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The Environmental and Financial Performance of European Green Energy Investments

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

Abstract

This paper addresses the relationship between environmental and financial performance of energy companies. For this purpose, we compare the performance of green energy portfolios of European stocks compared to their non-green counterparts from 2009 to 2018. Furthermore, we form portfolios based on the dimensions of the Environmental ASSET4 ESG pillar, namely the Environmental Pillar, Emission Reduction, Resource Reduction and Product Innovation dimensions and compare the performance of high-rated portfolios against low-rated portfolios.

Our results show that, for the most part, green energy portfolios are very similar to non-green portfolios in terms of performance, with most of our results not showing any statistical difference between green and non-green portfolios. However, when analyzing performance across different sub-periods, namely from 2009 to 2013 and 2014 to 2018, we observe an improvement in abnormal returns. These results suggest that, over time, the performance of green stocks improved but these improvements are not enough to outperform that of non-green portfolios.

Regarding the ranked-based portfolios, the results show that, overall, high-rated and low-rated portfolios perform similarly but, when considering a 50% cut-off and when using a sector benchmark (the MSCI Energy EU), as well as in the 2014 to 2018 sub-period, the high-rated portfolio formed on the Resource Reduction dimension significantly outperforms the low-rated portfolio.

Overall, our results suggest that investors will not suffer financial penalties by forming portfolios based on green energy screening.

Keywords: Environmental performance; Green energy; Green finance; Sustainable investments; ESG Investing.

Resumo

Este estudo investiga a relação entre o desempenho financeiro e ambiental de empresas de energia na Europa. Com este objetivo, comparamos o desempenho de carteiras de energia verde com carteiras de energia não verde no período de 2009 a 2018. De forma a comparar o desempenho ambiental com o desempenho financeiro, criámos carteiras baseadas nas dimensões do "Environmental ASSET4 ESG pillar", nomeadamente as dimensões Ambiental, Redução de emissões, Redução de recursos e Inovação de produto.

Os nossos resultados mostram que, na maioria dos casos, as carteiras de energia verde são muito semelhantes às carteiras de energia não verde em termos de desempenho financeiro, não havendo na maioria dos casos diferença estatisticamente significativas. No entanto, ao analisar o desempenho dos subperíodos (de 2009 a 2013 e 2014 a 2018), observamos uma melhoria do desempenho. Estes resultados sugerem que, ao longo do tempo, o desempenho financeiro das ações verdes melhoraram, embora não o suficiente para superar de forma significativa as carteiras de ações não verdes.

Considerando as carteiras baseadas na classificação ESG, na sua maioria, os nossos resultados mostram que as carteiras "high-rated" e "low-rated" têm um desempenho semelhante, mas quando consideramos um "cut-off" de 50% e o índice do sector de energia (MSCI Energy EU), e também o subperíodo de 2014 a 2018, a carteira "high-rated" formada na dimensão de Redução de recursos supera em termos financeiros a carteira "low-rated".

No geral, os nossos resultados sugerem que os investidores não sofrem qualquer tipo de penalizações financeiras ao formar carteiras baseadas em critérios de energia verde.

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1. Introduction

The increasing awareness about environmental issues such as global warming has led to a growing number of mutual funds investing in green stocks, addressing investors' needs towards socially responsible and green investing. This trend has been followed by a number of studies comparing the performance of green and socially responsible funds and indices to their conventional counterparts. These studies aim to answer a question that is important to investors: what is the financial impact of investing with environmental criteria? There are arguments that support a positive impact and others that are in favor of a negative impact. On one side, investing in environmentally friendly funds may lead to inferior performance when compared to its conventional peers and the market (e.g., Muñoz et al., 2014, Lesser et al., 2016, and Reboredo et al., 2017). On the other hand, there is evidence of improvement of risk-adjusted returns over time and of similar performance compared to conventional funds (e.g., Climent & Soriano, 2011, and Ibikunle & Steffen, 2017).

As environmental issues assume increasing importance in society, interest in promoting sustainability and environmentally friendly practices becomes a priority in the energy sector. One of the strategies to deal with the adverse effects of global warming concerns energy sources, namely by promoting energy efficiency practices and replacing fossil fuels with low-carbon and cleaner sources of energy (Ripple et al., 2020). Although renewables have grown significantly, more than 80% of the total global primary energy demand is satisfied by coal, oil and gas: the total increase in fuel demand in 2018 was met by 70% by fossil fuels (IEA, 2019). The urgency towards a low and carbon-free future has motivated accelerated growth of the green sources of energy. The investment towards green companies is growing and, while reducing the environmental impact, green energy investing stimulates a reduction in fossil fuel dependency. This increase in green energy investments in recent years - 200 billion in 2008 to over 300 billion in 2018 in clean energy (Bloomberg, 2019) - reflects the attractiveness not only of the idea of a conscious future but also of a financial performance standpoint.

Although there are some studies on the performance of green funds and portfolios of green stocks, few of them focus on a specific segment of stocks: green energy stocks.

This dissertation seeks to address the performance of green energy stocks and how portfolios screened on green energy criteria compare to non-green energy portfolios in the European market. To complement the analysis, we form green energy portfolios based on the ASSET4 ESG Environmental Pillar dimensions and assess the performance of high versus low ranked portfolios formed on these dimensions. Besides investigating the financial performance of green vs non-green energy stocks, we also address their environmental ratings based on ASSET4 Environmental Pillar dimensions.

This study contributes to the literature by evaluating the impact of environmental screening on the performance of investments in a specific sector within green stocks: green energy-related stocks. Some recent related studies address the performance of renewable energy funds – Reboredo et al. (2017), Martí-Ballester (2019a,b). However, evaluating the performance of green energy funds may not be the best way to assess the impact of green energy stocks in portfolio performance. As Kempf & Osthoff (2007) mention, the limitations of this approach are associated with the difficulties in disentangling the performance that is due to green effects from other effects, such as the fund manager skill or management fees. An alternative approach consists of forming synthetic portfolios of green stocks. There are very few studies that address the performance of green versus non-green portfolios of stocks, namely Ng & Zheng (2018), on the US market. There are a few papers on a related topic the financial effects of fossil fuel divestment (Henriques & Sadorsky, 2018, Trinks et al., 2018 and Hunt & Weber, 2019), all of which address North American companies. To the best of our knowledge, there are no studies on the performance of European green versus non-green stock synthetic portfolios. This dissertation contributes to fill this gap. With that said, this dissertation addresses the environmental and financial performance of green energy stocks with the research questions lying on: “Do green energy stocks outperform non-green energy stocks?” and “How do green energy stocks perform in terms of environmental dimensions”?

2. Literature Review

There are numerous studies on the relationship between corporate social and financial performance. Looking back to 1972 until 2003 and taking a look at the broader

view regarding socially responsibility, the review studies of Margolis & Walsh (2003) and Orlitzky, et al., (2003) argue that the majority of studies on the link between corporate social performance and financial performance conclude that there tends to be a positive association between these two dimensions.

From the investor's perspective, the question is how social screening affects portfolio performance. There are arguments in favor a negative impact, which are centered around diversification, and arguments in favor of a positive impact, which stem from stakeholder theory and a contemporary view of corporate social responsibility. A body of research addresses this issue empirically by evaluating the performance of actively managed socially responsible funds. Studies such as Reyes & Grieb (1998), Statman (2000), Bauer et al., (2005), and Cortez et al., (2009) compare the performance of socially responsible investment (SRI) mutual funds to conventional mutual funds and/or the market and find that their performance is similar.[1] Moving away from funds, there are some studies that form stocks portfolios based on SRI ratings where a simple strategy of being long in high-rated stocks and short in low-rated stocks is enough for significant outperformance (Kempf & Osthoff, 2007, Statman & Glushkov, 2009). The latter study also suggests that social screening yields better performance results than conventional portfolios but only when including the best rated companies of all sectors and that screening companies from the tobacco, alcohol gambling, etc. sectors penalizes portfolio performance. In general, most studies using this type of approach find either neutral or positive abnormal returns of portfolios socially responsible stocks.[2]

When it comes to green investing - which is a subset of the socially responsible investment market, there are arguments in favor of a positive impact and others in favor of a negative impact of environmental screening on portfolio performance. One of the arguments in the debate relating environmental performance and financial performance is that firms that increase their environmental performance must bear the costs of doing so at the expense of a diminished financial performance (e.g., Walley &

[1] For a more detailed discussion on the performance of actively managed SRI funds see, for example, the review papers of Capelle-Blancard & Monjon (2012) and Revelli & Viviani (2015).

[2] For a more detailed discussion of the empirical studies regarding the performance of portfolios of socially responsible stocks see, for instance, the review papers of Margolis & Walsh (2003), Orlitzky et al. (2003), and Javed et al. (2016).

Whitehead, 1994; Molina-Azorín et al. 2009). Furthermore, using restrictive screens should reduce the ability to diversify, thereby increasing portfolios' non-systematic risk compared to non-screened investments (Rudd, 1981, Grossman & Sharpe, 1986). Rudd (1981), for instance, argues that constraining a portfolio would introduce size and other biases that impact its financial performance. In contrast, there are arguments suggesting that increasing environmental performance can result in a competitive advantage and lower costs for the firms (e.g., Freeman & Evan, 1990; Porter & van der Linde, 1995; Ambec & Lanoie, 2008).

Regarding the performance of green funds - funds that adopt environmental criteria to investment screening, several studies document evidence of green funds underperforming the benchmark (e.g., Climent & Soriano, 2011, Silva & Cortez, 2016, Lesser et al. 2016, and Ibikunle & Steffen, 2017). Another interesting finding is that in recent sub-periods the performance of green funds does not differ significantly from their benchmark or conventional peers, suggesting an improvement by these funds over time (Climent & Soriano, 2011). Ibikunle & Steffen (2017) also document an improvement in recent periods regarding the risk-adjusted performance of green funds, as these outperform black peers between 2012-2014. When considering the crisis periods, there is evidence that green funds can offer investors some protection against market downturns (Muñoz et al. 2014, Lesser et al. 2016, Silva & Cortez, 2016 and Ibikunle & Steffen, 2017). Another study by Mallett & Michelson (2010) suggests that green funds do not perform worse than other socially responsible funds, although the study might be limited by the sample size. Likewise, Muñoz et al. (2014) find evidence of similar performance of green funds compared to other forms of SRI funds. Furthermore, Lesser et al. (2016) suggest that within the different screens, there are screens that seem to drive and justify part of the underperformance of green funds during non-crisis periods, which is the case of the significant underperformance of social and energy screens.

A recent stream of the literature has addressed the topic of fossil fuel divestment by analyzing the financial effects of divestment from fossil fuel companies (e.g., coal, oil and gas) on portfolio performance. Henriques & Sadorsky (2018) investigate this issue by focusing on the performance of several ETFs that represent specific sectors and the market. Their results show that including clean energy and divesting from fossil fuel and

utilities can result in higher risk-adjusted returns. However, as the study is limited to the US, other countries with fossil fuel accounting higher percentages of stock market capitalization may yield different results. Similarly to Henriques & Sadorsky (2018), Hunt & Weber (2019) analyze the Canadian TSX260 index with and without fossil fuel stocks and show that different divestment strategies result in higher risk-adjusted returns. Also, there is a direct relation between stricter divestment approaches and risk-adjusted returns. Furthermore, this study adds by suggesting that even in markets with a high fossil fuel concentration, divestment can be done successfully, not harming the financial performance by divesting in fossil fuels. Trinks et al. (2018) form portfolios with and without fossil fuel stocks and show that divesting from fossil fuel increases downside risk. In addition, when comparing fossil free portfolios to an unconstrained market portfolio, there is no statistically significant difference between the performance of both portfolios. However, in a more recent period, from 2011 to 2016, Trinks et al. (2018) observe underperformance of fossil fuel stocks, possibly justified by negative oil price shocks in the same period. Another study by Brzeszczyński et al. (2019) shows that, in the 11 year period from 2005 to 2016, energy and resource firms are neither rewarded or penalized by adopting SRI practices when compared to the market, although in this study the firms are not necessarily green and are only compared to the market.

Regarding the performance of actively managed mutual funds that invest in clean energy companies, such as renewable energy funds, Marti-Ballester (2019a) shows that only when compared to their matched specific benchmark do renewable energy funds outperform. When compared to a broader benchmark (S&P Global 1200 Energy), these funds do not achieve a positive and significant return. Martí-Ballester (2019b) suggests that when using a conditional model, renewable energy funds have a similar performance to their black peers and to the market, using conventional and specialized global benchmarks, but they perform worse than their conventional peers when adopting a specialized global market index as a benchmark. Additionally, the smaller investment possibilities of renewable energy funds means that they are losing on other possible better investments. Reboredo et al. (2017) conclude that renewable energy funds perform worse than conventional and SRI funds and, somewhat contradicting the argument of market downturn protection, find a higher downside risk than conventional and SRI funds. Apart from the evidence regarding the performance of green funds

tending towards underperformance or neutrality, it is also worth noting that investors are paying a premium for their socially responsible decisions when investing in alternative energy funds (Reboredo et al., 2017, Martí-Ballester, 2019b).

To the best of my knowledge, there are only two studies – those of Anderloni & Tanda (2017) and Ng & Zheng (2018) that deal with green energy stocks. Anderloni & Tanda (2017) focus on the performance of initial price offerings of European green and non-green energy stocks up to 36-months after the initial price offering and find that the financial performance of green energy companies does not differ from the non-green energy ones. In turn, Ng and Zheng (2018) show that synthetically formed green energy portfolios perform similarly or even better compared to its matching non-green portfolio and the S&P 500 Energy benchmark when considering the whole period and the economic boom from 2000 to 2009.

3. Methodology

Within the energy sector, we start by distinguishing green energy companies from the non-green energy companies. Then, we form a value-weighted portfolio of green energy companies and a value-weighted portfolio of non-green energy companies as well as a differences portfolio that reflects a strategy of a long position in the green portfolio and a short position in the non-green portfolio. In order to evaluate the financial performance of the portfolios, we use the Carhart (1997) four-factor model (Eq. 1) that accounts for the market, size, growth, and momentum factors. Previous findings in socially responsible and green funds suggest that the size and growth factors play a significant role in explaining performance in socially responsible and green funds (e.g., Ng & Zheng, 2018, Bauer et al., 2005, and Silva & Cortez, 2016). The four-factor model is represented as follows:

$$r_{p,t} = \alpha_p + \beta_p r_{m,t} + \beta_s SMB_t + \beta_h HML_t + \beta_m MOM_t + \varepsilon_{p,t} \text{ (Eq. 1)}$$

where $r_{p,t}$ is the excess return of portfolio p in period t; $r_{m,t}$is the market excess return in period t, SMB_t is the difference in return between small-cap and large-cap portfolios

in period t, HML_t is the difference in return between high book-to-market stocks and low book-to-market stocks in period t, MOM_t is the difference in returns of a portfolio of past winning stocks and a portfolio of past losing stocks (in the past 12 months) and $\varepsilon_{p,t}$ is the error term.

Considering that using an unconditional model might lead to biased estimates of performance (Ferson & Schadt, 1996), we follow Christopherson et al. (1998) and apply the four-factor model in a conditional setting that allows for alphas and betas to vary linearly over time as a function of a vector of conditioning information Z_{t-1} which represents the public information available at time t − 1 that is relevant for predicting returns at time t, as follows:

$$r_{p,t} = \alpha_{0p} + A'_p z_{t-1} + \beta_{0p} r_{m,t} + \beta'_{0p}(z_{t-1} r_{m,t}) + \beta_{1p} SMB_t + \beta'_{1p}(z_{t-1} SMB_{,t}) + \beta_{2p} HML_t + \beta'_{2p}(z_{t-1} HML_t) + \beta_{3p} MOM_t + \beta'_{3p}(z_{t-1} MOM_t) + \varepsilon_{p,t} \quad \text{(Eq. 2)}$$

where $z_{t-1} = Z_{t-1} - E(Z)$ represents a vector of deviations of Z_{t-1} from their unconditional average values, β_{0p}, β_{1p}, β_{2p}, β_{3p} are the average betas, β'_{0p}, β'_{1p}, β'_{2p}, β'_{3p} are vectors that measure the sensitivity of conditional betas to the information variables Z_{t-1}, A'_p is a vector that measures the response of the conditional alpha to the information variables, α_{0p} is the average conditional alpha, and $\varepsilon_{p,t}$ is the error term.

Complementing the study, we identify the stocks that are rated by ASSET4 ESG[3] and form portfolios based on the environmental dimensions of the ASSET4 ESG Scores. The procedure to form portfolios is inspired by Kempf & Osthoff, (2007) and Statman & Glushkov, (2009): Each year we rank companies according to their scores in the Environmental Pillar of the ASSET4 ESG database as well as in its three categories: Emission Reduction, Resource Reduction and Product Innovation. The portfolios are based on the highest and lowest rated companies for each dimension, considering a 30% and 50% cut-off. The portfolios are rebalanced annually and scores from period ***t-1*** are

[3] Asset4ESG is a source of social data. It is described in more detail in the next section.

used to form the portfolios in the period ***t***. The performance of these portfolios is also evaluated with the models presented in equations (1) and (2).

