portfolios based on ESG ratings, therefore alternative information sources should be considered. Scientific studies often rely on the climate change scoring from CDP organization as a source of climate performance information (Gasbarro et al., 2017; Kouloukoui et al., 2019; Sakhel, 2017). The CDP's questionnaire is a way for companies to voluntary report on carbon emissions annually. The CDP claims that to face climate change and deal with its associated risks, it is necessary to understand exposure to it, and to measure it.[2] CDP assigns scores to companies based on their answers to the questionnaire about climate risk. Scoring depends on the extent to which the questionnaire is answered and the quality of the given disclosure. Information in the CDP reports are important for investors and valued in the market. This is because the disclosure of physical risks exposure helps to reduce information asymmetry, especially for companies that fall under climate change-related regulations (Schiemann & Sakhel, 2019).

Some financial studies within environmental performance focus specifically on carbon emissions. Levi and Newton (2016) found that investing in the most polluting stocks can cost as much as 3.7% per year in risk-adjusted returns. According to Hunt and Weber (2019) and Plantinga and Scholtens (2021), the fossil fuel divestment strategy does not reduce risk-adjusted returns while offering decreased carbon exposure. When considering climate change risks associated with emissions, some researchers have studied the effect of emission disclosure (Alsaifi et al., 2020; Jaggi et al., 2017; Liesen et al., 2017; Schiemann & Sakhel, 2019), while others have investigated the relationship between the emission rates and companies' performance (Bender et al., 2019; Capasso et al., 2020). It appears that disclosure on carbon pays off. For example, US energy companies with disclosure have better stock performance, while a long-short portfolio of companies that do and do not disclose has become more profitable over time in Europe (Ziegler et al., 2011). Liesen et al. (2017) demonstrate that European companies with better disclosure of GHG emissions have positive abnormal returns. A long-short portfolio also generates a positive abnormal return. Liesen et al. (2017) also claim that disclosure proxies are more relevant for the financial market than environmental performance expressed in absolute GHG emissions levels. Reduced emission (or carbon) intensity has a positive correlation with companies' financial performance, such as Tobin's *q*, which Busch and Hoffmann (2011) use as a measure because it "reflects reputational effects, investor trust, and investor risk", and return-on-equity (Secinaro et al., 2020).

Grauel and Gotthardt (2016) highlight that national context matters for climate change-related disclosure because companies from countries with more stringent environmental policies and multinational companies are more likely to participate in the CDP questionnaire. There is a significant positive relationship between carbon disclosure and the market value of Italian firms (Jaggi et al., 2017). After the repeal of the carbon tax in Australia, the market began to react to companies' carbon performance as better carbon performance led to significantly higher market returns (Qian et al., 2020). However, in the UK, carbon disclosure announcements receive a negative reaction since good environmental performance can be associated with additional costs, according to Alsaifi et al. (2020).

2.1 | Hypothesis development

This article contributes to the literature on the impact of climate risk on investment. It studies the relationship between climate risk disclosure and companies' risk adjusted returns.

Climate risks for investors can be described as a function of probability, vulnerability, and exposure (Clapp et al., 2017). If climate risk probability is shared either globally (as in case of global warming, physical climate risk) or locally (as for climate policies, transitional climate risk), exposure and vulnerability are company specific. A climate exposure here should be understood as a measure of possible loss(es) of both physical and financial assets. For example, for transitional risks, the exposure can be measure via carbon footprint as regulation will be likely aim at GHG emissions. The higher footprint, the higher compliance costs, hence the lower expected cashflow. This means that companies that provide information about their emission levels and associate costs have an advantage since their profits are already partly adjusted for climate change-related costs. Moreover, according to the market's perception, companies with a larger carbon footprint are more likely to default ceteris paribus (Capasso et al., 2020); meaning they are considered riskier assets.

The vulnerability of investment "depends on how well the sector or asset can adapt to the impact" (Clapp et al., 2017, p. 10). Climate vulnerability restricts access to finance in general (Kling et al., 2021) Investors are therefore interested in companies with lower vulnerability and, thus, a better adaptability. Companies can reduce their vulnerability by implementing measures that will lower damage from identified risks or help with efficient adaptation. If a company takes active management of its exposure and vulnerability, it bears lower climate risks.

It means that investors concerned about climate risks can lean towards fossil divestment to reduce or eliminate exposure to high climate risk stocks. This will decrease demand on such stocks and lower risk-sharing opportunities leading to higher expected returns. This is referred to as a climate risk premium (Bolton & Kacperczyk, 2021). Alternatively, investors might be value-driven and prefer only low climate risk stocks due to expectations about better future cash flows as companies' contribution to climate change adaptation and mitigation becomes priced in the long term (Derwall et al., 2011). An increased demand for low climate risk stocks can lead to climate premium, for example, as Bernardini et al. (2021) discovered for the electric vehicle market. Given such pricing, long-term investing in low climate risk stocks with simultaneous short selling of high climate risk stock could be a profitable strategy (In et al., 2019). Therefore, I formulate the following hypothesis:

> Portfolios constructed from companies with different levels of climate disclosure show differences in risk-adjusted returns.

3 | DATA AND METHODOLOGY

A dataset concerning the Norwegian companies that participated or were invited to participate in the CDP questionnaire was constructed. Companies were asked to provide information about their carbon footprint and actions that they take or plan to implement to reduce the effects of climate change on the activities. Thus, the information

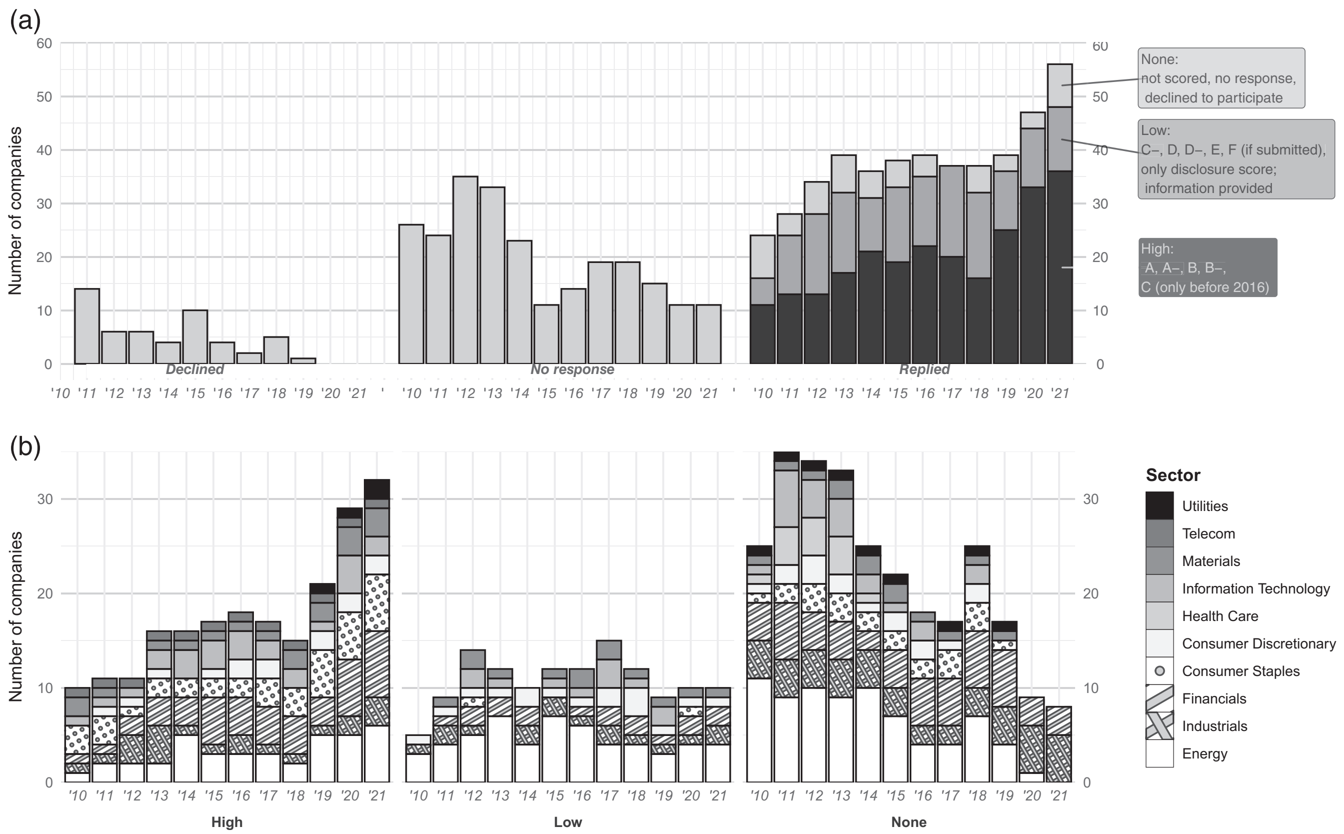

FIGURE 1 (a) Responses of Norwegian companies to the Carbon Disclosure Project (CDP) questionnaire, by type. The vertical axis shows the number of companies and the horizontal axis years, (b) Responses of Norwegian companies to the CDP questionnaire, industry breakdown within the same score category. The vertical axis shows the number of companies and the horizontal axis years.

in CDP reports is a good proxy for climate change exposure and vulnerability. At present, CDP scores for companies are freely available since 2010 at their official website (www.cdp.net). The scoring methodology has changed during the last 10 years. Before 2016, companies received a numeric disclosure score (0–100) and a character-based performance score (A–F). Since 2016, scores from A to F, with *A* being the best, were introduced. The recent questionnaire is aligned with recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). Thus, it measures companies' climate-related risks and opportunities in line with the TCFD and asks them to identify the financial implications of such risks.

Companies' CDP rankings from 2010 to 2021 represent all possible values in the rank range A(-), B(-), C(-), D(-), E, F, and not scored. It is not beneficial to address ranks separately because it results in small subsets with similar qualitative characteristics within neighboring subsets. Thus, all scores were re-arranged into three groups: high (A and B), low (C, D, E, and F), and no-score (referred to as none in the figures/tables)[3] based on the 2016 scoring methodology (Figure 1a). Additionally, the responses "see another/other" were removed from the dataset to ensure that each company is included only once, giving preference to the parent company if both parent and subsidiary company disclose. It is worth mentioning that scores before and after 2016 are not directly comparable; accordingly, I relied on the score translation given by CDP (2016), where C80 in 2015 corresponds to B- in 2016, for example. In total, there were 105 Norwegian companies for the period 2010–2021 that received CDP questionnaires. Although the number of participating companies slightly increases from 50 in 2010 to 67 in 2021, the coverage of companies' responses becomes better with fewer companies declining participation in the questionnaire. Fewer companies leave the CDP questionnaire unfilled.[4]

I constructed stock portfolios based on two methodologies: equal weighting (EW) and value weighting (VW). A portfolio is rebalanced after a new scoring arrives.[5] I assigned updated categories to the companies (high, low, or none) and recorded their market capitalization on these dates. This means that a portfolio includes all the stocks with the same CDP score category at the time of rebalancing (τ). A portfolio structure is thus dynamic and depends on the share of each stock in the total portfolio's market capitalization at the rebalancing:

$$r_{pt} = \sum_{i=1}^{N} w_{it} \cdot r_{it}$$

$$w_{it} = \begin{cases} \dfrac{1}{N} & \text{(EW)} \\ w_{i\tau} = \dfrac{\text{Market capitalization}_{i\tau}}{\sum_{i=1}^{N} \text{Market capitalization}_{i\tau}}, \tau \le t < \tau_{+1} & \text{(VW)} \end{cases} \tag{1}$$

where, r_{pt} is a return at time t of the portfolio p that includes N stocks; r_{it} is a return of the stock i at time t; w_{it} is a weight of stock i at time t; and τ is a date when a new score is published.

For the VW portfolios, the weights of individual stocks are determined on the score publishing date and remain constant until the next publishing.

I focus on two types of portfolios: long portfolios that assume investing in stocks from one scoring category (high, low, and none) and self-financed long-short portfolios that imply buying stocks with high scores and selling stocks with lower scores (low and none, separately). For portfolio performance analysis, I used the following measures: The Sharpe ratio, the information ratio (IR), the expected shortfall (ES), and the Sortino ratio. These are characteristic measures for the ex-post returns and are widely applied in the economics literature. The Sharpe (1994) ratio shows the reward in terms of excess return per unit of risk:

$$S_h = \frac{\overline{R}_p - \overline{r}_f}{\sigma_p} \tag{2}$$

where $\overline{R_p}$ is the mean return to the portfolio, $\overline{r_f}$ is the mean return to a risk-free asset, and σ_p is the standard deviation of the portfolio returns. Thus, if higher returns come from the cost of higher risk (σ_p), the investor will be worse off if S_h decreases.

The IR is similar to the Sharpe ratio by construction but compares portfolio returns with a benchmark, not a risk-free asset:

$$IR = \frac{\overline{R}_p - \overline{R}_B}{\sigma_{R_p - R_B}} \tag{3}$$

where $\overline{R}_B$ is the mean return to the benchmark, $\overline{R}_p - \overline{R}_B$ is called an active return, $\sigma_{R_p - R_B}$ is called the tracking error and is the standard deviation of the difference between portfolio and benchmark returns. In this article, I apply the IR for the whole period as well as two-year rolling estimates of the ratio.

It is important to consider a downside risk as low-carbon risk assets could be more sensitive to tail risks (Reboredo et al., 2022). The ES is a coherent measure of downside risk. When given at the 95% confidence level, ES shows the average return in the worst 5% of cases. The Sortino and Meer (1991) ratio shows an excess return per unit of downside risk (σ_d):

$$\text{Sortino ratio} = \frac{\overline{R_p} - \text{MAR}}{\sigma_d}, \sigma_d = \frac{1}{n}\sum_{i=1}^{n}\left[\min\left(R_{p_i} - \text{MAR}; 0\right)\right]^2, \tag{4}$$

where MAR is a minimum acceptable return. This study uses MAR $= 0$.

To control returns for the risk factors, I applied Fama and French (1993) three-factor model (FF3) to portfolio returns:

$$r_{pt} - r_{ft} = \alpha + \beta_M (r_{Mt} - r_{ft}) + \beta_{smb} SMB_t + \beta_{hml} HML_t + \varepsilon_t \tag{5}$$

where r_M is the return to the market portfolio, *SMB* is the small minus big-cap factor, and HML is the high minus low book-to-market-ratio factor.

To assess companies' performance, I used stock data from the OSE, which was obtained from TITLON, a database containing stock and bond prices and accounting data for all publicly listed firms from 1980 to 2020. I then matched CDP scoring for these 105 companies with the stock market data. I removed private companies and those that have not been traded for a long time (i.e., those companies that do not have sufficient stock price history) from the data.

Thus, I have a dataset consisting of daily returns of 104 companies with tradable stocks from 2010 to 2020. Additionally, I used the OSE index (OSEBX) as a proxy for the market and Fama-French's SMB and HML factors for OSEBX portfolios. A risk-free rate (r_f) given in TITLON is based on the log difference of the Norwegian Overnight Weighted Average rate from the Norwegian Central Bank after 2013 and the Norwegian Interbank Offered Rate before that.[6] I also used the Dow Jones Sustainability Index Nordic (DJSND) to compare the stocks' performance. The DJSND tracks the stocks of Nordic leaders in corporate sustainability. It helps to compare created portfolios with a thematic index in addition to the market. Since DJSND is denominated in US dollars, returns are adjusted for the exchange rate to make all returns calculated in Norwegian krone (NOK). I used the historical data for the exchange rate (USD-NOK) based on real-time quotes. A new, currency-adjusted time-series of DJSND return hereafter is referred to as DJSN.

4 | EMPIRICAL RESULTS

On average during 2010–2016, the no-score portfolio consists of 28 companies, while the high- and low-score portfolios are smaller with 15 and 13 companies, respectively. In recent years, the portfolios' sizes became the opposite. Companies with no score are also smaller on average (see Table 1). The median capitalization of the stock with low scores is higher than that of high-score stocks. However, the high-score stocks are more heterogeneous because they have a wider range of market capitalization.

The returns of stocks are highly and positively correlated: their correlations lie between 0.74 and 0.77. The correlation is even higher between the market and categorized stocks; it is in the 0.85–0.92 range. This suggests that industries and companies of different sizes are represented similarly to the Norwegian stock market. Energy, industrial, and financial companies represent a substantial portion of the CDP questionnaire participants (Figure 1b). Healthcare companies tend not to participate, while companies in the telecommunication sector score highly.

Despite a high correlation, the categorized stocks differ sharply in terms of risk–return profile. Low-score and no-score stocks produce 6–9 bp of monthly return, which is 9 times lower than high-score stocks. Moreover, the latter stocks are less volatile: the high-score stocks have a standard deviation of 4.5% while that of the other stocks is around 6%. DJSN earns 12 bp more than the market (OSEBX) monthly, or 93 bp, which is similar to the returns of the high-score stocks. The volatility of DJSN is lower than and the market's one (3.6% and 4.4% respectively, the latter is close to that of high-score stocks [4.47%]).