4. Data

Green stocks are defined as firms that produce energy directly from environmentally friendly sources (e.g., solar, wind, biodiesel, etc.) and firms closely related to energy efficiency (e.g., electricity storage, smart grid, clean transportation). In order to identify the European green and non-green energy firms to be included in the dataset, we use the Eikon database together with the altenergystocks.com website[4]. In the Eikon database we used the code "INDUS" and then selected the Energy Sector to retrieve all the constituents from the "Energy - Fossil Fuel" and "Renewable Energy" tabs for European Markets. The altenergystocks.com website was used to complement the green portfolio (including only European firms), excluding trust funds and ETF's. After retrieving all the firms for both portfolios, we started with a pool of 387 firms for the non-green portfolio and 122 for the green portfolio. We then collected the monthly market capitalization and return index data, in USD, of these firms on Eikon DataStream over the 2009-2018 period. As for some firms the search for these variables returned errors, we ended up with 321 firms for the non-green portfolio and 115 firms for the green portfolio. Table (1) presents the descriptive statistics for the green and non-green portfolios including all firms, with the non-green portfolio showing a lower minimum and higher maximum, a higher standard deviation, a higher mean and a lower median when compared to the green portfolio. As mentioned in the methodology section, we also check whether the green and non-green firms considered in the initial dataset are rated by ASSET4. Asset 4ESG is a database that provides information on companies' ratings in terms of several dimensions of corporate social responsibility, namely on the Environment, Social and Governance pillars. The overall rating of the Environmental pillar provided by ASSET ESG results from the aggregation of the scores in three of its categories: Emission Reduction, Resource Reduction and Product Innovation. We identify the companies in our initial dataset that are rated by ASSET4 ESG and form

[4] The altenergystocks.com website was also used by Ng & Zheng, (2018) to identify green energy stocks.

portfolios of green and non-green rated firms (44 and 85 firms, respectively). Table (2) presents the descriptive statistics for these portfolios. We observe that the non-green portfolio exhibits wider swings in returns, and similar to when all firms are included, it presents a higher mean but a lower median. As for the normality test, using the Jarque-Bera test the p-value shows that, in any case, we cannot reject the hypothesis of the returns being normally distributed.

Table 1 - Descriptive statistics of the green and non-green portfolios considering all firms.

This table presents descriptive statistics of monthly returns of the green and non-green portfolios**.** Portfolios are value-weighted**.** The dataset includes 436 companies from 2009 to 2018. P-value is the probability of the Jarque-Bera normality test.

Descriptive Statistics	Non-Green	Green
Nº Observations	120	120
Minimum	-15.01%	-14.17%
Maximum	21.28%	18.59%
Mean	1.01%	0.93%
Median	0.83%	1.25%
Variance	0.40%	0.40%
Stand. Deviation	6.32%	6.29%
Skewness	0.320	-0.099
Kurtosis	0.326	-0.062
Jarque-Bera test p-value	0.243	0.905

Table 2 - Descriptive Statistics of the green and non-green portfolios considering the ESG rated firms.

This table presents descriptive statistics of monthly returns of the green and non-green portfolios with ESG ratings from ASSET4. Portfolios are value-weighted. The dataset includes 129 companies from 2009 to 2018 (85 and 44 companies for the non-green and green portfolios, respectively). P-value is the probability of the Jarque-Bera normality test.

Descriptive Statistics	Non-Green	Green
Nº Observations	120	120
Minimum	-15.26%	-14.11%
Maximum	21.14%	18.58%
Mean	0.94%	0.90%
Median	0.73%	1.29%
Variance	0.41%	0.40%
Stand. Deviation	6.40%	6.30%
Skewness	0.312	-0.091
Kurtosis	0.294	-0.069
Jarque-Bera test p-value	0.271	0.917

As for information regarding the industry and location of the firms, Tables (3) and (4) show the number of stocks by country as well as industry that are considered for the green and non-green portfolios, respectively. The stocks in the green portfolio are mainly located in 6 countries - Germany, France, Sweden, United Kingdom, Italy and Poland, with the main industries for the portfolio being Renewable Energy Equipment, Alternative Fuels, Electrical Components and Alternative Energy. The non-green portfolio stocks are mostly located in the United Kingdom, Russia, Norway, Romania, France and Poland, with their main industries relating to Oil, Oil Equipment, Oil Refining, Coal, Offshore Drilling and Marine Transportation.

Table 3 - Number of stocks by country and industry: non-green portfolio

This table presents the number of stocks of the green portfolio, by country and industry, from 2009 to 2018.

Nation				Industry			
United Kingdom	96	Guernsey	4	Oil: Crude Producers	121	Chemicals: Divers.	2
Russia	37	Austria	3	Oil Equipment & Svs	53	Specialty Retailers	2
Norway	33	Spain	3	Integrated Oil & Gas	28	Multi-Utilities	2
Romania	13	Belgium	3	Coal	20	Security Services	1
France	12	Croatia	3	Oil Refining & Mkting	18	Hhold Equip. Products	1
Poland	11	Switzerland	3	Marine Transportation	16	Retail REITs	1
Ireland	9	Isle of Man	3	Offshore Drill & Svs	10	Alternative Fuels	1
Ukraine	9	Monaco	3	Pipelines	6	Div. Fin. Services	1
Bosnia & Herzegovina	9	Iceland	2	Machinery: Industrial	5	Consumer Svs: Misc.	1
Sweden	8	Montenegro	2	Gas Distribution	4	Consumer Digital Svs	1
Netherlands	7	Hungary	1	Gold Mining	4	Construction	1
Italy	7	Lithuania	1	Transport Services	3	Divers. Industrials	1
Greece	6	Finland	1	Specialty Chemicals	3	Comm. Vehicles, Parts	1
Jersey	5	Faroe Islands	1	General Mining	3	Consumer Lending	1
Cyprus	5	Portugal	1	Other Inv. Instrm.	3	Iron & Steel	1
Germany	5	Denmark	1	Metal Fabricating	2	Auto Parts	1
Bulgaria	4	Malta	1	Industrial Suppliers	2	Nonferrous Metals	1
Luxembourg	4	Macedonia	1				
Serbia	4						

Table 4 - Number of stocks by country and industry: green portfolio.

This table presents the number of stocks of the non-green portfolio in the dataset, by country and industry, from 2009 to 2018.

Nation		Industry			
Germany	20	Renewable Energy Eq.	46	Machinery: Industrial	2
France	16	Alternative Fuels	14	Auto Parts	1
Sweden	13	Electrical Components	7	Oil Refining & Mkting	1
United Kingdom	11	Alt. Electricity	7	Water	1
Italy	8	Specialty Chemicals	4	Machinery: Tools	1
Poland	8	Conv. Electricity	4	Prod. Tech. Equipment	1
Spain	7	Bldg Materials: Other	4	Elec. Eq: Other	1
Norway	6	Div. Fin. Services	4	Elec. Eq: Gauges	1
Switzerland	5	Biotechnology	3	Eng. & Contract Svs	1
Belgium	4	General Mining	2	Food Products	1
Denmark	4	Metal Fabricating	2	Chemicals: Divers.	1
Netherlands	3	Construction	2	Oil: Crude Producers	1
Austria	3	Multi-Utilities	2	Consumer Svs: Misc.	1
Finland	2				
Ireland	2				
Portugal	1				
Bosnia & Herzegovina	1				
Hungary	1				

Regarding the portfolios of companies with ASSET4 ESG scores, we merged the initial pool of firms from both green and non-green portfolios and for each company we collected the scores for the Environmental Score as well as for its three categories: Emission Reduction, Resource Reduction and Product Innovation. For each dimension we created high and low-rated portfolios with 50% and 30% cut-offs. Again, due to DataStream not returning the respective scores from each dimension for some firms, the high and low-rated portfolios are taken from a pool of 129 firms.

As benchmarks, we use a specialized and a general benchmark. The specialized benchmark was proxied by the MSCI Europe Energy Index. The return index (RI) data of this index was collected from DataStream. To compute the excess returns of the specialized index, we used the risk-free rate from Professor Kenneth French's data library. [5] As the general market benchmark, we use the European market excess returns from Professor Kenneth French's data library. The relevant risk factors associated with European markets that are necessary to the Carhart (1997) 4-factor model regression

[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

analysis were also collected from the Kenneth French website under the "Developed Markets Factors and Returns" section for European markets. As conditioning information, we chose two public information variables: the term spread and the dividend yield. These variables were also used by Leite & Cortez (2018) and Leite et al. (2018).The term spread is computed as the difference between the yield of a long term (proxied by the 10 Year EMU Benchmark) and a short-term bond (represented by the 3 Month Euribor). The dividend yield is based on the STOXX Europe 600 index. This data was collected from DataStream. To mitigate the possibility of spurious regressions, we followed the suggestion of Ferson et al. (2003) and stochastically detrended these series by subtracting the 12-month moving average. Also, these variables were used in the mean-zero form.

5. Empirical Results

5.1. Performance of green vs non-green portfolios

Table (5) presents the regression estimates of the unconditional multifactor model using all the firms initially included in the dataset. We perform the regressions using the MSCI Energy EU and the Kenneth French (KF) market factors as benchmarks. Besides evaluating performance for the overall period 2009-2018, we also evaluate portfolio performance for two subperiods of five years (2009-2013 and 2014-2018). In order to identify any differences between the green and non-green portfolios we also present the estimates of the difference between the green and non-green portfolios, consisting of a strategy of a long position in the green portfolio and a short position in the non-green portfolio. This approach is followed for all models implemented. Also, in some tables that consider the conditional model, some columns are omitted since those do not have any statistical significance.

Table 5 - Performance of green and non-green portfolios including all firms – unconditional model.

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α	β1Mkt	β2SMB	β3HML	β4MOM	Adj. R2
Kenneth French						
Green	0.002	1.070 ***	-0.106	0.258 ***	-0.024	92.58%
Non-Green	0.004	0.931 ***	0.015	0.122	-0.098	67.35%
Long-Short	-0.002	0.141	-0.117	0.133	0.074	12.62%
MSCI EU Energy						
Green	0.009 **	0.572 ***	-0.170	0.637 ***	-0.230 **	63.79%
Non-Green	0.005 ***	0.956 ***	0.282 ***	0.037	-0.169 ***	92.38%
Long-Short	0.003	-0.383 ***	-0.448 **	0.598 ***	-0.062	21.80%
2009-2013 KF						
Green	-0.001	1.031 ***	-0.061	0.445 ***	-0.039	95.61%
Non-Green	0.001	1.104 ***	0.317	-0.399	-0.093 *	82.53%
Long-Short	-0.002	-0.073	-0.378 *	0.844 ***	0.054	28.67%
2014-2018 KF						
Green	0.004	1.108 ***	-0.178 *	0.051	0.198 **	86.82%
Non-Green	0.008	0.902 ***	-0.460	0.771 ***	-0.217	53.87%
Long-Short	-0.004	0.209	0.291	-0.724 **	0.415	13.30%
2009-2013 MSCI						
Green	0.007	0.708 ***	-0.271	0.955 ***	-0.164	83.81%
Non-Green	0.006 **	1.012 ***	0.242 *	-0.106	-0.189 ***	93.53%
Long-Short	0.001	-0.304 ***	-0.513 ***	1.060 ***	0.025	45.43%
2014-2018 MSCI						
Green	0.006	0.439 ***	0.232	-0.135	-0.127	30.09%
Non-Green	0.004 *	0.894 ***	0.296 *	0.215 *	-0.149	90.79%
Long-Short	0.002	-0.455 ***	-0.064	-0.351	0.022	37.59%

As shown in the table, both portfolios show a neutral performance when using the general market index as benchmark. When using the MSCI Energy EU, both portfolios yield positive and significant abnormal returns. As for the subperiods analysis, performance tend to be neutral. The exception is the non-green portfolio, which shows positive and statistically significant returns when using the MSCI Energy EU benchmark. In either case, the difference between the performance of both portfolios is not

statistically significant, meaning that there are no abnormal gains resulting from a strategy of going long in green portfolios and short in non-green portfolios.

Taking a closer look to the risk factors estimates, when considering the whole period and using all KF factors, we observe that the non-green portfolio is not significantly exposed to any risk factor besides the market and the green portfolio is exposed to value stocks, although the difference between both portfolios is not statistically significant. But, when we use the MSCI Energy EU as the benchmark, the market risk factor on the green portfolio decreases from around 1 to around 0.6 and the exposure to value stocks also increases. As for the non-green portfolio, the market factor remains similar, but it shows exposure to a small firm effect. Comparing portfolios, all these differences are statistically significant, with the SMB factor significant at 5% level and the HML and market risk factors significant at the 1% level.

Considering now the period division with the KF market factor, we observe some interesting risk factor estimates. In the 2009 to 2013 period, the green portfolio is significantly exposed, at the 1% level, to value stocks. The results of the long-short portfolio show that the difference of the exposure to the SMB and HML factors is statistically significant at the 10% and 1% level, respectively, indicating that the green portfolios is more exposed to large and value stocks than the non-green portfolio. In the 2014 to 2018 period, these results change: the non-green portfolio is now significantly exposed to value stocks (at the 1% level), whereas the green portfolio is now negatively exposed to the size factor (at the 10% level) and positively exposed to the momentum factor (at the 5% level), although the momentum and size coefficients are not significantly different from those of the non-green portfolio.

The subperiod analysis with the MSCI Energy EU benchmark shows that in the first period, similarly to when using the KF market factor, the green portfolio is exposed to value stocks (at the 1% level). The green portfolios also exhibit a statistically significant lower market risk, at 1% level, compared to the non-green portfolio. The non-green portfolio shows positive and significant coefficient, at 10% level, for the size factor as well as a significant negative exposure, at 1% level, to momentum factor, although the latter does not result in a significant difference between portfolios' exposure to momentum. In the 2014 to 2018 period, the R^2 for the green portfolio declines and the risk exposures to the additional risk factors are now statistically insignificant. The non-

green portfolio shows some exposure to small cap and value stocks (although only at the 10% level). Yet, except for the market factor, none of these coefficients are statistically different between both portfolios. In the case of the former, the difference might be due to the benchmark used not capturing all relevant market effects in the second period.

As for the alphas, although the non-green portfolio shows a positive and statistically significant coefficient at the 5% and 10% levels, respectively, in the first and second period, there are no statistical difference between the performance of the two portfolios.

Table (6) presents the regression estimates for the conditional multifactor models with time-varying alphas and betas, and with the term spread and dividend yield used as public information variables. We can observe that in some cases the variables associated with the public information variables are statistically significant, supporting the use of the conditional models in performance evaluation. We performed Wald tests for the conditional alphas and betas and these are in every case statistically significant,[6] meaning that we reject the hypothesis of the conditional alphas and conditional betas being jointly equal to zero.

[6] The results of the Wald test are not reported for the sake of space.

Table 6 - Performance of green and non-green portfolios including all firms - conditional model.

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum; TS corresponds to the term spread, computed as the difference between the yield of a long-term and short-term bond (proxied by the 10 year EMU benchmark and 3-month Euribor, respectively); DY corresponds to the dividend yield and is based on the STOXX Europe 600 Index. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α	TS	DY	β1Mkt	β2MktTS	β3MktDY	β4SMB	β5SMB TS	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	β11MOM DY	Adj. R2
Kenneth French															
Green	0.002	0.007	-0.013 **	1.056 ***	-0.031	0.176	-0.119	-0.139	0.275 ***	0.119	-0.369	0.014	0.076	-0.147	92.37%
Non-Green	0.005	0.016 *	-0.020	0.922 ***	-0.017	0.035	-0.175	-0.219	0.179	1.270 ***	-0.831	-0.206	0.276 *	0.133	71.35%
Long-Short	-0.003	-0.009	0.007	0.137	-0.013	0.132	0.061	0.077	0.093	-1.157 **	0.465	0.221	-0.200	-0.286	7.67%
MSCI EU Energy															
Green	0.008 **	-0.004	-0.011	0.573 ***	-0.096	0.530 *	-0.063	0.470	0.620 ***	0.059	-0.351	-0.068	0.146	-0.210	65.34%
Non-Green	0.005 ***	-0.001	0.000	0.947 ***	-0.074	0.154	0.252 **	0.064	0.092	0.303	-0.232	-0.114	0.093	-0.068	92.12%
Long-Short	0.003	-0.003	-0.010	-0.373 ***	-0.022	0.374	-0.311	0.404	0.527 ***	-0.248	-0.122	0.047	0.053	-0.145	24.16%
2009-2013 KF															
Green	0.000	0.005	-0.003	1.019 ***	0.081	-0.206	-0.088	-0.083	0.516 ***	-0.115	0.636	-0.062	0.024	0.031	95.24%
Non-Green	-0.001	0.016 *	-0.018	1.124 ***	-0.120	0.087	0.021	-0.369	-0.410 *	1.102 **	-1.706 *	-0.183	0.187	-0.276	85.75%
Long-Short	0.001	-0.012	0.015	-0.105	0.200	-0.293	-0.108	0.284	0.926 ***	-1.218 **	2.344 *	0.122	-0.164	0.308	36.39%
2014-2018 KF															
Green	0.004 *	-0.010	-0.016 *	1.029 ***	0.514 *	0.607 **	-0.462 ***	1.331 **	0.123	0.213	-0.921 **	0.381 ***	0.526	1.450 ***	90.31%
Non-Green	0.006	0.006	-0.023	0.761 ***	0.657	0.057	-1.007 **	2.086	0.933 ***	0.806	-1.046	0.206	-0.302	-1.151	56.07%
Long-Short	-0.002	-0.015	0.007	0.272	-0.144	0.541	0.557	-0.772	-0.815 **	-0.589	0.127	0.175	0.822	2.602 *	11.28%
2009-2013 MSCI															
Green	0.009 *	-0.010	0.005	0.689 ***	0.093	0.120	-0.013	0.411	1.046 ***	-0.304	1.429	-0.063	0.031	0.379	85.63%
Non-Green	0.004	-0.007	0.004	1.027 ***	-0.139	0.258	0.250 *	-0.041	-0.049	0.093	-0.325	-0.046	0.030	-0.258	93.39%
Long-Short	0.006	-0.003	0.002	-0.338 ***	0.232 *	-0.137	-0.263	0.450	1.094 ***	-0.398	1.756 *	-0.016	0.000	0.637	53.43%
2014-2018 MSCI															
Green	0.002	0.013	-0.004	0.599 ***	-1.202 **	0.942 **	0.063	1.225	-0.055	0.757	-2.605 **	0.527	-2.094 *	1.856	37.80%
Non-Green	0.000	0.022 **	0.000	0.901 ***	0.128	0.076	0.343	-1.004	0.095	0.432	-0.140	-0.018	-0.499	0.584	90.75%
Long-Short	0.002	-0.009	-0.004	-0.302 **	-1.330 ***	0.866 *	-0.279	2.229	-0.150	0.325	-2.466 **	0.544	-1.594	1.273	46.64%

Starting by the full period, the portfolios show similar exposures to the risk factors as in the unconditional model, when using both the KF and MSCI Energy EU benchmarks. We now observe that when using the KF benchmark the non-green portfolio exhibits statistically significant coefficients, at 1% and 10% level, of the HML and MOM factors associated with the term spread. The significance of the public information variable (PIV) associated with these risk factors disappears when using the MSCI Energy EU benchmark. In this case, we observe similar risk exposures as in the unconditional model, except for the green portfolio, that offsets the lower market risk exposure with a statistically significant impact (at the 10% level) of the market factor coefficient when it is associated with the PIV dividend yield.

When the KF benchmark is used, the results regarding alphas for the full period show that portfolio performance is somewhat dependent on conditioning information, with the green portfolio showing a negative and statistically coefficient, at the 5% level, associated to the dividend yield, and the non-green portfolio exhibiting a positive and statistically significant coefficient, at 10% level, associated to the term spread. When using the MSCI Energy EU benchmark, the average alphas remain statistically significant, at the 5% and 1% levels, for the green and non-green portfolios, respectively, as in the analysis of the unconditional model. Yet, we now observe no significant effects in performance associated with the PIVs. In any case, there are no statistically significant differences between the portfolios regarding abnormal returns.

Turning to the analysis of subperiods, the results for the 2009-2013 period are similar to those obtained with the unconditional model, with the green portfolio significantly exposed to value stocks, at the 1% level, and the non-green portfolio exposed to growth stocks, at the 10% level. As in the case of the unconditional model, the green portfolio is significantly more exposed to value stocks than the non-green portfolio. Furthermore, the HML factor associated with the PIVs shows a statistically significant impact of the term spread in this factor in the non-green portfolio, as well as a significant different impact compared to the green portfolio. For this period, using the specialized benchmark, the non-green portfolio is no longer exposed to the HML factor. Regarding the size factor, the non-green portfolio shows a positive coefficient, although only statistically significant at the 10% level. Also, as with the unconditional model, the green portfolio shows a statistically significant lower exposure to market risk.

The 2014 to 2018 period shows changes in the risk exposures when using both benchmarks. When using the KF benchmark, the green portfolio is exposed to large firms and momentum, at the 1% level, and the non-green portfolio shows exposure to large firms and value stocks, with the size and momentum factors not being statistically different between portfolios. In the green portfolio, the PIVs show a statistically significant impact in all risk factors, with a positive impact on the market, size and momentum factors and a negative impact on the value factor. Regarding the differences between portfolios, only the momentum factor associated with the dividend yield shows a statistically significant difference between portfolios, although only at the 10% level. Considering the MSCI Energy EU benchmark, the non-green portfolio exhibits no significant exposure to the risk factors other than market risk. The green portfolio suffers a significant negative impact, at the 5% level, of the term spread associated with the market factor, and a significant positive impact of dividend yield associated with the value factor. Also, the dividend yield significantly impacts the value factor (at the 5% level) and the term spread significantly impacts the momentum factor (at the 10% level), although the latter impact does not differ significantly between portfolios. These odd estimates in the MSCI Energy EU benchmark are maybe due to the green portfolio R^2 plummeting from 85% to around 40%.

As for the alphas in the subperiods, in any case does the non-green portfolio present a statistically significant difference compared to the green portfolio.

5.2. Performance of green vs non-green portfolios with ESG Scores

In this section, we now focus on the firms of the initial dataset that are rated by ASSET4 ESG. This analysis thus excludes firms that in either portfolio did not possess data regarding the Environmental Pillar and its three dimensions.[7] The purpose of this analysis is to ensure that we compare only the firms that have a measurement of environmental impact and see whether removing these “unranked” firms results in a differences compared to the results shown in section 5.1.

[7] It is important to note that these are not portfolios formed based on ESG Scores. That type of analysis is performed in section 5.3.

Table (7) presents the regression estimates for the unconditional models using only the firms of each portfolio that had data on the Environmental Pillar. We can see that in all the cases, the main conclusions obtained previously hold, as the results are very similar to when all the initial firms were included.

Table 7 - Performance of green and non-green portfolios including only ESG rated firms - unconditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α	β1Mkt	β2SMB	β3HML	β4MOM	Adj. R2
Kenneth French						
Green	0.002	1.070 ***	-0.122	0.260 ***	-0.024	92.47%
Non-Green	0.004	0.939 ***	-0.037	0.137	-0.080	66.74%
Long-Short	-0.001	0.131	-0.085	0.123	0.055	45.47%
MSCI EU Energy						
Green	0.009 **	0.571 ***	-0.186	0.639 ***	-0.231 **	63.77%
Non-Green	0.004 ***	0.973 ***	0.239 **	0.043	-0.149 ***	92.69%
Long-Short	0.004	-0.401 ***	-0.425 **	0.596 ***	-0.082	22.73%
2009-2013 KF						
Green	-0.001	1.030 ***	-0.073	0.451 ***	-0.039	95.51%
Non-Green	-0.001	1.112 ***	0.261	-0.388	-0.072	82.15%
Long-Short	0.000	-0.082	-0.334	0.839 ***	0.033	26.80%
2014-2018 KF						
Green	0.004 *	1.110 ***	-0.199	0.049	0.200 *	86.78%
Non-Green	0.008	0.916 ***	-0.500	0.787 ***	-0.221	53.46%
Long-Short	-0.004	0.194	0.302	-0.738 *	0.421	11.00%
2009-2013 MSCI						
Green	0.007	0.707 ***	-0.283	0.960 ***	-0.164	83.77%
Non-Green	0.005 *	1.025 ***	0.189	-0.099	-0.169 ***	93.84%
Long-Short	0.002	-0.318 ***	-0.472 **	1.059 ***	0.005	44.69%
2014-2018 MSCI						
Green	0.006	0.439 ***	0.211	-0.137	-0.126	30.03%
Non-Green	0.004 *	0.916 ***	0.275 *	0.216 *	-0.147	91.09%
Long-Short	0.002	-0.477 ***	-0.063	-0.353	0.021	39.33%

Table (8) shows the regression estimates for the conditional models for the ESG rated firms. Similarly to what we find in the unconditional model, compared to the

results of the portfolios that included all firms, the risk exposures are similar. Also, we continue to observe similar shifts in risk exposures from one subperiod to another. In both conditional and unconditional models, the increase in the level of market risk in the non-green portfolio may be related to diversification issues, as the non-green portfolio went from a pool of 352 firms to only 85 firms when considering the rated firms only. Although the number of firms in the green portfolio also dropped, from 102 to 44, we assume that the impact of the lower number of firms on the non-green portfolio would be higher than on the green portfolio.

Similarly to what we found previously when including all the firms, in both unconditional and conditional models, the conclusion regarding the performance of the portfolios is that they perform similarly to each other and in no case we observe any statistically significant difference between the performance green and non-green portfolios.

Table 8 - Performance of green and non-green portfolios including only ESG rated firms - Conditional model.

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. TS corresponds to the term spread, computed as the difference between the yield of a long-term and short-term bond (proxied by the 10 year EMU benchmark and 3-month Euribor, respectively); DY corresponds to the dividend yield and is based on the STOXX Europe 600 Index. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α		TS		DY		β1Mkt		β2MktTS		β3MktDY		β4SMB		β5SMB TS		β7HML		β8HML TS		β8HML DY		β9MOM		β10MOM TS		β11MOM DY		Adj. R2
Kenneth French																													
Green	0.002		0.007		-0.014	**	1.056	***	-0.029		0.175		-0.137		-0.147		0.278	***	0.119		-0.372		0.014		0.079		-0.154		92.27%
Non-Green	0.005		0.016	*	-0.020		0.930	***	-0.013		0.043		-0.231		-0.217		0.188		1.291	***	-0.849		-0.211		0.260	*	0.162		70.97%
Long-Short	-0.003		-0.010		0.006		0.126		-0.016		0.133		0.094		0.070		0.091		-1.172	**	0.477		0.225		-0.182		-0.316		7.33%
MSCI EU Energy																													
Green	0.008	**	-0.004		-0.011		0.573	***	-0.095		0.528	*	-0.082		0.461		0.624	***	0.061		-0.355		-0.068		0.148		-0.217		65.27%
Non-Green	0.005	**	-0.001		0.000		0.963	***	-0.064		0.132		0.208	**	0.068		0.091		0.294		-0.210		-0.117	*	0.070		-0.045		92.36%
Long-Short	0.003		-0.003		-0.012		-0.390	***	-0.031		0.396		-0.290		0.394		0.532	***	-0.233		-0.145		0.049		0.078		-0.172		25.47%
2009-2013 KF																													
Green	0.000		0.005		-0.003		1.017	***	0.081		-0.202		-0.103		-0.091		0.526	***	-0.114		0.641		-0.060		0.026		0.030		95.15%
Non-Green	-0.002		0.016	*	-0.017		1.132	***	-0.116		0.090		-0.042		-0.371		-0.403	*	1.110	**	-1.695		-0.188		0.166		-0.237		85.74%
Long-Short	0.002		-0.011		0.014		-0.114		0.197		-0.292		-0.061		0.280		0.928	***	-1.223	**	2.336	*	0.128		-0.140		0.267		35.66%
2014-2018 KF																													
Green	0.004	*	-0.010		-0.017	**	1.031	***	0.523	*	0.598	**	-0.479	***	1.307	**	0.121		0.211		-0.919	**	0.380	***	0.541		1.458	***	90.31%
Non-Green	0.007		0.006		-0.024		0.771	***	0.704		0.044		-1.057	**	2.085		0.959	***	0.791		-1.074		0.209		-0.290		-1.225		55.80%
Long-Short	-0.002		-0.015		0.007		0.260		-0.181		0.554		0.578		-0.778		-0.839	**	-0.580		0.155		0.171		0.831		2.683	*	11.27%
2009-2013 MSCI																													
Green	0.009	*	-0.010		0.005		0.687	***	0.092		0.127		-0.029		0.402		1.055	***	-0.300		1.431		-0.061		0.033		0.377		85.60%
Non-Green	0.003		-0.007		0.005		1.039	***	-0.124		0.220		0.192		-0.033		-0.046		0.077		-0.269		-0.053		0.005		-0.220		93.55%
Long-Short	0.006		-0.002		-0.001		-0.352	***	0.216		-0.092		-0.220		0.435		1.101	***	-0.377		1.700	*	-0.009		0.029		0.597		53.29%
2014-2018 MSCI																													
Green	0.002		0.013		-0.005		0.600	***	-1.208	**	0.928	*	0.050		1.208		-0.058		0.752		-2.593	**	0.526		-2.100	*	1.848		37.60%
Non-Green	0.000		0.022	**	-0.002		0.925	***	0.133		0.082		0.334		-1.107		0.095		0.425		-0.142		-0.022		-0.497		0.557		91.11%
Long-Short	0.002		-0.009		-0.003		-0.324	**	-1.341	***	0.846	*	-0.284		2.315		-0.153		0.327		-2.450	**	0.547		-1.604		1.291		48.23%

We further explore the performance of green and non-green portfolios by comparing the performance of the green and non-green portfolios containing all the firms versus green and non-green portfolios of companies that are rated by ASSET4 ESG. Tables 9 to 12 present the results. We can see that the risk exposures are almost identical in every case. The same can be said for the abnormal performance estimates, that are nearly identical in every case. The major difference in performance is observed when comparing the performance of all non-green firms to non-green firms that are rated (Tables 11 and 12). In this case, we observe some outperformance of the former compared to the latter. In table 12, the non-green portfolio of all firms, when considering the first and full periods and for both benchmarks, shows a statistically significant outperformance at 1% level compared to the non-green portfolio with ESG rated firms only. These results indicate that the portfolio of non-green firms with Environmental ratings underperform the non-green portfolio that includes all firms. When using the conditional model, the results of the first and full periods with the MSCI Europe Energy benchmark still show a statistically significant difference in performance, at the 5% level, but those obtained with the KF benchmark show a statistically significant difference, at the 1% level, only in the 2009 to 2013 period.

Table 9 - Performance of a green portfolio containing all the initial firms and a green portfolio containing only the ESG-rated firms – unconditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α	β1Mkt	β2SMB	β3HML	β4MOM	Adj. R2
Kenneth French - All Period						
Green - All Firms	0.002	1.070 ***	-0.106	0.258 ***	-0.024	92.58%
Green - ESG Only	0.002	1.070 ***	-0.122	0.260 ***	-0.024	92.47%
Long - Short	0.000	0.000	0.016 ***	-0.002	0.000	14.94%
MSCI Energy EU - All Period						
Green - All Firms	0.009 **	0.572 ***	-0.170	0.637 ***	-0.230 **	63.79%
Green - ESG Only	0.009 **	0.571 ***	-0.186	0.639 ***	-0.231 **	63.77%
Long - Short	0.000	0.000	0.016 ***	-0.002	0.000	15.08%
2009 - 2013 KF						
Green - All Firms	-0.001	1.031 ***	-0.061	0.446 ***	-0.039	95.61%
Green - ESG Only	-0.001	1.030 ***	-0.073	0.452 ***	-0.039	95.50%
Long - Short	0.000	0.001	0.013 **	-0.006	0.000	8.87%
2014-2018 KF						
Green - All Firms	0.005	1.106 ***	-0.185 **	0.054	0.198 **	86.66%
Green - ESG Only	0.005	1.107 ***	-0.206 **	0.053	0.200 **	86.63%
Long - Short	0.000	-0.001	0.021 ***	0.002	-0.002	23.98%
MSCI 2009-2013						
Green - All Firms	0.007	0.708 ***	-0.271	0.955 ***	-0.164	83.81%
Green - ESG Only	0.007	0.707 ***	-0.283	0.961 ***	-0.164	83.77%
Long - Short	0.000	0.001	0.013 **	-0.006	0.000	8.92%
MSCI 2014-2018						
Green - All Firms	0.007	0.438 ***	0.224	-0.132	-0.127	30.13%
Green - ESG Only	0.007	0.438 ***	0.203	-0.133	-0.125	30.08%
Long - Short	0.000	0.000	0.021 ***	0.001	-0.001	23.53%

Table 10 - Performance of a green portfolio containing all the initial firms and a green portfolio containing only the ESG-rated firms - conditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. TS corresponds to the term spread, computed as the difference between the yield of a long-term and short-term bond (proxied by the 10 year EMU benchmark and 3-month Euribor, respectively); DY corresponds to the dividend yield and is based on the STOXX Europe 600 Index. The portfolios are value-weighted and rebalanced annually. . Panel A presents the results for the 2009 to 2018 period. Panel B present the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

Panel A

	α		DY		β1Mkt		β2MkTS	β3MkDY		β4SMB		β5SMB TS	β6SMB DY		β7HML		β9HML DY	β10MOM	β11MOM TS	β12MOM DY	Adj. R2
Kenneth French - All Period																					
Green - All Firms	0.002		-0.013	**	1.056	***	-0.031	0.176		-0.119		-0.139	0.418		0.275	***	-0.369	0.014	0.076	-0.147	92.37%
Green - ESG Only	0.002		-0.014	**	1.056	***	-0.029	0.175		-0.137		-0.147	0.436		0.278	***	-0.372	0.014	0.079	-0.154	92.27%
Long - Short	0.000		0.000	*	0.000		-0.002	0.000		0.018	***	0.007	-0.018	*	-0.003		0.003	-0.001	-0.002	0.007	15.20%
MSCI Energy EU - All Period																					
Green - All Firms	0.008	**	-0.011		0.573	***	-0.096	0.530	*	-0.063		0.470	0.374		0.620	***	-0.351	-0.068	0.146	-0.210	65.34%
Green - ESG Only	0.008	**	-0.011		0.573	***	-0.095	0.528	*	-0.082		0.461	0.391		0.624	***	-0.355	-0.068	0.148	-0.217	65.27%
Long - Short	0.000		0.000		0.001		-0.001	0.002		0.019	***	0.008	-0.017	*	-0.004		0.003	0.000	-0.002	0.008	15.33%

Table 10 - Performance of a green portfolio containing all the initial firms and a green portfolio containing only the ESG-rated firms - conditional model (Continued)

Panel B

	α		DY		β1Mkt		β2MkTS		β3MkDY		β4SMB		β5SMB TS		β6SMB DY	β7HML		β9HML DY		β10MOM		β11MOM TS		β12MOM DY		Adj. R2
2009-2013 KF																										
Green - All Firms	0.000		-0.003		1.019	***	0.081		-0.206		-0.088		-0.082		0.171	0.517	***	0.634		-0.062		0.025		0.031		95.23%
Green - ESG Only	0.000		-0.003		1.017	***	0.081		-0.202		-0.104		-0.089		0.196	0.526	***	0.639		-0.060		0.027		0.030		95.14%
Long - Short	0.000		0.000		0.002		0.000		-0.004		0.016	**	0.007		-0.024	-0.009		-0.005		-0.001		-0.002		0.001		1.21%
2014-2018 KF																										
Green - All Firms	0.005	**	-0.017	**	1.026	***	0.515	*	0.615	**	-0.474	***	1.348	**	-0.610	0.128		-0.924	**	0.380	***	0.531		1.450	***	90.28%
Green - ESG Only	0.005	**	-0.017	**	1.028	***	0.523	*	0.606	**	-0.491	***	1.324	**	-0.610	0.126		-0.922	**	0.379	***	0.546		1.457	***	90.29%
Long - Short	0.000		0.001		-0.002		-0.008		0.009		0.017	***	0.024		0.000	0.002		-0.002		0.001		-0.015		-0.007		23.65%
MSCI 2009-2013																										
Green - All Firms	0.009	*	0.005		0.688	***	0.094		0.120		-0.014		0.413		0.589	1.046	***	1.426		-0.063		0.032		0.379		85.63%
Green - ESG Only	0.009	*	0.005		0.686	***	0.092		0.127		-0.029		0.404		0.615	1.055	***	1.428		-0.062		0.034		0.377		85.60%
Long - Short	0.000		0.000		0.002		0.002		-0.007		0.015	**	0.009		-0.026	* -0.009		-0.002		-0.001		-0.002		0.002		2.50%
MSCI 2014-2018																										
Green - All Firms	0.002		-0.005		0.596	***	-1.200	**	0.951	**	0.047		1.247		0.665	-0.048		-2.618	**	0.527		-2.084	*	1.855		37.91%
Green - ESG Only	0.002		-0.005		0.597	***	-1.206	**	0.936	*	0.034		1.230		0.662	-0.050		-2.605	**	0.526		-2.091	*	1.846		37.72%
Long - Short	0.000		0.000		-0.001		0.006		0.014	*	0.014	**	0.017		0.003	0.003		-0.013		0.001		0.006		0.009		29.85%