TABLE 1 Summary statistics for risk factors, indices, and the Norwegian stocks in the sample.

	Mean	*SD*	Min	Median	Max	Skewness	Kurtosis	Capitalization	Obs.
Market	0.81	4.40	−14.83	1.08	16.56	−0.20	1.87		2739
DJSN	0.93	3.58	−10.41	0.56	9.29	−0.18	0.27		2739
SMB	0.61	4.38	−15.06	0.67	14.65	−0.18	1.35		2739
HML	−0.65	6.02	−16.42	−1.20	16.08	0.08	0.15		2739
High	0.81	4.47	−14.55	0.84	17.51	0.08	2.08	100M 1B 10B 100B	36,549
Low	0.06	5.88	−20.20	−0.13	22.31	0.04	2.03	100M 1B 10B 100B	31,600
None	0.09	6.21	−31.50	0.36	21.20	−0.90	5.10	100M 1B 10B 100B	63,311

Note: The table includes the size (SMB) and value (HML) factors, Oslo Stock Exchange Index (market), and currency-adjusted Dow Jones Sustainability Index Nordic (DJSN). The average (mean), minimum (min), median (median), and maximum (max) monthly returns and their *SD* are given in percentages. The capitalization column shows the distribution of the market capitalization for stocks with different scorings (high, low, none). Presented rectangles on boxplots show the interquantile range and median capitalization. The total number of used daily observations is given in obs column.

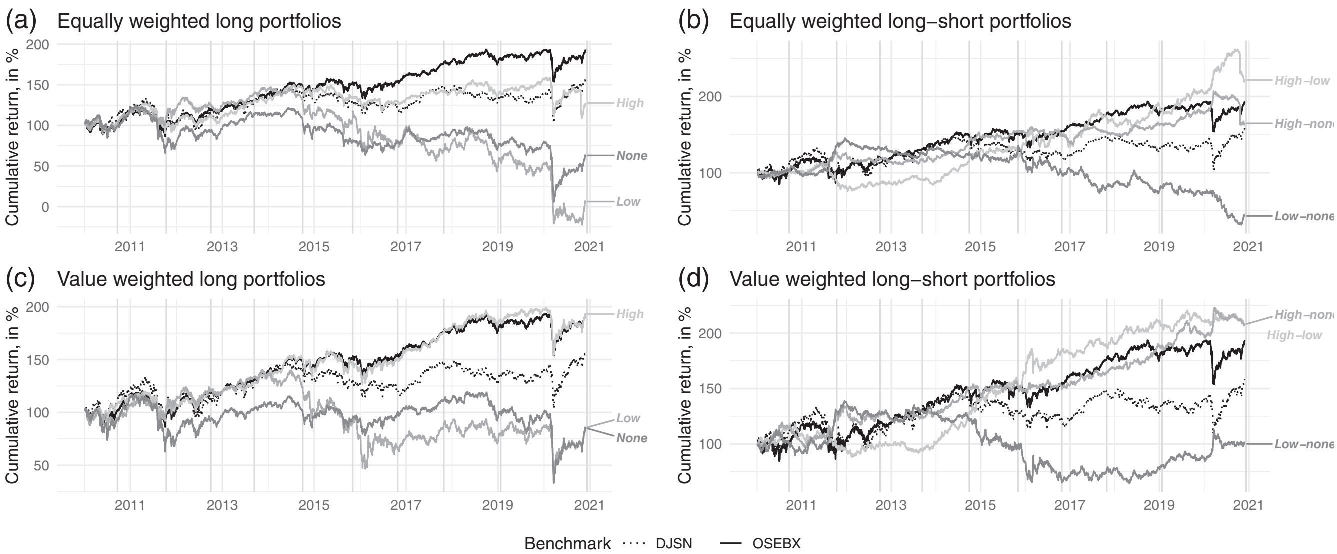

FIGURE 2 Performance of the portfolios, 2010–2020. Stocks' weights in the value-weighted portfolios are calculated based on market capitalization. The hyphen in the labels separates stocks' categories that are bought and short-sold, in that order. Wider vertical grey lines show the rebalance dates.

4.1 | Equally weighted portfolios

A strategy to invest an equal amount into the categorized stocks seems to have a positive outcome only for stocks in the high-score category (Figure 2). The low-score and no-score long portfolios began to lose value after the rebalancing in late 2014 when the new CDP scoring arrived. Within a five-year period (2014–2020), the value of the low-score portfolio was reduced by more than 70%. The no-score portfolio performed slightly better: by 2020, it lost 25% of its initial value, while the low-score portfolio lost 57% of its initial value (illustrated in darker gray lines in Figure 2a). Even though the high-score portfolio added 57% to the initial value by 2020 (Figure 2a, light gray line), its return is twice as low as that of the benchmarks. Its risk-adjusted compensation of 13 bp per unit risk is much lower than that offered by the Norwegian stock market (33 bp) and DJSN (40 bp). The ES for the high-score portfolio, market, and DJSN of 3% per day contrasts with the 3.6% for the low-score and no-score portfolios.

The long-short portfolios performed better. These portfolios are climate aligned, meaning that investors go long in stocks with better CDP scores and short stocks with lower CDP scores. Therefore, there are two portfolios to analyze: high-low and high-none. Both high-low and high-none stocks' portfolios increased their value over time, adding 104 and 80% respectively to the initial investments (Figure 2b, orange and red lines). This means that they produced 8% and 7% of the annualized return respectively, which

TABLE 2 The annualized measures of portfolios' performance.

a. Equally weighted	Market	DJSN	High	Low	None	High-low	High-none
Return	0.077	0.091	0.038	−0.062	−0.037	0.079	0.070
SD	0.180	0.186	0.165	0.227	0.173	0.164	0.114
Sharpe ratio	0.331	0.396	0.132	−0.337	−0.300	0.376	0.460
Inf. ratio: market		0.104	−0.402	−1.030	−1.050	0.008	−0.034
Inf. ratio: DSJN	−0.104		−0.344	−0.755	−0.793	−0.046	−0.098
Sortino ratio	0.044	0.050	0.027	−0.015	−0.011	0.048	0.060
ES	−0.030	−0.029	−0.030	−0.036	−0.036	−0.028	−0.016

b. Value-weighted	Market	DJSN	High	Low	None	High-low	High-none
Return	0.077	0.091	0.090	−0.037	−0.025	0.107	0.108
SD	0.180	0.186	0.181	0.228	0.187	0.153	0.125
Sharpe ratio	0.331	0.396	0.398	−0.227	−0.215	0.584	0.721
Inf. ratio: market		0.104	0.178	−0.950	−1.220	0.117	0.140
Inf. ratio: DSJN	−0.104		−0.011	−0.648	−0.744	0.064	0.072
Sortino ratio	0.044	0.050	0.051	−0.004	−0.004	0.067	0.083
ES	−0.030	−0.029	−0.026	−0.035	−0.035	−0.027	−0.017

Note: This table reports the annualized return (return) annualized *SD*, and Sharpe ratio based on the historical risk-free rate with an average of 1.6%. Information ratios are based on the Oslo stock exchange index (inf. ratio: market) and the currency-adjusted Dow Jones Sustainability Index Nordic (inf. ratio: DJSN) benchmarks. The downside risk measures—Sortino ratio and expected shortfall (ES)—were calculated for a target return of zero and a confidence level of 95%. Stocks' weights in the value-weighted portfolios are calculated based on market capitalization.