Table 11 - Performance analysis of a non-green portfolio containing all the initial firms and a non-green portfolio containing only the ESG-rated firms – Unconditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. The portfolios are value-weighted and rebalanced annually. The observation period is from 2009 to 2018. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

	α	β1Mkt	β2SMB	β3HML	β4MOM	Adj. R2
Kenneth French - All Period						
Non-Green - All Firms	0.004	0.931 ***	0.015	0.122	-0.098	67.35%
Non-Green - ESG Only	0.004	0.939 ***	-0.037	0.137	-0.080	66.74%
Long - Short	0.001 ***	-0.008 *	0.052 ***	-0.014 *	-0.018 *	27.48%
MSCI Energy EU - All Period						
Non-Green - All Firms	0.005 ***	0.956 ***	0.282 ***	0.037	-0.169 ***	92.38%
Non-Green - ESG Only	0.004 ***	0.973 ***	0.239 **	0.043	-0.149 ***	92.69%
Long - Short	0.001 ***	-0.017 ***	0.044 ***	-0.006	-0.020 **	40.81%
2009-2013 Mkt = KF						
Non-Green - All Firms	0.001	1.104 ***	0.317	-0.398 **	-0.093	82.53%
Non-Green - ESG Only	-0.001	1.112 ***	0.261	-0.388 **	-0.073	82.15%
Long - Short	0.001 ***	-0.008	0.056 ***	-0.011	-0.020 **	36.83%
2014-2018 Mkt = KF						
Non-Green - All Firms	0.008	0.899 ***	-0.468	0.775 ***	-0.217	53.78%
Non-Green - ESG Only	0.008	0.913 ***	-0.508	0.791 ***	-0.221	53.37%
Long - Short	0.000	-0.014 **	0.040 ***	-0.016	0.004	22.56%
MSCI 2009 - 2013						
Non-Green - All Firms	0.006 **	1.012 ***	0.242 *	-0.106	-0.190 ***	93.52%
Non-Green - ESG Only	0.005 *	1.024 ***	0.189 *	-0.099	-0.169 ***	93.83%
Long - Short	0.001 ***	-0.013 ***	0.054 ***	-0.007	-0.021 **	42.69%
MSCI 2014-2018						
Non-Green - All Firms	0.005 *	0.893 ***	0.288 *	0.219 *	-0.148	90.75%
Non-Green - ESG Only	0.005 *	0.915 ***	0.266 *	0.220 *	-0.146	91.05%
Long - Short	0.000	-0.022 ***	0.022 **	-0.001	-0.002	55.48%

Table 12 - Performance analysis of a non-green portfolio containing all the initial firms and a non-green portfolio containing only the ESG-rated firms – Conditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. TS corresponds to the term spread, computed as the difference between the yield of a long-term and short-term bond (proxied by the 10 year EMU benchmark and 3-month Euribor, respectively); DY corresponds to the dividend yield and is based on the STOXX Europe 600 Index. The portfolios are value-weighted and rebalanced annually. Panel A presents the results for the 2009 to 2018 period. Panel B presents the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

Panel A

	α		TS		DY	β1Mkt		β3MktDY		β4SMB		β5SMB TS		β6SMB DY	β7HML	β8HML TS		β8HML DY	β10MOM TS		β11MOM DY		Adj. R2
Kenneth French																							
Non-Green - All Firms	0.005		0.016	*	-0.020	0.922	***	0.035		-0.175		-0.219		0.077	0.179	1.270	***	-0.831	0.276	*	0.133		71.35%
Non-Green - ESG Only	0.005		0.016	*	-0.020	0.930	***	0.043		-0.231		-0.217		0.044	0.188	1.291	***	-0.849	0.260	*	0.162		70.97%
Long - Short	0.000		0.000		0.000	-0.007	*	-0.007		0.056	***	-0.002		0.033	-0.008	-0.022		0.018	0.015	**	-0.029	*	41.70%
MSCI Energy EU																							
Non-Green - All Firms	0.005	***	-0.001		0.000	0.947	***	0.154		0.252		0.064		0.129	0.092	0.303		-0.232	0.093		-0.068		92.12%
Non-Green - ESG Only	0.005	**	-0.001		0.000	0.963	***	0.132		0.208		0.068		0.076	0.091	0.294		-0.210	0.070		-0.045		92.36%
Long - Short	0.000	**	0.000		-0.001	-0.015	***	0.022	*	0.044	***	-0.003		0.053	0.001	0.009		-0.022	0.023	***	-0.023		52.24%

Table 12 - Performance analysis of a non-green portfolio containing all the initial firms and a non-green portfolio containing only the ESG-rated firms – Conditional model (Continued)

Panel B

	α	TS	DY	β1Mkt	β3MktDY	β4SMB	β5SMB TS	β6SMB DY	β7HML	β8HML TS	β8HML DY	β10MOM TS	β11MOM DY	Adj. R2
2009-2013														
Non-Green - All Firms	-0.001	0.016 *	-0.018	1.124 ***	0.087	0.020	-0.368	-0.213	-0.410 *	1.103 **	-1.708 *	0.188	-0.277	85.74%
Non-Green - ESG Only	-0.002	0.016 *	-0.017	1.131 ***	0.090	-0.043	-0.370	-0.262	-0.402 *	1.111 **	-1.697	0.167	-0.238	85.74%
Long - Short	0.001 **	0.000	-0.001	-0.007	-0.003	0.063 ***	0.002	0.049	-0.007	-0.007	-0.011	0.021 **	-0.039	53.34%
2014-2018														
Non-Green - All Firms	0.007	0.005	-0.024	0.757 ***	0.065	-1.019 **	2.103	1.601	0.938 ***	0.802	-1.048	-0.296	-1.152	56.09%
Non-Green - ESG Only	0.007	0.005	-0.025	0.768 ***	0.052	-1.069 **	2.103	1.659	0.965 ***	0.787	-1.077	-0.285	-1.226	55.83%
Long - Short	0.000	0.000	0.001	-0.010	0.013	0.050 ***	0.000	-0.058	-0.026 *	0.015	0.029	-0.012	0.074	24.09%
MSCI 2009-2013														
Non-Green - All Firms	0.004	-0.007	0.004	1.027 ***	0.257	0.250 *	-0.039	0.245	-0.049	0.094	-0.328	0.031	-0.258	93.37%
Non-Green - ESG Only	0.003	-0.007	0.005	1.038 ***	0.219	0.191	-0.031	0.165	-0.045	0.079	-0.271	0.005	-0.220	93.54%
Long - Short	0.001 ***	0.001	-0.002 **	-0.011 **	0.038 *	0.058 ***	-0.008	0.080 **	-0.003	0.016	-0.056	0.026 ***	-0.038 *	58.86%
MSCI 2014-2018														
Non-Green - All Firms	0.000	0.021 *	-0.001	0.898 ***	0.084	0.326	-0.983	-0.135	0.103	0.433	-0.152	-0.490	0.582	90.61%
Non-Green - ESG Only	0.000	0.021 **	-0.002	0.922 ***	0.091	0.318	-1.086	-0.134	0.103	0.425	-0.155	-0.487	0.555	90.98%
Long - Short	0.000	-0.001	0.001 *	-0.023 ***	-0.006	0.008	0.103 **	-0.001	0.000	0.007	0.003	-0.003	0.027	53.56%

5.3. Performance of environmentally ranked portfolios

Table (13) presents the regression estimates for the unconditional 4-factor model of high and low-rated portfolios formed based on the Environmental Pillar and its individual dimensions (Emission Reduction, Resource Reduction and Product Innovation), considering a 30% cut-off. In all cases we also present the estimates of the difference between the high and low-rated portfolios to represent the performance of a strategy of a long position in high-rated portfolios and a short position in low-rated portfolios.

Considering the full period (Panel A) and starting with the KF benchmark, we can see that whatever dimension considered, high and low-rated portfolios do not achieve statistically significant abnormal returns. Furthermore, no significant performance difference is observed between high and low-rated portfolios. Regarding the risk factors, the high-rated portfolios show negative coefficients associated to the size factor, although only significant at the 10% level in the portfolios formed on the Emission Reduction and Product Innovation dimensions. The coefficients of the HML factor are positive and statistically significant at the 5% level in the case of portfolios formed on the Environmental and Emission Reduction scores. The low-rated portfolio formed on the Emission Reduction dimension is exposed to the small size effect (at the 1% level). The results of the long-short portfolio show that high-rated portfolios formed on the individual dimensions of the Environmental pillar are less exposed to small firms than their low-rated peers. Also, high-rated portfolios formed on the Resource Reduction and Product Innovation dimensions are more exposed to the momentum effect than low-rated companies.

As for the performance estimates obtained with the specialized benchmark for the full period, we observe statistically significant abnormal returns of all high-rated portfolios and on the low-rated portfolio formed on the Resource Reduction and Product Innovation dimensions (although in this case the level of significance is only 10%). However, there are no statistically significant differences in the performance of high-rated and low-rated portfolios. In terms of systematic risk, we observe that high-rated portfolios have lower betas than low-rated portfolios, except for those based on

the Resource Reduction and Product Innovation dimensions. The exposure to the size factor shows a similar story to what we found previously with the general market benchmark: low-rated portfolios are more exposed to small size firms that high-rated firms. Furthermore, we find that low-rated portfolios are not exposed to the value factor, whereas high-rated portfolios are exposed to the value factor. Also, all low-rated portfolios have negative and statistically significant coefficients on the momentum factor, with low-rated portfolios formed on the Resource Reduction and Product Innovation dimensions being more exposed to firms with recent poor performance than their high-rated counterparts.

Moving on to the subperiod analysis, when the market is proxied by the KF benchmark (Panel B), we observe that the alpha coefficients are neutral. In the second period, the results change slightly, as the high-rated portfolios formed on the Environmental pillar and Resource Reduction dimensions now exhibit positive and statistically significant alphas at the 10% level. Yet, none of the differences between the alphas of the portfolios are statistically significant, meaning that there are no abnormal gains from following a strategy of going long in high-rated portfolios and short in low-rated portfolios. As for the risk factors, from 2009-2013 the high-rated portfolios are not exposed to any risk source other than the market, whereas the low-rated portfolios are exposed to small firms, growth stocks and, for the Resource Reduction and Product Innovation dimensions, firms with recent poor performance. On the second period, the low-rated portfolios are no longer exposed to the small size effect, but they are now exposed to value stocks. Unlike the first period, and with exception of the Environmental dimension, high-rated portfolios show significant exposure to large firms and value stocks.

In panel C, as with the MSCI Energy EU, the market risk exposure for the high-rated portfolios is lower and all the high-rated portfolios show exposure to value stocks. The low-rated portfolios show exposure to small cap firms, as all coefficients, except for the Environmental dimension, are statistically significant. Low-rated firms also show exposure to growth stocks, although only portfolios formed on the Emission Reduction and Resource Reduction dimensions have statistically significant coefficients on the HML factor. Also, with this benchmark the low-rated portfolios tend to show a negative exposure to the momentum factor, except for the Emission Reduction dimension. In the

2014 to 2018 period, we observe that neither high or low-rated portfolios have any significant exposure to the value factor and only the low-rated portfolios show exposure towards small cap stocks (whose coefficients are always statistically significant at least at the 5% level). Furthermore, we observe that the market risk exposure for the high-rated portfolios is lower compared to low-rated portfolios, with the Environmental Pillar and Emission Reduction dimensions differing significantly, at the 1% level, from the low-rated portfolios. As for the abnormal returns estimates, in the 2009 to 2013 period only one portfolio (the high-rated portfolio on the Product Innovation dimension) shows a statistically significant alpha, although only at the 5% level. However, we can conclude that in this period high-rated portfolios did not outperform low-rated ones. In the 2014 to 2018 period, the only positive alphas are those of the high- and low-rated portfolios formed on the Resource Reduction dimension, although only at the 10% level. In this period, we also observe that the high-rated portfolio formed on the Environmental Pillar dimension significantly outperformed the low-rated portfolio.

Table 13 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Unconditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. The portfolios are value-weighted and rebalanced annually. Panel A presents the results for the 2009 to 2018 period. Panels B and C present the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

Panel A

Kenneth French	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	0.000		1.056	***	-0.090		0.210	**	0.039		88.38%
Low Rated	-0.003		1.058	***	0.334		-0.111		-0.195		54.82%
Long-Short	0.003		-0.001		-0.424		0.321		0.235	*	2.73%
Emission Reduction											
High Rated	0.001		1.016	***	-0.206	*	0.235	**	0.061		88.40%
Low Rated	0.001		1.062	***	0.824	***	0.073		-0.126		50.84%
Long-Short	0.000		-0.046		-1.030	***	0.162		0.187		11.03%
Resource Reduction											
High Rated	0.002		1.080	***	-0.176		0.180		-0.021		77.01%
Low Rated	0.007		1.051	***	0.252		-0.016		-0.217	*	65.24%
Long-Short	-0.005		0.029		-0.428	***	0.195		0.196	**	8.16%
Product Innovation											
High Rated	0.002		1.037	***	-0.223	*	0.184		0.018		83.68%
Low Rated	0.005		1.007	***	0.386		0.023		-0.249	*	56.29%
Long-Short	-0.003		0.029		-0.609	***	0.161		0.267	**	9.57%
MSCI Energy EU											
Environmental Score											
High Rated	0.005		0.731	***	-0.035		0.433	***	-0.125		74.96%
Low Rated	-0.001		1.047	***	0.611	***	-0.173		-0.285	***	73.42%
Long-Short	0.006		-0.316	***	-0.646	***	0.606	***	0.160		14.41%
Emission Reduction											
High Rated	0.005	**	0.789	***	-0.092		0.372	***	-0.077		85.34%
Low Rated	0.002		1.120	***	1.150	***	-0.051		-0.200	*	74.18%
Long-Short	0.002		-0.331	***	-1.243	***	0.423	**	0.123		22.11%
Resource Reduction											
High Rated	0.004	**	0.980	***	0.044		0.197	*	-0.134	**	89.77%
Low Rated	0.008	***	1.001	***	0.499	***	-0.042		-0.316	***	81.28%
Long-Short	-0.004		-0.021		-0.455	***	0.239	*	0.182	**	8.79%
Product Innovation											
High Rated	0.005	***	0.899	***	-0.042		0.238	***	-0.100	**	92.19%
Low Rated	0.006	*	0.991	***	0.645	***	-0.031		-0.336	***	72.71%
Long-Short	-0.002		-0.092		-0.687	***	0.269		0.236	**	10.91%

Table 13 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Unconditional model (Continued)

Panel B

2009-2013 KF	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	-0.005		1.123	***	0.020		0.112		0.065		91.53%
Low Rated	0.000		1.206	***	0.326		-0.760	**	-0.228		67.43%
Long-Short	-0.005		-0.083		-0.306		0.871	***	0.294	**	17.53%
Emission Reduction											
High Rated	-0.002		1.046	***	0.012		0.195		0.083		91.04%
Low Rated	0.002		1.143	***	0.837	***	-0.572	**	-0.183		72.00%
Long-Short	-0.004		-0.097		-0.825	***	0.767	***	0.266	**	31.03%
Resource Reduction											
High Rated	-0.003		1.137	***	0.070		-0.118		0.016		88.74%
Low Rated	0.002		1.233	***	0.611	**	-0.574	**	-0.247	*	75.40%
Long-Short	-0.005		-0.095		-0.540	**	0.456	**	0.263	**	16.47%
Product Innovation											
High Rated	-0.002		1.081	***	0.017		0.001		0.025		90.89%
Low Rated	0.001		1.236	***	0.638	**	-0.740	***	-0.261	*	73.03%
Long-Short	-0.003		-0.155		-0.621	**	0.740	***	0.286	**	22.66%
2014-2018 KF											
Environmental Score											
High Rated	0.005	*	1.010	***	-0.184		0.273	*	-0.086		79.84%
Low Rated	-0.004		1.020	***	0.269		0.686	*	-0.372		42.29%
Long-Short	0.010		-0.010		-0.454		-0.413		0.286		0.26%
Emission Reduction											
High Rated	0.004		1.055	***	-0.535	***	0.322	**	0.038		82.75%
Low Rated	0.002		1.243	***	0.621		1.000	**	-0.222		40.06%
Long-Short	0.001		-0.187		-1.156	**	-0.678		0.259		12.46%
Resource Reduction											
High Rated	0.009	*	1.229	***	-0.578	*	0.627	**	-0.319		69.42%
Low Rated	0.009		1.045	***	-0.361		0.721	**	-0.117		55.05%
Long-Short	0.000		0.184	**	-0.217		-0.095		-0.202		10.16%
Product Innovation											
High Rated	0.006		1.141	***	-0.634	***	0.490	**	-0.006		74.43%
Low Rated	0.009		0.960	***	-0.026		0.946	**	-0.438		44.96%
Long-Short	-0.003		0.181		-0.607	*	-0.456		0.432		11.32%

Table 13 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Unconditional model (Continued)

Panel C

2009-2013 MSCI	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	0.002		0.905	***	-0.129		0.533	***	-0.051		88.39%
Low Rated	0.006		1.067	***	0.222		-0.403		-0.339	**	73.28%
Long-Short	-0.004		-0.162	*	-0.352		0.935	***	0.288	**	20.83%
Emission Reduction											
High Rated	0.004		0.891	***	-0.098		0.539	***	-0.018		93.01%
Low Rated	0.002		1.143	***	0.837	***	-0.572	**	-0.183		72.00%
Long-Short	-0.004		-0.097		-0.825	***	0.767	***	0.266	**	31.03%
Resource Reduction											
High Rated	0.004		0.985	***	-0.041		0.240	*	-0.091		92.67%
Low Rated	0.002		1.233	***	0.611	**	-0.574	**	-0.247	*	75.40%
Long-Short	-0.005		-0.095		-0.540	**	0.456	**	0.263	**	16.47%
Product Innovation											
High Rated	0.004	*	0.938	***	-0.088		0.340	***	-0.078		94.85%
Low Rated	0.008		1.065	***	0.514	*	-0.345		-0.379	***	76.36%
Long-Short	-0.004		-0.127		-0.602	**	0.685	***	0.302	***	22.57%
2014-2018 MSCI											
Environmental Score											
High Rated	0.006		0.538	***	0.298		-0.001		-0.297		54.56%
Low Rated	-0.008	*	1.021	***	1.133	***	0.050		-0.289		75.38%
Long-Short	0.014	**	-0.483	***	-0.835	**	-0.050		-0.008		23.49%
Emission Reduction											
High Rated	0.003		0.676	***	0.059		-0.050		-0.112		75.77%
Low Rated	-0.003		1.246	***	1.675	***	0.223		-0.119		72.34%
Long-Short	0.006		-0.570	***	-1.616	***	-0.273		0.007		35.05%
Resource Reduction											
High Rated	0.006	*	0.964	***	0.253		0.060		-0.384	**	85.77%
Low Rated	0.006	*	0.934	***	0.435	**	0.154		-0.102		83.98%
Long-Short	0.000		0.030		-0.183		-0.093		-0.282	*	3.16%
Product Innovation											
High Rated	0.004		0.862	***	0.112		-0.011		-0.087		88.93%
Low Rated	0.006		0.907	***	0.744	**	0.388		-0.394		67.64%
Long-Short	-0.002		-0.045		-0.632	**	-0.399		0.307		9.19%

Table (14) presents the regression estimates of the conditional four-factor model for portfolios based on the Environmental Pillar (and its three categories) with a 30% cut-

off. The results for the full period are reported in Panels A and B. Starting with the KF index as the market factor and considering the whole period (Panel A), the alpha estimates do not show any abnormal performance. Yet, the alpha coefficients associated to the PIVs are, in some cases, statistically significant. The term spread seems to affect performance positively, while the dividend yield affects performance negatively. However, we do not observe any significant differences between the impact of the PIVs on the performance of the two portfolios. The exposure to the risk factors remains similar compared to the unconditional model. The coefficients of the additional risk factors associated with the term spread show a positive and statistically significant impact of this variable on the HML and MOM factors in high and low-rated portfolios, except for the Emission Reduction dimension, where the coefficient associated to the low-rated portfolio is not statistically significant. Furthermore, the dividend yield, when associated with the HML factor, is also statistically significant at the 10% level in the case of the Environmental and Emission Reduction dimensions.

The use of the specialized benchmark (Panel B) also shows the same exposures as the unconditional model, but it seems to be less affected by the PIV variables than when using the KF benchmark. We observe a positive effect (at the 10% level) of PIVs on the size factor of the high-rated portfolio, and on the momentum factor of the low-rated portfolio in the Environmental and Emission Reduction dimensions, respectively. It is worth noting that the lower market risk exposure in the high-rated portfolios is, with exception of the Resource Reduction dimension, offset by the dividend yield associated with the market factor affecting it positively. As for the alpha coefficients, the PIVs do not affect performance significantly. We also note that for the Environmental dimension there is a statistically significant difference, at the 10% level, between the coefficient of the alpha associated to the dividend yield of both portfolios All the portfolios in the remaining dimensions do not show any statistical difference in the alpha associated to PIVs.

Analyzing the 2009 to 2013 period and starting with the results of the with the KF benchmark (Panel C), the risk exposures of the portfolios remain largely similar to those of the unconditional model, apart from the low-rated portfolios no longer showing exposure to small cap stocks. The value factor in the low-rated portfolios is significantly affected in a positive way by the term spread and in a negative way by the dividend

yield. In the 2014 to 2018 period, the risk estimates remain mostly the same as in the unconditional model, with all high-rated portfolios now showing a statistically significant exposure, at the 1% level, to large cap stocks. Yet, the PIVs now have a more visible effect in the size factor, with the high-rated portfolios being positively affected by the term spread associated with the size factor and the low-rated portfolios significantly affected, in a positive way, by the dividend yield associated with the size factor. The results also show lower market risk coefficients for both portfolios, which is offset by an increase in market risk estimates that are associated with the PIVs. That is the case of the high-rated portfolio formed on the Environmental dimension and the low-rated portfolio formed on the Product Innovation dimension. Also, we observe the same changes in risk exposures between high and low-rated portfolios. Regarding performance, the alphas in the first period are neutral and do not differ between portfolios. In the second period, the only portfolio with a statistically significant alpha is the high-rated one formed on the Emission Reduction dimension, although it is only statistically significant at the 10% level. Although there are statistically significant estimates for the dividend yield alpha in three high-rated portfolios, there is no statistically significant difference between portfolios concerning this coefficient.

Regarding the results with the MSCI Energy EU as a benchmark (Panel D), we can observe that in the first period some of the significant coefficients of size and value of the low-rated portfolios disappear, compared to the unconditional model, and are offset by the PIVs associated with the risk factor variables (although they are only statistically significant in the case of the Emission Reduction dimension). As for the second period, the high-rated portfolios formed on the Environmental and Emission Reduction dimensions show a lower market risk coefficient compared to the low-rated peers. In addition, the high-rated portfolios are not exposed to any risk factor other than the market, although the PIVs dividend yield and term spread seem to negatively affect the value and momentum factors, respectively. The low-rated portfolios are exposed to small cap stocks, except for those formed on the Resource Reduction and Product Innovation dimensions, in which case these portfolios are only exposed to the market factor. The PIV's affect the market risk exposure significantly in all dimensions, except for the Emission Reduction, in different ways. In the first sub-period, the alphas in show no statistical difference between portfolios. In the second sub-period, the low-rated

portfolio formed on the Environmental dimension not only exhibits significant negative abnormal returns at the 1% level, but also underperforms the high-rated portfolio (at the 1% level). All the remaining portfolios show very similar alphas, including the alphas associated to the PIVs that are, in some cases, significant but do not differ significantly between portfolios.

Table 14 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Conditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. TS corresponds to the term spread DY corresponds to the dividend yield. The portfolios are value-weighted and rebalanced annually. Panels A and B present the results for the 2009 to 2018 period, using the KF and MSCI EU Energy Index, respectively. Panels C and D present the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey & West, (1987) method.

Panel A

Kenneth French	α	TS	DY	β1Mkt	β3MktDY	β4SMB	β5SMB TS	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	Adj. R2
Environmental Score													
High Rated	0.002	0.005	-0.016 *	1.005 ***	0.285	-0.211 *	0.030	0.237 **	0.770 ***	-0.728 *	-0.015	0.198 **	89.42%
Low Rated	-0.003	0.001	-0.007	1.049 ***	-0.395	0.040	0.288	-0.070	1.251 **	-0.481	-0.197	0.510 **	58.66%
Long-Short	0.005	0.005	-0.009	-0.045	0.680	-0.251	-0.258	0.307	-0.481	-0.247	0.182	-0.312	6.70%
Emission Reduction													
High Rated	0.001	0.012 ***	-0.018 ***	1.009 ***	0.040	-0.351 ***	-0.310	0.266 ***	0.698 ***	-0.681 *	0.004	0.188 **	90.78%
Low Rated	0.002	0.012	-0.009	1.088 ***	-0.111	0.615 *	-0.151	0.132	0.815	-0.300	-0.231	0.167	51.72%
Long-Short	-0.001	0.001	-0.010	-0.079	0.152	-0.965 ***	-0.159	0.133	-0.117	-0.381	0.235	0.022	8.83%
Resource Reduction													
High Rated	0.004	0.016 **	-0.018	1.072 ***	0.050	-0.318 *	-0.167	0.166	0.837 **	-0.675	-0.256 **	0.071	80.18%
Low Rated	0.006	0.013	-0.022	1.040 ***	0.201	0.005	-0.285	0.116	1.573 ***	-1.114	-0.194	0.403 **	69.82%
Long-Short	-0.001	0.003	0.004	0.032	-0.152	-0.323 **	0.118	0.051	-0.736 **	0.439	-0.062	-0.332 **	25.81%
Product Innovation													
High Rated	0.002	0.015 **	-0.019 **	1.045 ***	0.091	-0.360 ***	-0.370	0.200 *	0.761 ***	-0.751	-0.099	0.099	86.25%
Low Rated	0.006	0.011	-0.011	0.972 ***	0.102	0.179	0.056	0.138	1.616 ***	-0.816	-0.310	0.408 *	58.61%
Long-Short	-0.004	0.004	-0.008	0.072	-0.011	-0.539 **	-0.426	0.062	-0.855 *	0.064	0.211	-0.309 *	8.85%

Table 14 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Conditional model (Continued)

Panel B

MSCI Energy EU	α	TS	DY	β1Mkt	β3MktDY	β4SMB	β5SMB TS	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	Adj. R2
Environmental Score													
High Rated	0.006 *	-0.006	-0.010	0.696 ***	0.623 **	-0.017	0.512 *	0.441 ***	0.481	-0.568	-0.039	0.187	76.56%
Low Rated	-0.003	-0.021	0.020	1.040 ***	-0.455	0.517 **	0.637	-0.186	0.175	0.309	-0.120	0.297	75.50%
Long-Short	0.009 *	0.015	-0.030 *	-0.344 ***	1.078 **	-0.534 **	-0.125	0.627 **	0.306	-0.877	0.081	-0.110	22.17%
Emission Reduction													
High Rated	0.004	-0.001	-0.008	0.781 ***	0.356 *	-0.086	0.073	0.404 ***	0.225	-0.473	0.022	0.114	85.15%
Low Rated	0.002	-0.012	0.019	1.151 ***	-0.120	1.148 ***	0.247	-0.044	-0.454	0.616	-0.131	-0.058	74.49%
Long-Short	0.002	0.011	-0.027	-0.370 ***	0.476	-1.235 ***	-0.174	0.448 *	0.679	-1.089	0.152	0.171	22.35%
Resource Reduction													
High Rated	0.006 **	-0.001	-0.001	0.966 ***	0.252	0.081	0.226	0.171	0.042	-0.167	-0.203 **	-0.071	89.72%
Low Rated	0.007 **	-0.006	-0.001	0.995 ***	0.308	0.404 **	0.135	0.084	0.555	-0.439	-0.122	0.251 *	82.63%
Long-Short	-0.001	0.006	0.001	-0.029	-0.056	-0.323 **	0.091	0.087	-0.514	0.272	-0.081	-0.321 ***	25.41%
Product Innovation													
High Rated	0.005 **	-0.002	-0.002	0.909 ***	0.244 *	-0.013	0.044	0.243 ***	-0.020	-0.244	-0.056	-0.023	92.02%
Low Rated	0.007	-0.006	0.005	0.954 ***	0.398	0.587 **	0.396	0.080	0.747	-0.347	-0.230	0.260	72.25%
Long-Short	-0.002	0.004	-0.006	-0.045	-0.153	-0.601 ***	-0.352	0.163	-0.767 *	0.103	0.173	-0.283	8.91%

Table 14 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Conditional model (Continued)

Panel C

2009-2013 KF	α	TS	DY	β1Mkt	β2MktTS	β3MktDY	β4SMB	β5SMB TS	β6SMB DY	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	β11MOM DY	Adj. R2
Environmental Score																
High Rated	-0.003	-0.001	-0.001	1.062 ***	-0.012	0.183	-0.142	-0.190	0.097	0.245	0.407	-0.100	0.057	0.094	0.206	91.24%
Low Rated	-0.007	-0.002	-0.017	1.191 ***	-0.114	0.287	-0.196	-0.069	-0.401	-0.811 **	1.621 **	-2.920 *	-0.101	0.509 **	-0.345	74.01%
Long-Short	0.004	0.001	0.016	-0.129	0.102	-0.104	0.054	-0.122	0.498	1.056 ***	-1.214 **	2.820 **	0.158	-0.414 *	0.551	31.79%
Emission Reduction																
High Rated	-0.001	0.013 *	-0.011	1.033 ***	0.076	-0.201	-0.232	-0.313	-0.140	0.267 *	0.517	-0.269	-0.018	0.148	-0.086	93.07%
Low Rated	-0.005	0.018	-0.032	1.213 ***	-0.291	0.595	0.416	-0.514	0.580	-0.755 **	1.488 **	-3.856 ***	-0.168	0.247	-1.041 *	77.24%
Long-Short	0.004	-0.006	0.021	-0.180	0.367 *	-0.796 *	-0.648 **	0.201	-0.721	1.022 ***	-0.971 *	3.587 ***	0.150	-0.098	0.956 *	41.54%
Resource Reduction																
High Rated	-0.002	0.013	-0.011	1.157 ***	-0.042	0.135	-0.139	-0.487	-0.072	-0.163	0.476	-0.898	-0.151	-0.022	-0.082	90.93%
Low Rated	-0.004	0.014	-0.025	1.247 ***	-0.293	0.346	0.203	-0.320	0.152	-0.543 *	1.792 ***	-3.018 **	-0.170	0.385 *	-0.665	79.67%
Long-Short	0.002	-0.001	0.014	-0.090	0.251	-0.210	-0.342	-0.168	-0.224	0.380	-1.316 **	2.119 *	0.020	-0.408 **	0.584	35.79%
Product Innovation																
High Rated	-0.002	0.013 *	-0.007	1.122 ***	0.035	-0.237	-0.190	-0.354	-0.262	-0.022	0.394	-0.407	-0.136	0.019	-0.105	93.44%
Low Rated	-0.004	0.011	-0.021	1.209 ***	-0.426 *	0.863	0.323	-0.450	0.325	-0.666 **	1.822 **	-3.287 **	-0.131	0.341	-0.456	75.38%
Long-Short	0.002	0.002	0.014	-0.087	0.461 **	-1.100 **	-0.513 *	0.097	-0.587	0.644 **	-1.429 **	2.880 **	-0.006	-0.322	0.351	29.48%
2014-2018 KF																
Environmental Score																
High Rated	0.004	0.001	-0.018 *	0.888 ***	0.685 *	0.593 *	-0.660 ***	1.864 *	-0.412	0.411 ***	0.355	-1.298 **	0.284 *	0.026	0.779	84.61%
Low Rated	-0.006	0.006	-0.002	0.906 ***	0.773	-1.683 *	0.192	1.007	4.221 *	0.776 *	0.225	-0.284	-0.204	0.694	-0.973	40.99%
Long-Short	0.009	-0.005	-0.016	-0.018	-0.088	2.276 **	-0.851	0.857	-4.633 **	-0.364	0.130	-1.014	0.489	-0.669	1.752	0.01%
Emission Reduction																
High Rated	0.005 *	-0.008	-0.020 *	0.956 ***	0.421	0.224	-0.944 ***	2.035 ***	0.437	0.486 ***	0.261	-1.050 **	0.288 *	0.237	-0.182	86.94%
Low Rated	0.007	-0.030	-0.011	1.059 ***	1.080	-1.609	0.409	2.140	6.338 **	1.143 *	-0.127	0.393	-0.180	1.588	-0.522	40.12%
Long-Short	-0.002	0.022	-0.009	-0.103	-0.659	1.833 *	-1.353 **	-0.106	-5.901 **	-0.657	0.389	-1.443	0.468	-1.351	0.340	12.74%
Resource Reduction																
High Rated	0.007	0.004	-0.016	1.058 ***	0.840	0.172	-1.270 ***	3.043 **	0.760	0.822 ***	0.801	-1.275	0.171	-0.088	-0.815	73.01%
Low Rated	0.007	0.015	-0.035	0.873 ***	0.795	0.518	-0.924 **	1.711	2.650 *	0.906 ***	0.450	-0.647	0.322	-0.550	-0.779	60.44%
Long-Short	0.001	-0.011	0.019	0.185 *	0.045	-0.346	-0.347	1.332	-1.890 **	-0.084	0.351	-0.628	-0.151	0.462	-0.036	10.58%
Product Innovation																
High Rated	0.007	-0.006	-0.033 **	1.043 ***	0.276	0.479	-1.092 ***	2.199 **	0.898	0.644 ***	0.673	-1.121	0.278	0.122	-0.466	78.91%
Low Rated	0.004	0.017	0.005	0.722 ***	1.889 *	-0.174	-0.726	1.554	1.707	1.114 **	0.874	-0.710	0.147	-0.320	-1.284	47.26%
Long-Short	0.003	-0.022	-0.038	0.321 *	-1.614 **	0.653	-0.366	0.645	-0.809	-0.470	-0.201	-0.410	0.130	0.442	0.818	17.02%

Table 14 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 30% cut-off – Conditional model (Continued)