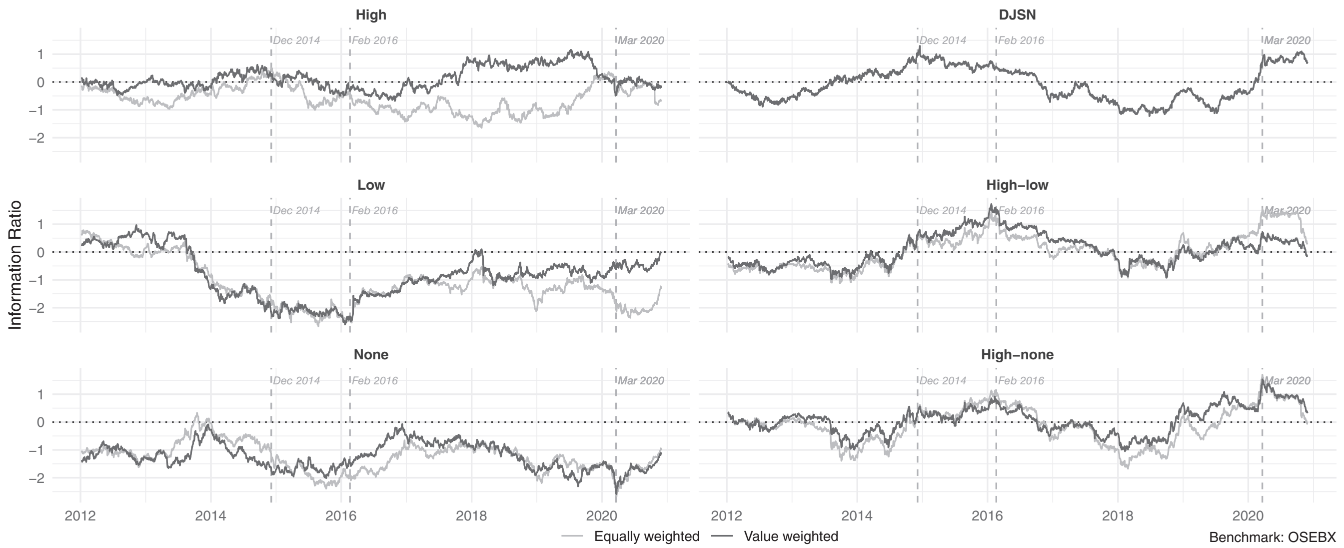

FIGURE 3 Historical information ratio for portfolios with a 2-year rolling window. Stocks' weights in the value-weighted portfolios are calculated based on market capitalization. Dashed vertical lines correspond with the detected structural breaks for the scored portfolios

are comparable with the 7.7% of the market and 9% of the DJSN. However, high-low and high-none volatilities are lower, which produces higher Sharpe ratios than the market offers. These portfolios are also superior to the market portfolio and DJSN based on the ES measure.

If the information and Sortino ratios define portfolios' performance, the high-low portfolio is the only one that outperforms the Norwegian market (Table 2). If compared with the currency-adjusted DJSND, equally weighted long-short portfolios underperformed significantly.

4.2 | Value weighted portfolios

The VW portfolio has a higher return in general. The low-score and no-score long portfolios have negative returns, as is the case for the EW portfolios. The low-score portfolio reduced its value by approximately 15% during 2010–2019. The no-score portfolio performed slightly better by losing 4% of the initial value (Figure 2c). The high-score portfolio added 50% to the value in the last 5 years and 98% of the initial value in total. This is comparable with the appreciation of the benchmark portfolios. It is easy to see a high correlation of the high-score portfolio with the Norwegian stock market Figure 2. The high-score portfolio also has the lowest volatility among the categorized portfolios: its returns vary within 18% annually (Table 1). This is similar to the volatility of the benchmark portfolios.

Nevertheless, the average returns of the high-score portfolio are 1.3% higher than those of the market, meaning that the VW portfolio of climate-aligned stocks outperforms the market. The high-score portfolio also outperforms both the market and DJSN by a marginal 67 and 2 bp of compensation per unit of overall risk respectively, and by 4 and 3 bp, respectively, in compensation for downside risk. In the VW strategy, the high-score portfolio performed better than the market according to the information and Sortino ratios as well.

The long-short portfolios performed better. The portfolios of high-low and high-none stocks both increased their value over time more than both benchmarks. This means that the former produced

TABLE 3 Regression results of the Fama–French three-factor model.

	Alpha		Market		SMB		HML		R^2
a. Value weighted portfolios									
High	0.001		0.954	***	0.075	***	0.034	***	0.868
Low	−0.037	**	1.082	***	−0.045	***	0.080	***	0.745
None	−0.036	***	0.994	***	−0.227	***	−0.046	***	0.826
High-low	0.030	**	−0.040	***	0.302	***	0.081	***	0.122
High-none	0.032	*	−0.128	***	0.119	***	−0.046	***	0.047
b. Equally weighted portfolios	Alpha		Market		SMB		HML		R^2
High	−0.014		0.836	***	−0.260	***	−0.036	***	0.710
Low	−0.063	***	1.082	***	−0.282	***	0.015		0.671
None	−0.34	***	0.882	***	−0.410	***	−0.002		0.776
High-low	0.014		−0.046	***	0.150	***	−0.034	***	0.038
High-none	0.043	**	−0.246	***	0.021		−0.051	***	0.070
c. Value weighted portfolios without energy stocks	Alpha		Market		SMB		HML		R^2
High	0.009		0.868	***	0.067	***	−0.024	***	0.794
Low	0.005		0.918	***	−0.024		0.005		0.617
None	−0.012		0.861	***	−0.260	***	−0.077	***	0.727
High-low	0.016		0.006		0.327	***	0.053	***	0.119
High-none	−0.002		−0.050	***	0.091	***	−0.029	*	0.013
d. Equally weighted portfolios without energy stocks	Alpha		Market		SMB		HML		R^2
High	0.025	**	0.750	***	−0.224	***	−0.050	***	0.752
Low	−0.08		0.796	***	−0.230	***	−0.073	***	0.542
None	0.002		0.760	***	−0.429	***	−0.031	***	0.711
High-low	0.017		−0.010		0.205	***	−0.019	*	0.064
High-none	0.027		−0.046	***	0.006		0.023		0.003

Note: This table reports estimated coefficients for long portfolios of stocks with high, low, and no scores, and long-short portfolios of these stocks constructed with equal weighting (a and c) and value weighting by market capitalization (b and d). Alpha stands for an intercept given as a percentage of daily return, market is a slope for risk-adjusted return of Oslo stock exchange index (or beta-coefficient), and SMB and HML are size and value factors. Asterisks indicate the significance of the coefficients: **p* < .1; ***p* < .05; ****p* < .01. Subtables c and d show regression results for the sample without energy stocks. R^2 shows a coefficient of determination for each portfolio.

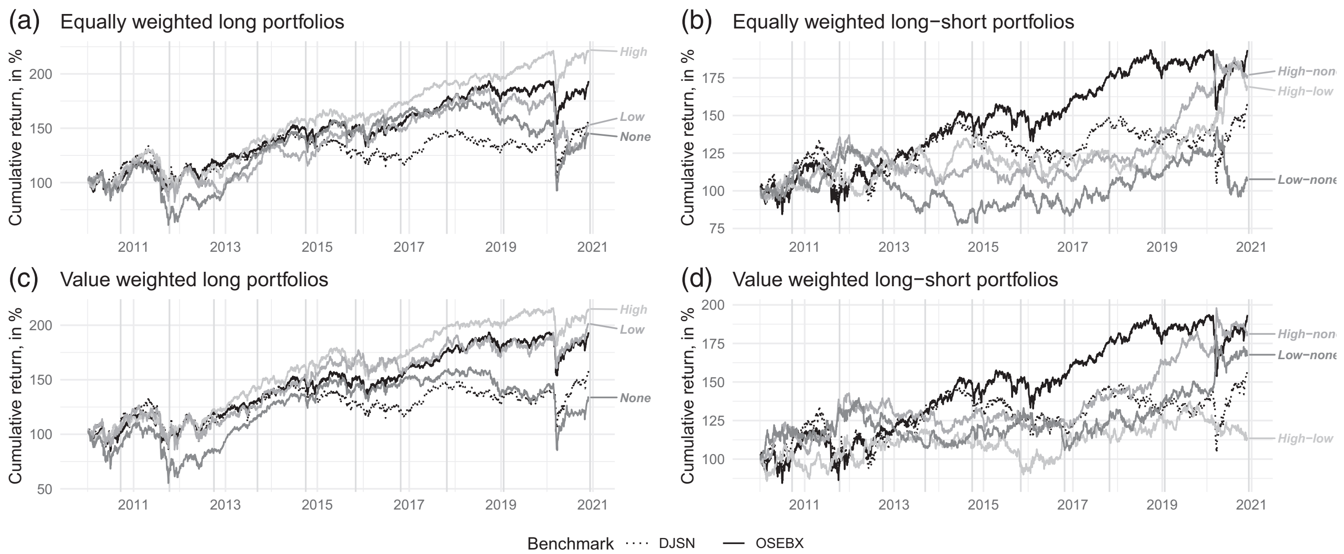

FIGURE 4 Performance of the portfolios without stocks from the energy sector, 2010–2020. Stocks' weights in the value-weighted portfolios are calculated based on market capitalization. The hyphen in the labels separates stocks categories that are bought and short-sold, in that order. Wider vertical grey lines show the rebalance dates.

10.8% of annualized returns. However, the high-low and high-none volatilities are lower, which produced higher Sharpe ratios than both the market and sustainability index. This outperformance exists when portfolios are compared by the IR and downside risk-based measures. The IR with DJSN as a benchmark shows that the high-low and high-none portfolios have ratios of 0.064 and 0.072, respectively. These are the only two cases of positive IRs with DJSN as a benchmark (Table 2). The testing also shows that the IR of the high-low portfolio is statistically greater than zero.