Panel D

2009-2013 MSCI	α	TS	β1Mkt	β2MktTS	β3MktDY	β4SMB	β5SMB TS	β6SMB DY	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	β11MOM DY	Adj. R2
Environmental Score															
High Rated	0.003	-0.019 *	0.883 ***	-0.043	0.408	0.069	0.208	0.523	0.676 ***	-0.232	1.098	0.136	0.008	0.329	90.70%
Low Rated	-0.002	-0.026	1.074 ***	-0.028	0.137	0.056	0.412	-0.228	-0.420 *	0.523	-1.104	-0.003	0.352 *	-0.283	77.67%
Long-Short	0.005	0.007	-0.191 *	-0.015	0.270	0.013	-0.204	0.751	1.095 ***	-0.755	2.202 **	0.139	-0.344 *	0.613	34.97%
Emission Reduction															
High Rated	0.005	-0.005	0.864 ***	0.012	0.143	-0.043	0.004	0.422	0.656 ***	-0.024	0.574	0.073	0.053	0.058	93.08%
Low Rated	0.001	-0.005	1.048 ***	-0.362 **	1.063 ***	0.655 **	-0.093	1.215 **	-0.272	0.491	-2.311 **	-0.030	0.145	-1.007 **	83.95%
Long-Short	0.004	0.000	-0.184 *	0.374 **	-0.920 **	-0.699 ***	0.097	-0.794	0.928 ***	-0.516	2.885 ***	0.103	-0.092	1.064 **	47.25%
Resource Reduction															
High Rated	0.004	-0.008	0.992 ***	-0.099	0.429 *	0.094	-0.113	0.460	0.280 *	-0.307	0.366	-0.038	-0.138	0.007	92.92%
Low Rated	0.003	-0.014	1.088 ***	-0.175	0.261	0.390	0.209	0.345	-0.093	0.565	-1.051	-0.068	0.244	-0.584	81.25%
Long-Short	0.001	0.006	-0.096	0.076	0.168	-0.297	-0.323	0.116	0.373	-0.872 *	1.417	0.030	-0.383 **	0.590	35.99%
Product Innovation															
High Rated	0.005	-0.007	0.955 ***	-0.023	0.109	0.004	-0.025	0.333	0.385 ***	-0.287	0.562	-0.027	-0.097	0.027	94.58%
Low Rated	0.002	-0.015	1.059 ***	-0.303	0.715	0.534	0.116	0.409	-0.192	0.506	-1.009	-0.032	0.215	-0.438	76.80%
Long-Short	0.002	0.008	-0.104	0.281	-0.606	-0.529 *	-0.141	-0.075	0.577 **	-0.793	1.572	0.005	-0.312	0.464	24.73%
2014-2018 MSCI															
Environmental Score															
High Rated	0.001	0.018	0.588 ***	-0.553	0.815 **	-0.047	1.114	0.069	0.095	0.519	-2.320 **	0.310	-1.657 **	1.657	57.02%
Low Rated	-0.017 ***	0.034 **	1.122 ***	0.362	-1.396 ***	2.008 ***	-2.643 **	0.405	-0.325	-0.828	2.498 **	-0.642 **	0.612	1.059	84.07%
Long-Short	0.019 ***	-0.016	-0.534 ***	-0.915 *	2.211 ***	-2.054 ***	3.756 **	-0.336	0.420	1.347	-4.818 ***	0.952 **	-2.269 *	0.598	46.74%
Emission Reduction															
High Rated	-0.001	0.014	0.806 ***	-0.891 ***	0.512 *	0.052	0.461	0.363	-0.011	0.578	-1.617 **	0.296	-1.513 **	0.751	78.50%
Low Rated	-0.006	0.001	1.295 ***	0.508	-1.441 **	2.500 ***	-2.102	2.134	-0.137	-1.391	3.468 **	-0.684 *	1.416	1.806	77.80%
Long-Short	0.005	0.014	-0.488 ***	-1.399 **	1.953 ***	-2.449 ***	2.562	-1.771	0.126	1.970	-5.085 ***	0.980 **	-2.929 **	-1.056	50.75%
Resource Reduction															
High Rated	0.000	0.027 *	1.012 ***	-0.291	0.306	0.117	0.344	-0.405	0.016	0.597	-0.985	0.013	-1.280	0.834	85.51%
Low Rated	0.001	0.029 **	0.912 ***	0.125	0.384	0.374	-1.198	1.364	0.096	0.052	-0.151	0.126	-1.020	0.961	84.85%
Long-Short	-0.001	-0.002	0.100	-0.417	-0.078	-0.257	1.541	-1.769 *	-0.080	0.545	-0.834	-0.113	-0.260	-0.127	6.04%
Product Innovation															
High Rated	0.001	0.012	0.970 ***	-0.634 ***	0.531 **	0.163	-0.258	0.300	-0.049	0.735	-1.291 **	0.213	-1.070 *	0.957	89.98%
Low Rated	-0.002	0.044 *	0.846 ***	0.580	0.126	0.624	-1.408	-0.242	0.224	0.363	0.254	-0.159	-0.914	0.614	67.31%
Long-Short	0.003	-0.032	0.124	-1.214 **	0.406	-0.461	1.151	0.542	-0.273	0.372	-1.545	0.372	-0.156	0.343	16.09%

Table (15) presents the regression estimates for the unconditional four-factor model of high and low-rated portfolios formed based on the individual Environmental Pillar and its three categories, considering a 50% cut-off. In the full period (Panel A), with the KF benchmark, the 50% cut-off estimates show an increase in the exposure of the low-rated portfolios to small caps. The size coefficients are now statistically significant in all dimensions, except for the Environmental Pillar, while the value and momentum estimates remain mostly similar. Regarding the abnormal returns' coefficients, the high-rated portfolio formed on the Resource Reduction dimension has a positive and statistically significant alpha, at the 10% level, but the difference compared to the low-rated alpha is not statistically significant. The results further show that the low-rated portfolio formed on the Environmental dimension underperforms the high-rated one, although only at the 10% level. These results may be due to the low-rated portfolio increasing the number of firms that have higher Environmental scores. The results with the MSCI Energy EU benchmark show that high-rated portfolios exhibit more exposure to small size caps than low-rated portfolios. The value and momentum factors are still very similar to those of the 30% cut-off portfolios. The alpha estimates also show changes compared to the 30% cut-off portfolios. In this case, we observe that the high-rated portfolio formed on the Resource Reduction dimension performs significantly better, at the 10% level, than its low-rated counterpart.

In the 2009 to 2013 period (Panel B), the results using the KF benchmark show very similar estimates regarding the risk factors and alpha estimates, with most exposures and coefficients with the same significance as the estimates from the 30% cut-off. The high-rated and the low-rated portfolios show neutral performance. Yet, the high-rated portfolio formed on the Environmental pillar underperforms the low-rated portfolio at the 5% level. In the 2014 to 2018 period, using the KF benchmark, similarly to in the results of the 30% cut-off, we observe similar changes in risk exposures compared to the 2009 to 2013 period, with the high-rated portfolios exposed to large cap firms and value stocks and the low-rated portfolios tending towards small caps. Regarding performance, we observe improvements in the alpha estimates, with the high-rated portfolios presenting positive and significant estimates in the Emission Reduction and in Resource Reduction dimensions. And in the latter case, high-rated firms even outperform their low-rated peers at the 5% level.

The results of the first period with the MSCI Energy EU benchmark (Panel C) show mostly similar exposures as in the 30% cut-off portfolios, with low-rated portfolios' exposure to growth stocks increasing for portfolios formed on the Product Innovation dimension and decreasing for the remaining ones. With this benchmark, the alpha estimates for the high-rated portfolios are positive but lower than the low-rated portfolios, resulting, in the Environmental Pillar dimension, in a statistically significant difference, at the 5% level. This means that the low-rated portfolio significantly outperforms the high-rated one in this dimension. As for the second period, the market risk exposures are slightly higher for the Environmental Pillar and Emission Reduction dimensions and lower for the other two dimensions, when compared to the results of the 30% cut-off portfolios. When compared to the first period, the trend in risk exposures is similar to the previous results, with low-rated portfolios tending towards small cap and value stocks and high-rated portfolios mostly exposed only to market risk. Regarding alphas, we observe slight improvements in the high-rated portfolios' estimates when compared to the 2009 to 2013 period. In contrast, the low-rated portfolios exhibit lower alpha estimates, with the low-rated portfolio in the Resource Reduction dimension being negative and statistically significant, at the 10% level. As a result, we observe that in this dimension high-rated portfolios outperform, at 1% level, low-rated ones.

Table 15 – Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Unconditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (1). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. SMB, HML and MOM are proxied using the data available in Professor Kenneth French's website. The portfolios are value-weighted and rebalanced annually. Panel A presents the results for the2009 to 2018 period. Panels B and C present the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey-West (1987) method.

Panel A

Kenneth French	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	0.001		1.092	***	0.004		0.155		0.002		82.22%
Low Rated	0.006		0.967	***	-0.055		0.096		-0.103		65.38%
Long-Short	-0.005	*	0.124	**	0.059		0.059		0.105		3.14%
Emission Reduction											
High Rated	0.002		1.037	***	-0.231	*	0.224	*	0.047		83.09%
Low Rated	0.006		1.007	***	0.514	*	0.035		-0.284	*	52.30%
Long-Short	-0.004		0.030		-0.746	***	0.189		0.330	**	13.89%
Resource Reduction											
High Rated	0.003	*	0.964	***	-0.072		0.162		0.033		85.89%
Low Rated	-0.001		1.127	***	0.751	***	-0.066		-0.083		57.42%
Long-Short	0.005		-0.164	*	-0.823	***	0.228		0.116		11.57%
Product Innovation											
High Rated	0.002		0.982	***	-0.253	**	0.159	*	0.046		88.66%
Low Rated	0.005		0.960	***	0.683	**	0.174		-0.297	*	47.02%
Long-Short	-0.004		0.022		-0.935	***	-0.016		0.342	**	11.25%
MSCI Energy EU											
Environmental Score											
High Rated	0.005	*	0.897	***	0.160		0.257	**	-0.134	*	84.84%
Low Rated	0.007	***	0.999	***	0.227	**	0.002		-0.175	***	90.62%
Long-Short	-0.002		-0.102	**	-0.067		0.255	**	0.041		3.39%
Emission Reduction											
High Rated	0.005	***	0.902	***	-0.048		0.276	***	-0.071		91.78%
Low Rated	0.007	*	1.056	***	0.819	***	-0.078		-0.355	***	73.11%
Long-Short	-0.002		-0.154	**	-0.867	***	0.354	*	0.284	**	20.13%
Resource Reduction											
High Rated	0.006	***	0.775	***	0.055		0.267	***	-0.091		86.36%
Low Rated	0.000		1.078	***	1.020	***	-0.097		-0.187	*	74.24%
Long-Short	0.006	*	-0.303	***	-0.965	***	0.364	**	0.096		23.07%
Product Innovation											
High Rated	0.005	**	0.768	***	-0.140		0.287	***	-0.086		86.12%
Low Rated	0.005		1.084	***	1.028	***	-0.003		-0.346	***	70.61%
Long-Short	0.000		-0.316	***	-1.168	***	0.289		0.260	*	20.11%

Table 15 – Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Unconditional model (Continued)

Panel B

2009-2013 KF	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	-0.004		1.135	***	0.184		-0.077		-0.018		89.88%
Low Rated	0.004		1.126	***	0.298		-0.467	**	-0.094		80.53%
Long-Short	-0.008	**	0.010		-0.113		0.389	***	0.076		15.32%
Emission Reduction											
High Rated	-0.003		1.098	***	0.019		0.004		0.062		91.23%
Low Rated	0.003		1.194	***	0.719	**	-0.753	**	-0.316	**	70.24%
Long-Short	-0.006		-0.096		-0.700	***	0.757	***	0.379	***	27.98%
Resource Reduction											
High Rated	-0.001		1.036	***	0.073		-0.058		0.042		92.60%
Low Rated	0.002		1.253	***	0.775	**	-0.621	**	-0.093		70.98%
Long-Short	-0.003		-0.217	*	-0.701	**	0.563	**	0.136		14.43%
Product Innovation											
High Rated	-0.001		1.018	***	-0.075		0.074		0.062		94.00%
Low Rated	0.001		1.144	***	0.733	**	-0.804	***	-0.371	**	69.08%
Long-Short	-0.002		-0.126		-0.807	***	0.878	***	0.434	***	28.14%
2014-2018 KF											
Environmental Score											
High Rated	0.007		1.225	***	-0.341		0.528	**	0.060		72.90%
Low Rated	0.009		1.011	***	-0.653	*	0.858	***	-0.265		58.33%
Long-Short	-0.002		0.213	**	0.312	*	-0.329	**	0.325	**	21.53%
Emission Reduction											
High Rated	0.008	**	1.135	***	-0.637	***	0.559	***	-0.045		74.07%
Low Rated	0.010		1.069	***	0.098		1.066	**	-0.436		43.46%
Long-Short	-0.002		0.065		-0.735	**	-0.507	*	0.390		12.30%
Resource Reduction											
High Rated	0.008	**	0.983	***	-0.285		0.435	***	-0.060		74.85%
Low Rated	-0.004		1.094	***	0.656		0.621		-0.320		43.26%
Long-Short	0.011	**	-0.111		-0.941	**	-0.187		0.260		10.26%
Product Innovation											
High Rated	0.004		1.015	***	-0.525	**	0.293	**	0.004		77.25%
Low Rated	0.011		1.116	***	0.436		1.469	***	-0.450		43.46%
Long-Short	-0.007		-0.101		-0.961	**	-1.176	***	0.453		23.35%

Table 15 – Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Unconditional model (Continued)

Panel C

2009-2013 MSCI	α		β1Mkt		β2SMB		β3HML		β4MOM		Adj. R2
Environmental Score											
High Rated	0.002	***	0.961	***	0.061		0.302	**	-0.128	*	91.39%
Low Rated	0.009	***	1.003	***	0.204		-0.140		-0.196	**	88.07%
Long-Short	-0.007	**	-0.042		-0.144		0.442	***	0.068		16.20%
Emission Reduction											
High Rated	0.003		0.943	***	-0.093		0.357	***	-0.043		94.22%
Low Rated	0.010	*	1.052	***	0.613	**	-0.395		-0.427	***	75.62%
Long-Short	-0.006		-0.110		-0.706	***	0.753	***	0.384	***	28.87%
Resource Reduction											
High Rated	0.006	**	0.851	***	-0.055		0.314	**	-0.063		92.67%
Low Rated	0.009	*	1.068	***	0.643	**	-0.209		-0.215		73.28%
Long-Short	-0.004		-0.217	**	-0.697	***	0.524	**	0.152		17.01%
Product Innovation											
High Rated	0.006	**	0.814	***	-0.214		0.461	***	-0.044		90.11%
Low Rated	0.006		1.053	***	0.658	**	-0.506	**	-0.471	***	78.73%
Long-Short	-0.001		-0.239	**	-0.872	***	0.967	***	0.427	***	33.71%
2014-2018 MSCI											
Environmental Score											
High Rated	0.005		0.840	***	0.392		0.055		-0.079		74.80%
Low Rated	0.005	**	0.986	***	0.182		0.246	**	-0.200	*	94.46%
Long-Short	0.000		-0.145	**	0.210		-0.192		0.120		27.02%
Emission Reduction											
High Rated	0.006	**	0.861	***	0.107		0.058		-0.124		88.49%
Low Rated	0.005		1.061	***	0.996	***	0.405		-0.354		70.83%
Long-Short	0.000		-0.201	*	-0.889	**	-0.347		0.231		17.98%
Resource Reduction											
High Rated	0.006	**	0.695	***	0.319	*	0.039		-0.159		80.43%
Low Rated	-0.008	*	1.077	***	1.568	***	-0.048		-0.242		76.96%
Long-Short	0.014	***	-0.382	***	-1.249	***	0.087		0.083		31.62%
Product Innovation											
High Rated	0.003		0.717	***	0.099		-0.115		-0.099		83.29%
Low Rated	0.007		1.131	***	1.392	***	0.763	**	-0.351		68.37%
Long-Short	-0.004		-0.413	***	-1.293	***	-0.878	**	0.252		34.98%

Table (16) presents the regression estimates for the conditional four-factor model of high and low-rated portfolios formed based on the individual Environmental pillar dimensions, considering a 50% cut-off. For the full period (Panels A and B), and starting with the KF benchmark (Panel A), when compared to the 30% cut-off portfolios, the additional firms in the portfolios do not affect the results significantly, although we observe some slight changes in some of the risk exposures. The value factor associated

with the term spread is now statistically significant for all portfolios and for all dimensions, and although the value factor associated with the dividend yield estimate is negative, the overall effects from the PIVs in this factor are positive. The alphas also change slightly, with the alphas associated to PIVs mostly cancelling each other out, resulting in no significant difference in these alphas. Comparing high and low-rated portfolios, the latter exhibits higher abnormal returns in the Environmental dimension, at 10% level, but in the Resource Reduction dimension the high-rated portfolio beats the low-rated one.

The results obtained with the MSCI Energy EU benchmark (Panel B) show that the additional PIVs do not, for the most part, affect the performance or risk exposures, but the additional firms now increase the overall market risk in the Environmental Pillar and Emission Reduction dimensions and decrease it in the other two dimensions. Also, when compared to the 30% cut-off portfolios, the PIVs associated with the market risk lose their significance. In contrast to the results obtained with the KF benchmark, the alphas associated to the PIVs do not show any statistical significance, nor do they differ between the portfolios. However, the average abnormal performance estimates do show better estimates for the high-rated portfolios, even outperforming significantly, at the 5% level, the low-rated portfolio formed on the Resource Reduction dimension.

Looking at the first period and using the KF benchmark (Panel C), the high-rated portfolios lose their previous statistical significance towards value stocks. Also, the low-rated portfolios seem to be, for the most part, the only ones that are significantly affected by the PIVs. Both PIVs associated with the value factor seem, overall, to affect this factor negatively, with the exception of the Environmental Pillar, showing a statistically significant difference for both coefficients. Regarding performance, the alphas associated to the term spread are only statistically significant at the 10%. Anyhow, the high- and low- rated portfolios do not differ significantly from each other regarding the effect of this PIV on performance. The abnormal performance estimates further shows no statistically significant difference between high and low-rated portfolios. In the second period, regarding the PIVs, the size factor associated with the dividend yield differs significantly in the Environmental and Resource Reduction portfolios, at the 5% and 1% levels respectively. The PIV term spread affects the size factor significantly in all dimensions, except for the Environmental Pillar, although when

compared to the low-rated portfolio there is no statistically significant difference between the portfolios. The PIVs associated to alphas show a negative and statistically significant effect, at the 10% level, on the high-rated portfolios formed on the Emission Reduction and Product Innovation dimensions. The abnormal performance, on the other hand, shows improvements to the estimates of high and low-rated portfolios formed on Emission and Resource Reduction dimensions, which present statistically significant estimates, at the 10% and 5% levels, respectively high-ranked portfolios formed on the latter dimension even outperform low-ranked ones, at the 10% level.

Considering the MSCI Energy EU benchmark (Panel D), the results of the first period show a less impact of the risk factors associated to the PIVs. The additional firms do not seem to have much impact on risk exposures, as high-rated portfolios are still exposed to value stocks, while low-rated portfolios are exposed to small cap stocks. The exception is the low-rated portfolio in the Environmental dimension, which is not exposed to any factor other than the market. The PIVs associated to the alphas of the high-rated portfolios cancel each other's effects, while in low-rated portfolios the effect is, overall, negative for all dimensions. Comparing the estimates of alpha, we find no statistical differences between the performance of high and low-rated portfolios. In the second period, we observe, once again, that high-rated portfolios tend to show no significant exposure to risk factors other than the market, while low-rated portfolios show, except for the Environmental dimension, exposure towards small cap stocks. In this period, the PIVs associated with the market risk factor have a neutral impact in high and low-rated portfolios formed on the Environmental and Emission Reduction dimensions, while in the Resource Reduction and Product Innovation dimensions the impact is, overall, negative. As for the alphas, the PIV term spread associated to alpha improves when compared to the 2009 to 2013 period and are, in the Environmental dimension, impacted positively and significantly, at the 10% level, in high and low-rated portfolios, while in the Emission Reduction dimension only the low-rated portfolio has a statistically significant and positive impact, at the 5% level. Regarding performance, the alpha estimates are worse than in the first period, with the low-rated portfolios performing worst in most dimensions, except for the Environmental Pillar, and being negative and statistically significant, at 5% level, in the Resource Reduction dimension.

In this latter dimension, high-rated portfolios perform significantly better (at the 1% level) than low-rated portfolios.

Table 16 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Conditional model

This table presents estimates of monthly abnormal returns, factor loadings, and the adjusted R^2 obtained from regressing equation (2). Mkt corresponds to the excess returns of the benchmark, proxied by market returns in Professor Kenneth French's website (Kenneth French) or the returns of the MSCI EU Energy Index in excess of the risk-free rate (MSCI EU Energy); SMB is the difference in return between small-cap and large-cap portfolios; HML is the difference in return between of high book-to-market and low book-to-market portfolios; and MOM is the difference in return between portfolios of stocks considered to have strong momentum and portfolios of stocks considered to have weak momentum. SMB, HML and MOM are proxied using the data available in Professor Kenneth French's website; TS corresponds to the term spread, computed as the difference between the yield of a long-term and short-term bond(proxied by the 10 year EMU benchmark and 3-month Euribor, respectively); DY corresponds to the dividend yield and is based on the STOXX Europe 600 Index. The portfolios are value-weighted and rebalanced annually. Panels A and B presents the results for the 2009 to 2018 period, using the KF and MSCI EU Energy Index, respectively. Panels C and D present the results for the subperiods using the KF and MSCI EU Energy Index, respectively. ***, **, and * indicate significance at the 1%, 5% and 10% level, respectively. Standard errors are corrected for heteroskedasticity and autocorrelation using the Newey & West, (1987) method.

Panel A

Kenneth French	α	TS	DY	β1Mkt	β3MktDY	β4SMB	β7HML	β8HML TS	β9MOM	β10MOM TS	Adj. R2
Environmental Score											
High Rated	0.002	0.015 *	-0.015	1.097 ***	0.061	-0.102	0.189	0.787 ***	-0.096	0.123	83.97%
Low Rated	0.006	0.015	-0.024 *	0.955 ***	0.030	-0.305	0.148	1.479 ***	-0.202	0.347 **	70.36%
Long-Short	-0.004 *	0.000	0.009	0.142 **	0.031	0.204	0.041	-0.692 **	0.106	-0.224 **	10.65%
Emission Reduction											
High Rated	0.003	0.014 **	-0.018 **	1.034 ***	0.115	-0.372 ***	0.239 **	0.779 ***	-0.084	0.113	85.59%
Low Rated	0.006	0.019	-0.021	0.988 ***	-0.017	0.302	0.127	1.852 ***	-0.364 *	0.473 **	55.22%
Long-Short	-0.003	-0.005	0.003	0.046	0.132	-0.674 ***	0.112	-1.073 **	0.281 *	-0.360 **	15.16%
Resource Reduction											
High Rated	0.005 **	0.011 **	-0.014 *	0.944 ***	0.068	-0.185 *	0.176 *	0.747 ***	-0.081	0.175 **	88.33%
Low Rated	-0.002	0.014	-0.020	1.111 ***	-0.179	0.455	-0.018	1.092 **	-0.112	0.464 **	60.20%
Long-Short	0.007	-0.002	0.007	-0.168 *	0.247	-0.640 ***	0.195	-0.345	0.031	-0.290	13.57%
Product Innovation											
High Rated	0.002	0.013 ***	-0.016 **	0.981 ***	0.093	-0.348 ***	0.178 **	0.521 **	0.005	0.159 **	90.10%
Low Rated	0.006	0.024	-0.015 ***	0.965	-0.110	0.591 *	0.296	1.937 ***	-0.410 *	0.406	50.63%
Long-Short	-0.005	-0.011	-0.001	0.016	0.203	-0.939 ***	-0.119	-1.416 **	0.415 **	-0.247	14.46%

Table 16 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Conditional model (Continued)

Panel B

MSCI Energy EU	α	TS	DY	β1Mkt	β3MktDY	β4SMB	β7HML	β8HML TS	β9MOM	β10MOM TS	Adj. R2
Environmental Score											
High Rated	0.005 *	-0.002	0.000	0.901 ***	0.337	0.212	0.287 **	0.102	-0.064	0.027	84.34%
Low Rated	0.006 **	-0.004	-0.001	0.982 ***	0.036	0.139	0.040	0.427 *	-0.117	0.158 *	91.06%
Long-Short	-0.002	0.002	0.001	-0.081 *	0.302	0.073	0.247 **	-0.325	0.053	-0.131	9.43%
Emission Reduction											
High Rated	0.005 ***	-0.002	-0.002	0.903 ***	0.272 *	-0.021	0.279 ***	0.021	-0.041	-0.010	91.61%
Low Rated	0.007	-0.003	0.005	1.025 ***	-0.083	0.755 ***	-0.014	0.678	-0.284 *	0.286	72.26%
Long-Short	-0.002	0.001	-0.006	-0.122	0.354	-0.776 ***	0.293	-0.657	0.243	-0.296 *	16.78%
Resource Reduction											
High Rated	0.007 **	-0.003	0.000	0.764 ***	0.176	0.093	0.267 **	0.171	-0.063	0.080	85.97%
Low Rated	-0.001	-0.006	0.001	1.059 ***	-0.050	0.936 ***	-0.095	0.168	-0.045	0.278 *	75.12%
Long-Short	0.009 **	0.003	-0.001	-0.295 ***	0.226	-0.843 ***	0.362 **	0.003	-0.018	-0.198	26.07%
Product Innovation											
High Rated	0.004 *	-0.002	-0.001	0.776 ***	0.162	-0.084	0.278 ***	-0.086	0.011	0.081	85.99%
Low Rated	0.006	-0.003	0.020	1.083 ***	-0.491	1.072 ***	0.074	0.402	-0.312 *	0.178	71.08%
Long-Short	-0.002	0.001	-0.022	-0.307 **	0.652	-1.156 ***	0.204	-0.488	0.323 *	-0.098	21.03%

Table 16 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Conditional model (Continued)

Panel C

2009-2013 KF	α	TS	DY	β1Mkt	β2MktTS	β3MktDY	β4SMB	β5SMB TS	β6SMB DY	β7HML	β8HML TS	β8HML DY	β10MOM TS	β11MOM DY	Adj. R2
Environmental Score															
High Rated	-0.004	0.011	-0.009	1.147 ***	-0.106	0.113	-0.008	-0.504 *	-0.012	-0.032	0.603	-0.781	0.042	-0.113	91.15%
Low Rated	0.000	0.016	-0.023	1.154 ***	-0.074	-0.009	-0.070	-0.122	-0.234	-0.543 **	1.294 ***	-2.215 **	0.299 *	-0.442	84.67%
Long-Short	-0.004	-0.006	0.015	-0.006	-0.031	0.122	0.062	-0.383	0.222	0.510	-0.691	1.434	-0.257	0.329	25.91%
Emission Reduction															
High Rated	-0.002	0.010	-0.004	1.122 ***	0.015	-0.109	-0.174	-0.394	-0.158	0.014	0.338	-0.307	0.012	-0.010	93.10%
Low Rated	-0.002	0.016	-0.027	1.192 ***	-0.398	0.659	0.386	-0.278	0.171	-0.735 **	1.952 ***	-3.494 **	0.393	-0.554	72.89%
Long-Short	0.000	-0.006	0.023	-0.069	0.413 *	-0.768	-0.560 *	-0.116	-0.330	0.749 **	-1.614 **	3.187 **	-0.381 *	0.544	33.81%
Resource Reduction															
High Rated	0.001	0.010 *	-0.008	1.027 ***	0.027	-0.053	-0.115 *	-0.193	-0.115	-0.031	0.456	-0.321	0.088	0.150	94.30%
Low Rated	-0.006	0.016	-0.035	1.279 ***	-0.171	0.614	0.245	-0.346	0.435	-0.802 **	1.682 **	-4.311 ***	0.471 **	-1.156 *	77.18%
Long-Short	0.006	-0.007	0.027	-0.252 **	0.198	-0.667	-0.360	0.154	-0.550	0.770 ***	-1.225 **	3.989 ***	-0.383 *	1.306 **	29.52%
Product Innovation															
High Rated	0.000	0.010 *	-0.003	1.033 ***	0.049	-0.182	-0.210 *	-0.294	0.026	0.127	0.155	0.196	0.082	0.151	95.52%
Low Rated	-0.005	0.022	-0.033	1.139 ***	-0.588 **	0.757	0.477	-0.437	0.196	-0.689 **	2.308 ***	-3.680 **	0.409 *	-0.627	74.04%
Long-Short	0.004	-0.012	0.030	-0.106	0.636 **	-0.939 *	-0.687 **	0.143	-0.171	0.815 **	-2.153 ***	3.876 **	-0.327	0.779	35.70%
2014-2018 KF															
Environmental Score															
High Rated	0.004	0.005	-0.017	1.092 ***	0.815	0.214	-0.836 **	1.911	0.260	0.663 ***	0.558	-1.076	-0.020	-0.107	74.34%
Low Rated	0.008	0.002	-0.033	0.878 ***	0.334	0.147	-1.224 ***	2.289	2.082	1.061 ***	0.867	-1.459	-0.505	-1.407	61.74%
Long-Short	-0.004	0.003	0.016	0.214 **	0.482	0.067	0.388	-0.378	-1.822 **	-0.398 **	-0.308	0.383	0.485	1.299 *	24.12%
Emission Reduction															
High Rated	0.008 *	-0.004	-0.029 *	1.024 ***	0.417	0.386	-1.129 ***	2.125 *	0.729	0.723 ***	0.605	-1.224	-0.044	-0.455	77.71%
Low Rated	0.003	0.027	-0.014	0.823 ***	1.794	-0.179	-0.633	2.026	2.191	1.219 **	1.346	-1.268	-0.236	-0.851	45.06%
Long-Short	0.005	-0.031	-0.015	0.201	-1.377	0.565	-0.496	0.099	-1.462	-0.496	-0.741	0.045	0.192	0.396	13.30%
Resource Reduction															
High Rated	0.008 **	-0.003	-0.018	0.886 ***	0.654	0.361	-0.660 ***	2.080 **	0.162	0.485 **	0.983	-0.696	0.866	0.312	77.93%
Low Rated	-0.004	0.003	-0.026	0.890 ***	1.240	-1.004	0.255	2.736	4.611 **	0.852 *	-0.146	-0.226	1.105	-0.760	47.04%
Long-Short	0.011 *	-0.006	0.008	-0.004	-0.586	1.365 *	-0.916 **	-0.656	-4.449 ***	-0.367	1.129	-0.470	-0.239	1.072	17.36%
Product Innovation															
High Rated	0.005	-0.002	-0.024 *	0.936 ***	0.052	0.308	-0.892 ***	2.143 **	0.840	0.425 **	0.318	-0.868	0.025	-0.148	80.18%
Low Rated	0.007	0.024	-0.015	0.908 ***	1.287	-0.472	-0.109	3.333	2.694	1.547 **	0.823	-0.164	0.827	0.176	39.73%
Long-Short	-0.002	-0.026	-0.009	0.027	-1.235	0.779	-0.783	-1.190	-1.854	-1.122 **	-0.505	-0.704	-0.802	-0.324	16.65%

Table 16 - Performance of high and low-rated portfolios performance analysis using the ASSET4 ESG Environmental Pillar dimensions with a 50% cut-off – Conditional model (Continued)

Panel D

2009-2013 MSCI	α	TS	DY	β1Mkt	β2MktTS	β3MktDY	β4SMB	β7HML	β8HML TS	β8HML DY	β9MOM	β10MOM TS	β11MOM DY	Adj. R2
Environmental Score														
High Rated	0.002	-0.011	0.010	0.968 ***	-0.124	0.350	0.183	0.418 **	-0.225	0.551	0.020	-0.067	-0.008	91.28%
Low Rated	0.006 *	-0.007	-0.002	1.013 ***	-0.051	0.124	0.138	-0.154	0.379	-0.844	-0.070	0.165	-0.338	88.48%
Long-Short	-0.004	-0.004	0.012	-0.045	-0.072	0.226	0.044	0.572 ***	-0.604 *	1.395 *	0.090	-0.232 *	0.330	27.70%
Emission Reduction														
High Rated	0.004	-0.010 *	0.013	0.958 ***	-0.041	0.188	0.033	0.430 ***	-0.376	0.771	0.050	-0.107	0.100	94.20%
Low Rated	0.004	-0.012	0.002	1.061 ***	-0.209	0.404 *	0.581	-0.323	0.607	-1.242	-0.140	0.260	-0.494	75.52%
Long-Short	0.000	0.001	0.011	-0.103	0.168	-0.216	-0.549 *	0.753 ***	-0.984	2.013	0.189	-0.366 *	0.594	30.46%
Resource Reduction														
High Rated	0.007 *	-0.008	0.009	0.842 ***	0.008	0.076	0.054	0.394 **	-0.158	0.789	0.001	-0.010	0.276	90.30%
Low Rated	0.001	-0.007	-0.014	1.083 ***	-0.108	0.591	0.504 *	-0.286	0.666	-2.339 *	0.074	0.360 *	-1.046	76.61%
Long-Short	0.006	-0.001	0.022	-0.241 **	0.116	-0.515	-0.450	0.681 **	-0.824	3.128 ***	-0.073	-0.370 *	1.322 **	31.86%
Product Innovation														
High Rated	0.007 *	-0.007	0.011	0.810 ***	0.032	0.063	-0.070	0.568 ***	-0.334	1.136	0.074	0.012	0.350	89.87%
Low Rated	0.000	-0.009	0.000	1.071 ***	-0.381 **	0.501	0.648 **	-0.344	0.701	-1.307	-0.105	0.250	-0.660	81.20%
Long-Short	0.006	0.001	0.011	-0.261 **	0.413 **	-0.438	-0.718 **	0.912 ***	-1.035	2.443 *	0.179	-0.237	1.010	37.67%
2014-2018 MSCI														
Environmental Score														
High Rated	-0.002	0.031 *	0.003	0.959 ***	-0.579	0.518	0.407	-0.025	0.621	-1.327	0.367	-1.647 *	1.349	75.10%
Low Rated	0.001	0.017 *	-0.003	1.022 ***	-0.128	0.086	0.268	0.169	0.572	-0.586	-0.015	-0.801	0.354	94.51%
Long-Short	-0.003	0.014	0.006	-0.063	-0.450	0.432	0.139	-0.194	0.049	-0.741	0.381 *	-0.846	0.995	21.54%
Emission Reduction														
High Rated	0.002	0.015	-0.005	0.949 ***	-0.483 *	0.589 **	0.100	0.022	0.645	-1.394 **	0.207	-1.089 *	1.169 *	89.48%
Low Rated	-0.006	0.054 **	0.009	1.033 ***	0.470	-0.459	1.071 *	0.163	0.505	0.502	-0.103	-1.076	0.693	70.61%
Long-Short	0.008	-0.040	-0.014 *	-0.084	-0.952 *	1.048 *	-0.970 *	-0.141	0.140	-1.896	0.311	-0.012	0.476	23.25%
Resource Reduction														
High Rated	0.002	0.016	0.003	0.796 ***	-0.480 *	0.347	0.393	-0.090	0.947	-0.784	0.077	-0.530	1.304 *	80.86%
Low Rated	-0.013 **	0.027	0.002	1.022 ***	0.655	-1.175 **	1.917 ***	-0.186	-1.453	2.330 **	-0.505	0.799	1.010	81.66%
Long-Short	0.016 ***	-0.010	0.001	-0.226 *	-1.136 ***	1.521 ***	-1.524 ***	0.095	2.400 **	-3.114 ***	0.583 *	-1.329	0.294	48.84%
Product Innovation														
High Rated	-0.001	0.013	0.003	0.840 ***	-0.727 ***	0.250	0.180	-0.131	0.343	-0.934	0.199	-1.224 **	0.815	85.63%
Low Rated	-0.004	0.044	0.027	1.137 ***	0.611	-1.457 **	1.806 ***	0.391	-0.755	2.885 *	-0.499	0.252	1.409	70.15%
Long-Short	0.003	-0.031	-0.024	-0.297	-1.337 *	1.708 **	-1.625 **	-0.522	1.099	-3.819 **	0.698	-1.476	-0.595	39.85%

5.4. Environmental performance of green and non-green energy portfolios

In this section, we evaluate the environmental performance of green and non-green portfolios and link environmental performance to financial performance.