4.3 | Historical performance

To ensure that the obtained results persist, I calculated a rolling IR for the portfolios based on the daily data and then annualized it (Figure 3). I used two-year overlapping rolling windows to obtain a smoother trend. I also checked the one-year window and found that the results held. The no-score portfolio has the only negative IR. This means that the portfolio of companies that do not report on climate change never outperforms OSEBX.

I ran the FF3 (Equation 5) to determine whether disclosing companies' higher returns can be explained by exposure to the risk factors (Table 3a,b). Based on the FF3, the equally weighted long portfolios are more exposed to the large-cap stocks. These portfolios have a negative alpha, which is insignificant for the high portfolio. Alpha, or excess return, was −6.3 bp for the low-score portfolio and −3.4 bp for the no-score portfolio daily. The high-none long-short portfolio offers a positive excess return of 4.3 bp, which is significant only at a 5% level.

Based on the FF3, the VW high portfolio is more exposed to small-cap value stocks because of positive β_{smb} and β_{hml}, corroborating Alsaifi et al. (2020) research. In contrast, low- and no-score stocks are negatively correlated with the SMB factor and must include large-cap stocks predominantly. I checked portfolios' annual market capitalization and did not find a significant difference in capitalization between them (except for two pairs in different years). This means that size is not the main factor driving differences in excess returns for the created portfolios. The high-none portfolio offer positive excess returns of 4.3 bp for the VW strategy, which is significant at a 5% level.

4.4 | Additional analysis

The energy sector has large share on the Norwegian stock market because of the oil and gas industry's contribution to the country's economy. Fluctuations in the price of oil consequently affect the Norwegian stock market. Oil price is also an important consideration in this study because the decline in IR for the low- and no-score portfolios coincides with the oil price plunge in 2014 through 2016. For this reason, I examined the performance of the portfolios conditioned on industry and time.

I ran a structural break test on the excess returns of the long portfolios following an approach described in Pretis et al. (2018). The results suggested few periods when the portfolio alphas changed (available in the Appendices and marked on Figure 3). One of them is December 2014, when low-scored portfolio excess returns and IR of EW high portfolio declined. This supports an assumption about the influence of the oil price on these portfolios.

Applying the asset pricing models on high, low, and no-scored portfolios within the same industry showed that the energy sector had significant negative abnormal returns for EW and VW portfolios for all specifications (Table A4, in Appendices). These findings suggest that the energy sector could drive some of the estimated abnormal returns. It is likely that a combination of fossil fuel divestment,

TABLE 4 The annualized measure of portfolios performance by subperiods.

	High (1)	High (2)	High (3)	Low (1)	Low (2)	Low (3)	None (1)	None (2)	None (3)	High-low (1)	High-low (2)	High-low (3)	High-none (1)	High-none (2)	High-none (3)
Return	0.059	0.030	0.345	−0.078	−0.048	0.337	−0.020	−0.122	0.215	0.117	0.067	−0.010	0.069	0.162	0.077
SD	0.197	0.158	0.313	0.255	0.192	0.328	0.206	0.174	0.345	0.170	0.125	0.155	0.133	0.117	0.185
Sharpe ratio	0.195	0.130	1.090	−0.372	−0.292	1.013	−0.188	−0.741	0.616	0.557	0.458	−0.071	0.363	1.296	0.407
Inf. ratio: market	−0.075	0.154	−0.140	−1.027	−0.729	−0.163	−0.979	−1.661	−0.848	0.182	0.219	−1.144	0.018	0.734	−0.834
Inf. ratio: DSJN	−0.001	−0.156	−0.194	−0.661	−0.469	−0.383	−0.495	−1.061	−0.665	0.220	−0.016	−1.217	0.031	0.641	−1.007
Sortino ratio	0.035	0.021	0.097	−0.017	−0.013	0.093	0.000	−0.051	0.060	0.065	0.053	0.001	0.053	0.124	0.048
ES	−0.028	−0.049	−0.058	−0.037	−0.053	−0.056	−0.037	−0.057	−0.085	−0.033	−0.017	−0.019	−0.017	−0.017	−0.015

Note: This table reports the annualized return (return), annualized SD, and Sharpe ratio based on the historical risk-free rate with an average of 1.6% for value-weighted portfolios, where stocks are weighted by market capitalization. Information ratios are based on the Oslo stock exchange index (inf. ratio: market) and currency-adjusted Dow Jones Sustainability Index Nordic (inf. ratio: DJSN) benchmarks. The downside risk measures—Sortino ratio and expected shortfall (ES)—were calculated for a target return of zero and a confidence level of 95%. The period 1 covers 2010 to 2015 (before 2016), the period 2 is for 2016–2019, the period 3 is after 2020.

lowered oil sector growth, and demand–supply mismatch affected stocks' and portfolios' performance. Thus, the portfolios without energy stocks should be considered.

Overall, the performance of the portfolios without energy stocks was similar: portfolios of higher-scored stocks performed better than stocks with lower or no scores in absolute terms. The new portfolios of high- and low-score stocks still exhibited good performance (Figure 4a,c) since they added over 80% of their initial value by 2020. The no-score portfolio underperformed the others and the market and offers 53% above the initial value for EW and 45% for VW portfolios.

The difference can be observed for the long-short portfolios. All portfolios constructed by long-term investing in higher scored stocks and selling short those with lower scores had lower returns than the benchmarks in 2010 through 2019 (Figure 4b,d). The high-none portfolio performed the best, adding 45% (for EW) and 67% (for VW) of the value since 2010. However, major positive returns for this portfolio happened after 2016. The high-low portfolio increased by only 25%, which is four times less than the market did. The high-low portfolio's stable performance (Figure 4d) suggests that scored stocks for long and short investment have similar returns and risks (as Figure 4a,c show); thus, they almost offset each other.

According to the Sharpe and information ratios, most portfolios do not beat the benchmarks (Appendices, Table A1). The VW high-none portfolio offers a slightly higher (0.353 vs. 0.331) reward per unit of risk when the Sharpe ratio is considered. The high-score portfolio is superior according to the Sharpe, Sortino, and information ratios for EW and VW approaches Figure A1.

After controlling for risk factors (Table 3c,d), only the EW portfolio of high-score stocks generated an excess return of 2.5 bp daily that is statistically significant. Estimates for alpha in VW portfolios without energy stocks show the same relationship: the better the score, the higher the alpha, albeit insignificant estimates of alphas. The obtained regression results also hold for the extended factor model, including the liquidity and momentum factors (Appendices, Table A2).

Because the oil price plunge in 2014 and the CDP methodology change in 2016 could impact the portfolio performance, I compared the excess returns before and after the mentioned periods for the full sample and the sub-sample without energy stocks. Additionally, the period beginning in 2020 was considered to analyze changes that happened on the market during COVID-19. The results suggest that the abnormal returns indeed changed between these periods: the EW low portfolio performed worse after 2014/2016 than before, while the EW high-none portfolio began to earn 7.8 bp daily (Appendices, Table A3). Similar is true for the VW portfolios. The EW high-low portfolio without energy stocks has a positive and significant alpha only after 2016. At the same time, there is also significant positive alpha for the high-score and significant negative alpha for no-score portfolios after 2016. Results show that after 2016 no-energy EW and unrestricted VW high-low portfolios generate from 4.4 to 5.4 bp daily (or 1% monthly). Portfolios' excess returns mostly have not changed during COVID, except for the EW low-score portfolio, which started to generate negative 21 bp.

I calculated the performance measure for the portfolios before (period 1) and after 2016 (period 2), as well as under COVID-19 (period 3). Indeed, the risk and return profiles of the VW portfolios changed between periods (Table 4). The second period looks less volatile since all portfolios have a lower standard deviation than before, but these differences in variances are not significant according to the F-test.

In period 3, portfolios of the stocks that received higher scores (i.e., high and low) increased their returns. All portfolios exhibit a smaller ES. However, the increase in average returns between periods is found to be statistically insignificant. Albeit increased average variance, Sharpe ratio become better for the low-score portfolio (from 0.19 to 1.01) and the high-score portfolio (from 0.13 to 1.09). In addition, the Sortino ratio of all portfolios become higher in the third period.

There were also changes in the performance of long-short portfolios. According to the standard deviation, both portfolios become less volatile in the second period, which the F-test on variances supports. This allowed the portfolio high-none to beat the market according to all measures based on ratios in the second period. However, COVID impacted negatively performance of the long-short portfolios. The described dynamic between first two periods suggests that climate-aligned stocks have better performance that holds over time and improves. The portfolio of non-disclosing stocks systematically has not only lower but negative returns and higher downside risks. This dynamic was disrupted by the unexpected negative shock to the market from the COVID-19.

5 | DISCUSSION

Distinguishing companies in the Norwegian stock market by their climate risk exposure creates a strategy of climate-aligned investment. This study suggests that the Norwegian stock market appreciates companies' sustainable performance. The stocks of companies that disclose climate risks and work to reduce risk exposure are found to generate an extra 1.3% annualized return over the market return. The high-score stocks' portfolio offers 9% of annual returns, which is comparable to the return from the DJSND when adjusted to currency. Higher returns and similar to the market's volatility create a better performance of low climate risk companies in terms of risk compensation, allowing them to outperform the market portfolio.

It is important to account for the energy sector's influence due to its prominent presence on the stock market and its contribution to the Norwegian economy. The results show the improved performance measures for the long portfolios after excluding energy stocks, but not for long-short portfolios. The energy stock exclusion does not affect the average stock size in the portfolios.

The high-score portfolios with lower climate risk do not have abnormal returns after controlling for the value and size risk factors. However, significant positive abnormal returns were found for the high-scored portfolio without energy stocks. The EW portfolio offers 6.4% of abnormal annual returns (2.5 bp daily). The divestment assumption can explain this result: the increased demand for low climate risk stocks raised the returns for no-energy stocks. For example, Derwall et al. (2011) suggest that "doing well while doing good" can stem from the error-in-expectation and should be corrected in the long run, leading to a gradual decrease in low climate risk abnormal returns.

Nonetheless, this article shows that a low climate risk portfolio has gained a positive return recently. The two-year rolling window IR shows that the high-score portfolio steadily outperformed the benchmark after 2016. This suggests that low-climate-risk companies could gain extra value in the future as this trend continues and a legislative basis for climate disclosure comes into place.

The results for the whole sample portfolios with higher climate risk also point towards divestment because low and no-score portfolios experience negative average returns. They also have significantly negative abnormal returns, suggesting that the market penalizes companies with higher climate risks, as evidenced by the 9.7% annualized abnormal loss for the low-score portfolio (−4 bp daily). The underperformance of this portfolio can be a sign of divestment from companies with higher climate risk and a shift to lower climate risk companies. However, the analysis shows no compensation for the additional climate risk suggesting no climate premium.

There are positive and significant alphas for the long-short high-none unrestricted EW portfolios. In recent years—after 2016—EW energy-free and VW full sample high-low portfolios also offer on average 4–5 bp of daily abnormal returns. This supports previous findings that shorting high-carbon-footprint companies helps to deal with climate risks (Andersson et al., 2016). However, unlike the results in the paper by Liesen et al. (2017), positive returns of long-short portfolios do not come from outperformance of low climate risks stocks, but significant underperfromance of ones with higher risks.

The underperformance of companies with unknown or higher climate risks is an interesting finding within sustainable investment research. It highlights that the market might account for climate risks by offering lower returns for non-climate-aligned companies, which contrasts with previously provided evidence of positive alpha for companies with higher CO_2 emissions (i.e., higher climate risks) (Bolton & Kacperczyk, 2021). Findings suggest that the Norwegian market does not compensate for higher climate exposure. When there is compensation, investors are willing to hold riskier assets if this risk is priced properly. This study shows that investors might not want to hold stocks with higher climate risk at all. This can be explained by the fact that sustainable investing has become mainstream, extending the argument Leite et al. (2018) made for Sweden. This means that the market is more mature for sustainable investment and can provide a reasonable valuation of carbon and climate-related performance.

Although there is no compensation for additional climate exposure, investors can get better annualized total returns, making decisions based on the disclosure. Performance measures for recent years prove that portfolios with non-disclosing companies do not beat the market and undercompensate portfolio risks.

Since investors are not ready to divest from fossil fuels even after considering climate and fossil fuel risks as long as such investments are profitable (Christophers, 2019), they might distinguish stocks within sectors based on long-term climate alignment. This means that disclosing energy companies could have an advantage over non-disclosing companies allowing them to generate a positive total return (see Table A4 for more sector-related results).

If risk factors in terms of long portfolios explain a significant portion of the total variance (67%–86%), FF3 explains only up to 11% of the total variance of long-short portfolios. This means that the climate-aligned long-short portfolios' returns are not preliminarily driven by compensation for the exposure to size and value risk factors. The stable outperformance of the high-score portfolio over the market portfolio on the OSE since 2016, suggests that low climate risk companies could gain extra value in the future.

5.1 | Implications

1. *Theory*: The portfolio analysis of the disclosing companies suggests that the Norwegian stock market penalizes companies with higher climate risks. This finding contradicts the theoretical assumption that additional risk is compensated for. It suggests that investors do not require compensation as for high climate risks as they might prefer to avoid such risk.
2. *Policy*: As it is shown for the case of Norway, the stock market may compensate for additional risk associated with climate change for some sectors but not for the market as whole. Thus, tailoring and implementation of the climate policy should account for its potential asymmetric effect, also among sectors to avoid strategically disadvantageous changes on the market.
3. *Practice*: Climate-aligned portfolios generate abnormal returns, and the Norwegian stock market penalizes companies with higher climate risks. Thus, it is beneficial for socially responsible investors to short-sell the low-score companies, because this offers outstanding performance and hedging against climate risks. Long-short portfolios based on high-score stocks have a negative market beta, meaning that these portfolios can offer a hedge opportunity against market downturns.

5.2 | Limitations

Despite the unique prerequisites for sustainable investing, the Norwegian stock market is comparatively small, which might limit the results' generalizability. This demonstrates that further research must be conducted on different (and larger) samples from different markets to determine whether these findings are country specific. A longer-term dynamic of portfolio performance should be studied further to identify whether error-in-expectation is present. Although this study follows a traditional approach in asset pricing, it could be beneficial to include also other control variables such as macro- and corporate governance factors that potentially impact firm performance.

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ENDNOTES

[1] As of August 2020.

[2] CDP also works with other environmental topics: freshwater and forest. For of this paper, the focus is on climate change scoring.

[3] I decided to omit the medium-score category because preliminary results show that it has similar characteristics to the low-score category.

[4] Even though both declining to participate and leaving the questionnaire unfilled lead to a missing carbon disclosure, they represent different attitudes. A company declining to participate decides to hold back information. A company with no response provides no signal to the market.

[5] The approximated ranking announcement were on January 1, 2009; September 20, 2010; October 13, 2011; October 1, 2012; September 12, 2013; October 1, 2014; November 2, 2015; October 25, 2016; October 27, 2017; January 22, 2019; and October 20, 2020 according to the research.

[6] Historical data is partly available at the Norwegian Central Bank's website: www.norges-bank.no

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APPENDIX A

A.1 | ALTERNATIVE SPECIFICATIONS

This subsection presents the results of the additional analysis. Table A1 reports the performance measures for a sub-sample that excludes energy stocks. The results suggest that the restricted long portfolios have better average returns, compensation for downside risk, and lower variance and expected shortfall than the unrestricted portfolios.

Table A2 reports the regression analysis results based on the Fama–French three-factor model augmented by the momentum and liquidity risk factors. The estimates are similar to the initial model, presented in Table 3.

TABLE A1 The annualized measures of portfolios' performance without energy stocks.

a. Equally weighted	Market	DJSN	High	Low	None	High-low	High-none
Return	0.077	0.091	0.111	0.074	0.053	0.020	0.046
SD	0.180	0.186	0.155	0.179	0.158	0.140	0.120
Sharpe Ratio	0.331	0.396	0.598	0.315	0.232	0.029	0.248
Inf. Ratio: market		0.104	0.321	−0.024	−0.189	−0.244	−0.146
Inf. Ratio: DSJN	−0.104		0.130	−0.102	−0.235	−0.303	−0.209
Sortino Ratio	0.044	0.050	0.067	0.043	0.034	0.018	0.040
ES	−0.030	−0.029	−0.027	−0.029	−0.034	−0.022	−0.016
b. Value-weighted	**Market**	**DJSN**	**High**	**Low**	**None**	**High-low**	**High-none**
Return	0.077	0.091	0.111	0.075	0.034	0.012	0.065
SD	0.180	0.186	0.175	0.212	0.173	0.167	0.136
Sharpe ratio	0.331	0.396	0.532	0.273	0.100	−0.025	0.353
Inf. ratio: market		0.104	0.379	−0.013	−0.396	−0.256	−0.054
Inf. ratio: DSJN	−0.104		0.133	−0.090	−0.365	−0.306	−0.117
Sortino ratio	0.044	0.050	0.062	0.040	0.024	0.013	0.048
ES	−0.030	−0.029	−0.026	−0.032	−0.033	−0.029	−0.019

Note: This table reports the annualized return (return) annualized SD, and Sharpe ratio based on the historical risk-free rate with an average of 1.6%. Information ratios are based on the Oslo stock exchange index (inf. ratio: market) and the currency-adjusted Dow Jones Sustainability Index Nordic (inf. ratio: DJSN) benchmarks. The downside risk measures—Sortino ratio and expected shortfall (ES)—were calculated for a target return of zero and a confidence level of 95%. Stocks' weights in the value-weighted portfolios are calculated based on market capitalization.

TABLE A2 Regression results of the Fama–French three-factor model, augmented by the liquidity and momentum factors.

	Alpha		Market		SMB		HML		LIQ		MOM		R^2
a. Value weighted portfolios													
High	0.002		−0.029	***	0.078	***	0.029	***	−0.018	*	0.947	***	0.869
Low	−0.035	**	−0.036	***	−0.040	**	0.074	***	−0.027	*	1.073	***	0.746
None	−0.033	***	−0.070	***	−0.219	***	−0.054	***	0.003		0.979	***	0.830
High-low	0.029	**	0.041	***	0.297	***	0.084	***	−0.020		−0.032	**	0.126
High-none	0.032	*	0.006		0.118	***	−0.044	***	0.010		−0.126	***	0.047
b. Equally weighted portfolios													
High	−0.013		−0.005		−0.259	***	−0.041	***	−0.051	***	0.832	***	0.712
Low	−0.059	***	−0.085	***	−0.271	***	0.004		−0.009		1.063	***	0.675
None	−0.031	***	−0.074	***	−0.402	***	−0.009		0.010		0.867	***	0.782
High-low	0.013		0.069	***	0.143	***	−0.032	**	−0.061	***	−0.035	**	0.053
High-none	0.040	*	0.080	***	0.012		−0.045	***	−0.042	*	−0.231	***	0.079
c. Value weighted portfolios without energy stocks													
High	0.009		0.008		0.066	***	−0.021	***	0.023	**	0.871	***	0.794
Low	0.005		0.004		−0.024		0.005		−0.008		0.919	***	0.617
None	−0.010		−0.037	***	−0.255	***	−0.082	***	−0.002		0.853	***	0.729
High-low	0.013		0.045	***	0.321	***	0.060	***	0.025		0.018		0.123
High-none	−0.003		0.004		0.090	***	−0.026		0.031		−0.048	***	0.014
d. Equally weighted portfolios without energy stocks													
High	0.024	**	0.014	*	−0.226	***	−0.048	***	−0.003		0.753	***	0.752
Low	−0.006		−0.048	***	−0.224	***	−0.078	***	0.000		0.785	***	0.544
None	0.004		−0.041	***	−0.425	***	−0.034	***	0.013		0.752	***	0.713
High-low	0.015		0.056	***	0.199	***	−0.014		−0.016		0.001		0.072
High-none	0.024		0.063	***	−0.002		0.030	**	−0.003		−0.033	**	0.010

Note: This table reports estimated coefficients for long portfolios of stocks with high, low, and no score, and long-short portfolios of these stocks constructed with equal weighting (a and c) and value weighting by market capitalization (b and d). Alpha stands for an intercept given as a percentage of daily return, market is a slope for risk-adjusted returns of Oslo stock exchange index (or beta-coefficient), SMB and HML are size and value factors, LIQ and MOM are liquidity and momentum factors. Stars show significance of the coefficients: *$p < .1$; **$p < .05$; ***$p < .01$. Subtables c and d show regression results for the sample without energy stocks. R^2 shows a coefficient of determination for each portfolio.

TABLE A3 Estimated portfolios' excess returns for different subsamples based on the Fama–French three-factor model.

a. Equally weighted portfolios, whole sample

	2010–2020		Before 2014		After 2014		Before 2016		After 2016		After Covid	
High	−0.014		0.010		−0.034	*	−0.005		0.001		−0.139	
Low	−0.063	***	−0.004		−0.103	***	−0.08	*	−0.080	**	−0.215	**
None	−0.034	***	−0.015		−0.048	***	−0.031	**	−0.028		−0.076	
High-low	0.014		0.016		0.011		0.019		0.026		−0.065	
High-none	0.043	**	0.005		0.066	**	0.026		0.078	**	0.074	

b. Equally weighted portfolios, sample without energy stocks

	2010–2020		Before 2014		After 2014		Before 2016		After 2016		After Covid	
High	0.019	*	0.018		0.018		0.020		0.026	*	0.009	
Low	−0.007		−0.012		−0.004		0.004		0.004		−0.131	
None	−0.002		0.013		−0.012		0.020		−0.031	*	−0.052	
High-low	0.015		−0.004		0.028		−0.007		0.054	**	0.060	
High-none	0.021		0.021		0.019		0.009		0.019		0.138	

c. Value-weighted portfolios, whole sample

	2010–2020		Before 2014		After 2014		Before 2016		After 2016		After Covid	
High	0.001		0.007		−0.005		0.002		0.008		−0.024	
Low	−0.037	**	−0.013		−0.053	**	−0.049	**	−0.022		−0.011	
None	−0.036	***	−0.035	**	−0.034	**	−0.031	**	−0.038	**	−0.066	
High-low	0.030	**	0.032		0.026		0.025		0.044	*	0.040	
High-none	0.032	*	0.011		0.045	*	0.043	*	0.027		−0.015	

d. Value-weighted portfolios, sample without energy stocks

	2010–2020		Before 2014		After 2014		Before 2016		After 2016		After Covid	
High	0.009		0.014		0.004		0.012		0.004		0.010	
Low	0.006		−0.001		0.010		0.003		−0.005		0.058	
None	−0.015		−0.007		−0.020		0.001		−0.036	*	−0.051	
High-low	0.018		0.011		0.020		0.004		0.037		0.058	
High-none	−0.003		0.006		−0.010		0.002		0.006		−0.050	

Note: This table reports estimated alphas (excess returns) for long portfolios of stocks with high, low, and no scores as well as long-short portfolios of these stocks constructed with equal weighting and value weighting by market capitalization. Stars show significance of the coefficients: $^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

TABLE A4 Estimated abnormal returns for industry portfolios by categories.

Sector	High		R^2	Low		R^2	None		R^2
a. Equally weighted portfolios, CAPM									
Energy	−0.174	***	0.282	−0.159	***	0.453	−0.124	***	0.524
Industrials	0.038		0.221	−0.013		0.167	−0.055	**	0.321
Financials	0.013		0.579	0.010		0.489	0.015		0.499
Consumer Staples	0.033		0.303	−0.007		0.249	0.062	**	0.215
Consumer Discretionary	−0.003		0.070	−0.099		0.115	−0.059		0.150
Health Care							−0.022		0.083
Information Technology	0.045		0.210	0.030		0.187	−0.043		0.183
Materials	−0.011		0.419	0.002		0.396	−0.001		0.334
Telecom	0.017		0.377						
Utilities	0.088	**	0.098	−0.024		0.040	0.084	*	0.028
b. Value-weighted portfolios, CAPM									
Sector	**High**		R^2	**Low**		R^2	**None**		R^2
Energy	−0.029		0.571	−0.120	***	0.491	−0.080	***	0.651
Industrials	0.044		0.240	0.006		0.187	−0.054	**	0.393
Financials	0.010		0.627	0.024		0.456	0.003		0.540
Consumer Staples	0.026		0.342	−0.007		0.249	0.046		0.233
Consumer Discretionary	−0.014		0.078	−0.084		0.117	−0.058		0.125
Health Care							−0.015		0.116
Information Technology	0.046		0.211	0.028		0.191	−0.061		0.154
Materials	−0.020		0.423	0.000		0.393	0.004		0.341
Telecom	0.017		0.377						
Utilities	0.084	**	0.096	−0.024		0.040	0.086	*	0.028
c. Equally weighted portfolios, FF3									
Sector	**High**		R^2	**Low**		R^2	**None**		R^2
Energy	−0.166	***	0.293	−0.145	***	0.476	−0.112	***	0.559
Industrials	0.048		0.264	−0.006		0.197	−0.040	*	0.409
Financials	0.017		0.582	0.013		0.491	0.022		0.547
Consumer Staples	0.029		0.316	0.016		0.268	0.061	**	0.234
Consumer Discretionary	0.005		0.136	−0.105	*	0.129	−0.034		0.212
Health Care							−0.014		0.120
Information Technology	0.047		0.280	0.018		0.286	−0.035		0.284
Materials	−0.010		0.420	0.003		0.405	−0.005		0.338
Telecom	0.006		0.413						
Utilities	0.097	**	0.146	−0.024		0.040	0.091	*	0.033
d. Value-weighted portfolios, FF3									
Sector	**High**		R^2	**Low**		R^2	**None**		R^2
Energy	−0.023		0.576	−0.107	***	0.509	−0.071	***	0.669
Industrials	0.051	*	0.279	0.011		0.207	−0.045	**	0.451
Financials	0.014		0.634	0.026		0.459	0.008		0.567
Consumer Staples	0.021		0.350	0.016		0.268	0.045		0.255
Consumer Discretionary	−0.006		0.134	−0.093		0.130	−0.035		0.179
Health Care							−0.008		0.158
Information Technology	0.047		0.279	0.016		0.298	−0.053		0.255

(Continues)

TABLE A4 (Continued)

d. Value-weighted portfolios, FF3

Sector	High		R^2	Low		R^2	None		R^2
Materials	−0.019		0.424	0.001		0.403	0.000		0.346
Telecom	0.006		0.413						
Utilities	0.092	**	0.143	−0.024		0.040	0.092	*	0.032

e. Equally weighted portfolios, FF3 + MOM

Sector	High		R^2	Low		R^2	None		R^2
Energy	−0.164	***	0.293	−0.138	***	0.482	−0.105	***	0.569
Industrials	0.047		0.265	−0.005		0.198	−0.037		0.411
Financials	0.020		0.585	0.012		0.491	0.023		0.548
Consumer Staples	0.028		0.317	0.018		0.269	0.060	**	0.234
Consumer Discretionary	0.003		0.136	−0.089		0.144	−0.029		0.214
Health Care							−0.012		0.120
Information Technology	0.045		0.282	0.015		0.288	−0.033		0.285
Materials	−0.012		0.420	0.005		0.406	−0.006		0.339
Telecom	0.005		0.414						
Utilities	0.097	**	0.146	−0.028		0.046	0.092	**	0.033

f. Value-weighted portfolios, FF3 + MOM

Sector	High		R^2	Low		R^2	None		R^2
Energy	−0.019		0.579	−0.100	***	0.516	−0.063	***	0.682
Industrials	0.050	*	0.279	0.011		0.207	−0.042	**	0.453
Financials	0.016		0.635	0.023		0.460	0.010		0.568
Consumer Staples	0.020		0.351	0.018		0.269	0.043		0.256
Consumer Discretionary	−0.008		0.135	−0.078		0.145	−0.030		0.181
Health Care							−0.007		0.158
Information Technology	0.046		0.281	0.012		0.299	−0.051		0.255
Materials	−0.022		0.425	0.004		0.404	−0.001		0.346
Telecom	0.005		0.414						
Utilities	0.093	**	0.143	−0.028		0.046	0.093	**	0.033

g. Equally weighted portfolios, FF3 + LIQ

Sector	High		R^2	Low		R^2	None		R^2
Energy	−0.162	***	0.296	−0.144	***	0.476	−0.112	***	0.559
Industrials	0.049		0.265	−0.005		0.198	−0.040	*	0.409
Financials	0.016		0.582	0.013		0.491	0.021		0.547
Consumer Staples	0.030		0.316	0.040		0.293	0.060	**	0.235
Consumer Discretionary	0.002		0.138	−0.107	*	0.130	−0.039		0.216
Health Care							−0.013		0.120
Information Technology	0.046		0.280	0.013		0.291	−0.035		0.284
Materials	−0.009		0.420	0.004		0.405	−0.005		0.338
Telecom	0.004		0.417						
Utilities	0.098	**	0.147	−0.031		0.048	0.095	**	0.036

h. Value-weighted portfolios, FF3 + LIQ

Sector	High		R^2	Low		R^2	None		R^2
Energy	−0.022		0.577	−0.106	***	0.509	−0.070	***	0.669
Industrials	0.051	*	0.279	0.011		0.207	−0.045	**	0.451

TABLE A4 (Continued)

h. Value-weighted portfolios, FF3 + LIQ

Sector	High		R^2	Low		R^2	None		R^2
Financials	0.014		0.634	0.026		0.459	0.007		0.567
Consumer Staples	0.023		0.351	0.040		0.293	0.043		0.256
Consumer Discretionary	−0.009		0.136	−0.095		0.130	−0.040		0.184
Health Care							−0.006		0.159
Information Technology	0.047		0.279	0.012		0.302	−0.053		0.255
Materials	−0.019		0.424	0.002		0.403	−0.001		0.346
Telecom	0.004		0.417						
Utilities	0.094	**	0.144	−0.031		0.048	0.096	**	0.036

Note: This table reports estimated coefficients for long portfolios of stocks with high, low, and no scores from the same industry and constructed with equal weighting and value weighting (by market capitalization). Alpha stands for an intercept given as a percentage of daily return. In the model specification, CAPM is the capital asset pricing model with market factor only, Fama–French three-factor model (FF3) also includes SMB and HML, which are size and value factors. LIQ and MOM are liquidity and momentum factors. Stars show significance of the coefficients: *$p < .1$; **$p < .05$; ***$p < .01$. R^2 shows a coefficient of determination for each portfolio.

A.2 | PORTFOLIO PERFORMANCE CONDITIONED BY TIME

I performed a structural breaks analysis based on the approach described in Pretis et al. (2018). The impulse saturation method can detect structural breaks without pre-specification of suspected dates. It relies on autoregressive modeling of the abnormal returns generated from the Fama–French three-factor model. Suggested paths with significant steps in the excess return levels are present in Figure A1.

There are four major periods when the changes have happened. After closer examination, almost all of them are related to sustainable development and investing:

1. August 2011: A big plunge of the Oslo Stock Exchange index.
2. December 2014: The Ministry of Finance of Norway released new guidelines concerning responsible investment for the Government Pension Fund Global, effective from January 1, 2015.
3. February 2016: Statistics Norway showed that investments in oil and gas extraction felt more than it was predicted due to the further reduction of the exploration activities.
4. March 2020: The Norwegian Government announced a national lockdown after an abrupt rise in the reported cases of SARS-CoV-2 infections.

A.3 | INDUSTRY EFFECT

The portfolios within each sector were considered and the excess return of each were estimated. Energy portfolios in all model specifications have negative abnormal returns.

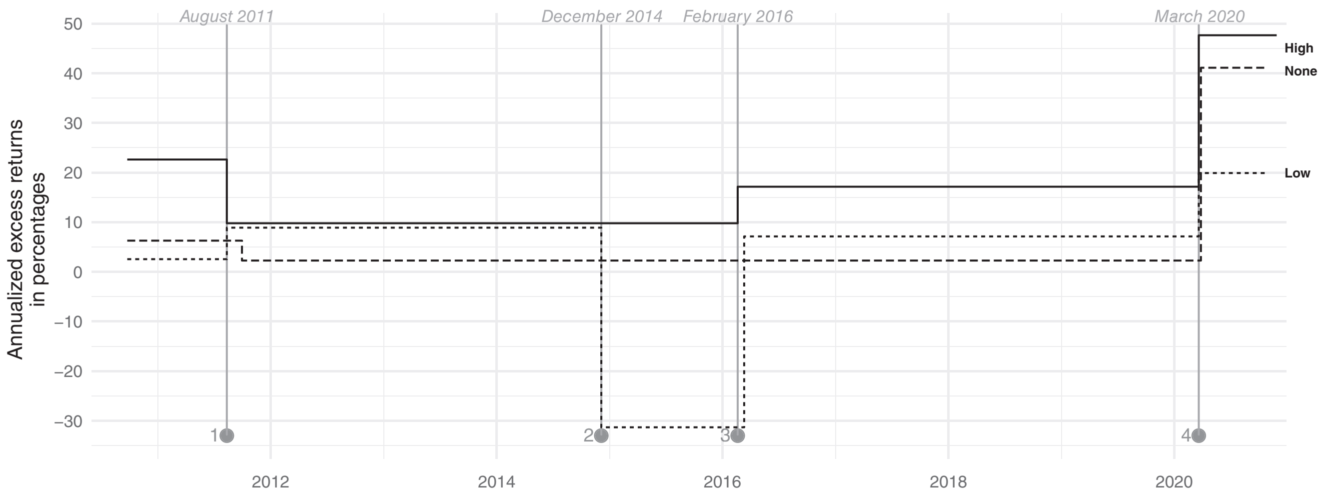

FIGURE A1 Detected structural breaks in the time-series of estimated abnormal returns. Structural breaks are detected with the impulse saturation method, described in Pretis et al. (2018). Abnormal returns are estimated by Fama–French three-factor model on the weekly data.