Starting with the green and non-green portfolios of companies that are rated by ASSET4 ESG. Figure (1) plots the evolution over time of the average Environmental ESG Pillar score, as well as the scores of each of its individual category. We can see that in all dimensions, the green portfolio's annual average score is higher than that of the non-green portfolio, with the difference being statistically significant at 1% level, as we can observe in Table (17). It is worth noting that in the Emission Reduction dimension, the non-green portfolio's average score is not as low as in the other dimensions.

Figure 1 - Evolution of Environmental ESG Pillar dimensions scores for the green and non-green portfolios

This figure shows the mean Environmental, Resource Reduction, Emission Reduction and Product Innovation scores of portfolios of green and non-green firms from 2008 to 2018.

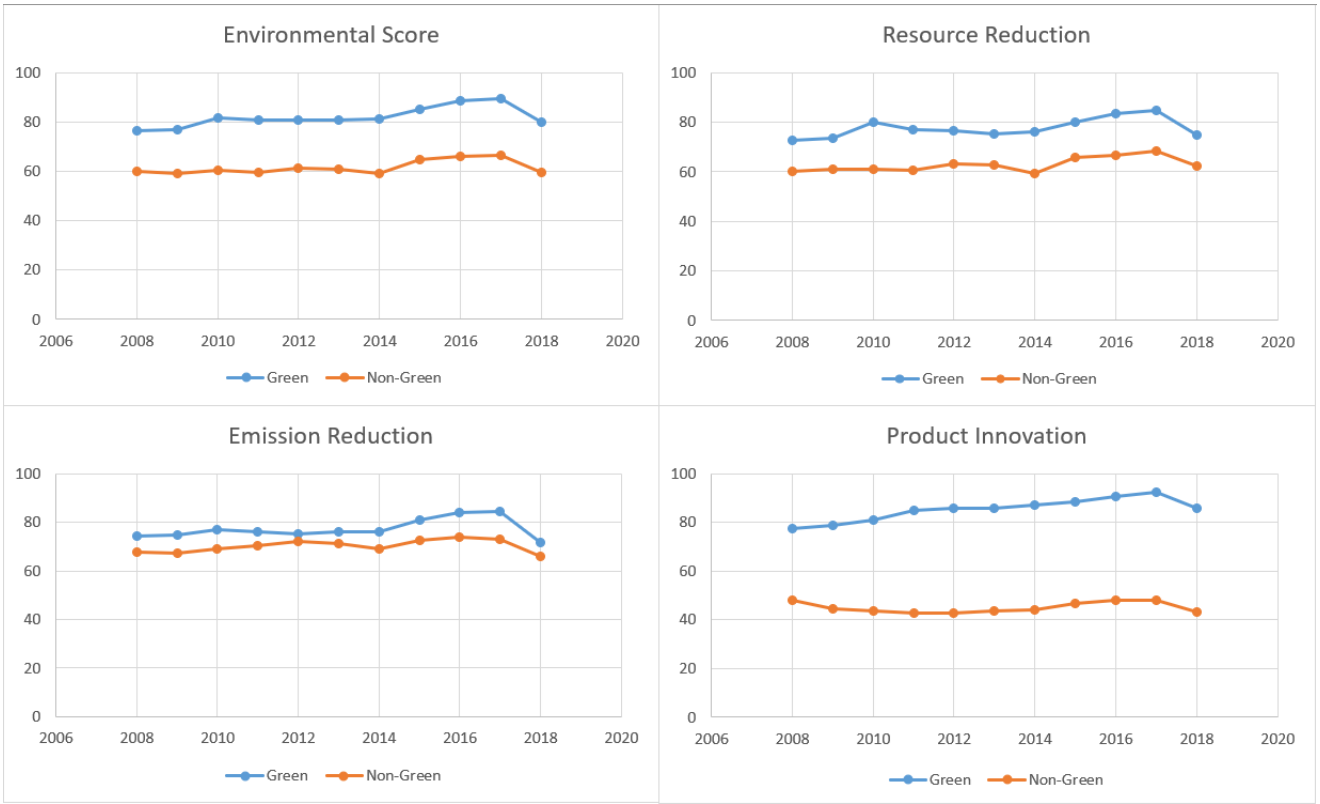


Table 17 – Mean Environmental, Emission Reduction, Resource Reduction and Product Innovation scores

This table shows the Environmental, Emission Reduction, Resource Reduction and Product Innovation scores of the green, non-green, and difference portfolio. The significance of differences between means is based on a two-sample T-test assuming unequal variance. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. The sample period is from 2009 to 2018.

	Non-Green Portfolio		Green Portfolio		Differences Portfolio	
Variables	N	Mean	N	Mean	Mean	
Environmental Score	85	61,680	44	82,098	20,418	***
Emission Reduction	85	70,203	44	77,283	7,080	***
Resource reduction	85	62,815	44	77,695	14,880	***
Product Innovation	85	45,084	44	85,239	40,155	***

To further investigate how the scores progress along the years, we split the green and non-green portfolios of rated stocks in 50% and 30% cut-offs, according to their ASSET4 ESG ratings, and plot the evolution of high-ranked and low-ranked stocks of each portfolio in Figures (2) and (3). We can observe that the average scores of the high-ranked portfolio of non-green stocks almost match but are always lower than those of the high-ranked portfolio of green stocks, especially when considering the 30% cut-off. Also, while average scores of the low-rated portfolio of non-green stocks do not change much throughout the years, the scores of the low-rated portfolio of green stocks show an improvement over time, almost matching the scores of the high rated portfolio of non-green stocks in the Environmental and Product Innovation dimensions when considering the 30% cut-off, and even surpassing the high-ranked portfolio of non-green stocks in the Product Innovation dimension when considering the 50% cut-off. While there is a significant difference between the evolution of the green ESG ratings and the non-green ESG ratings, there isn't any accompanying changes in performance of the green and non-green ESG rated portfolios.

Figure 2 – Evolution of Environmental ESG Pillar dimensions scores for the green and non-green portfolios considering a 50% cut-off

This figure shows the mean Environmental, Resource Reduction, Emission Reduction and Product Innovation scores of green and non-green firms from 2009 to 2018.

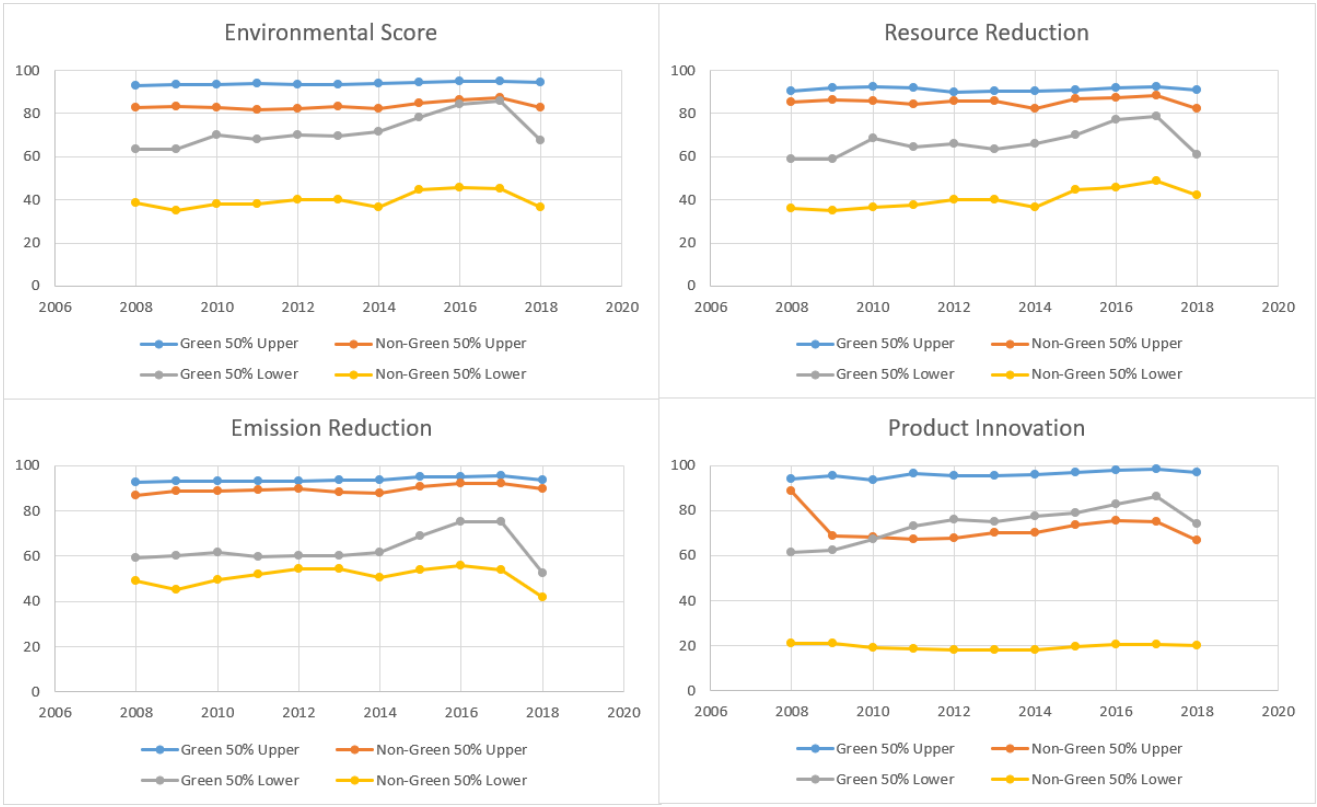
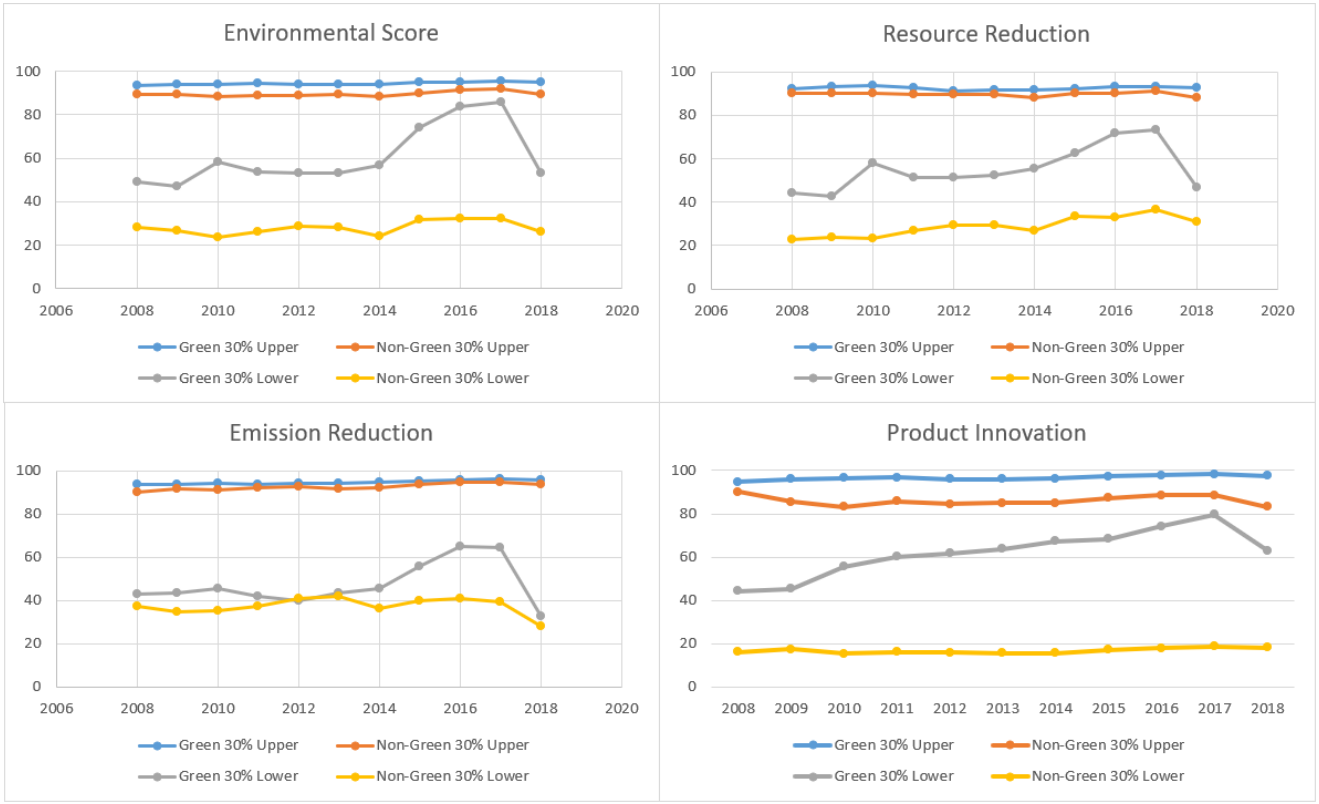


Figure 3 – Evolution of Environmental ESG Pillar dimensions scores for the green and non-green portfolios considering a 30% cut-off

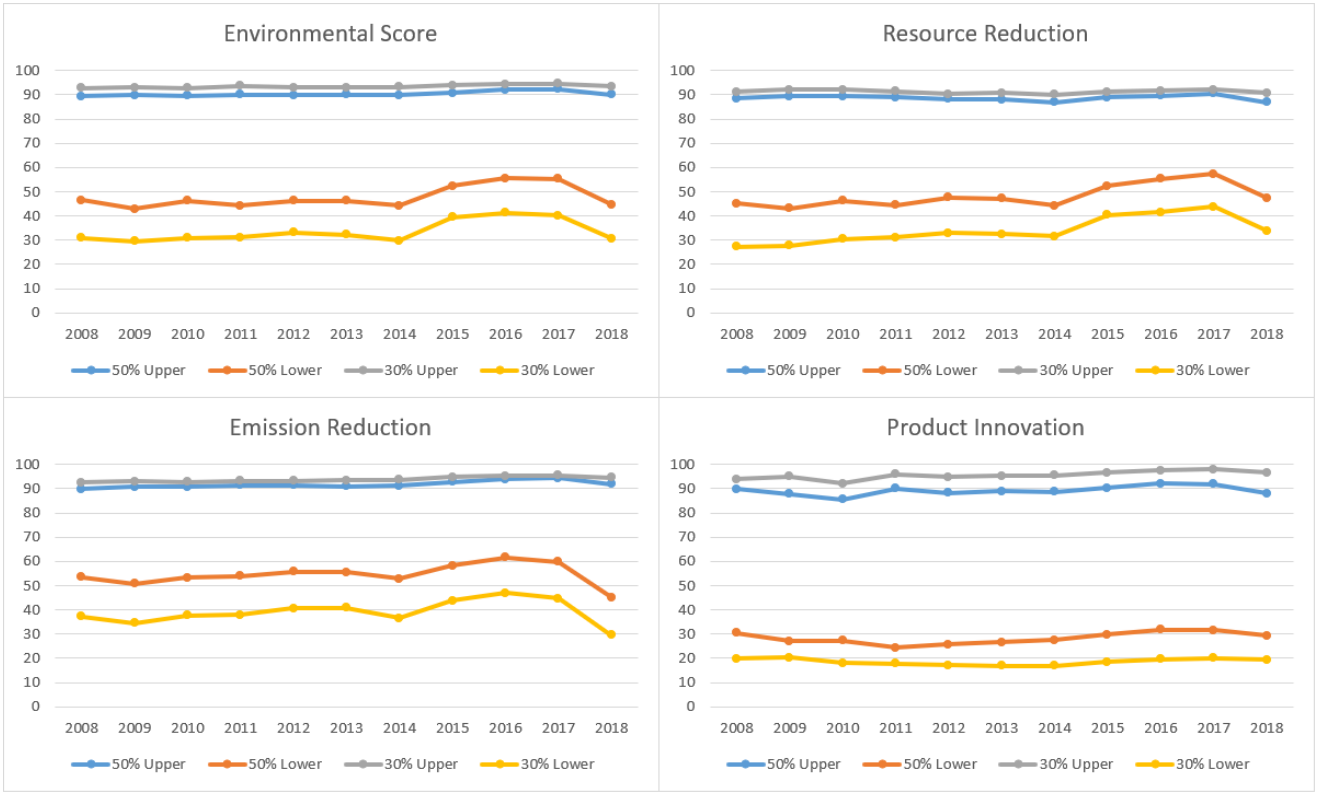
This figure shows the mean Environmental, Resource Reduction, Emission Reduction and Product Innovation scores of green and non-green firms from 2009 to 2018.



As for the ESG based portfolios, we can see in Figure (4) that the high-rated portfolios' scores are usually in the mid to low 90's for all dimensions and cut-offs, while the low-rated portfolios scores are in the high 50's to low 40's (high 30's to low 30's), except for the Product Innovation dimension, where it stays around 30 (around 20) in the 50% cut-off (30% cut-off). The improvements of the 50% and 30% lower cut-off portfolios' ESG ratings from 2014 to 2018 may be tied to the significantly higher abnormal returns of the high-rated portfolio when compared to the low-rated counterpart in the second subperiod in terms of the Environmental and Resource Reduction dimensions, as observed in tables 13 to 16.

Figure 4 – Evolution of Environmental ESG Pillar dimensions scores for the ESG rated portfolios considering 50% and 30% cut-offs.

This figure shows the mean Environmental, Resource Reduction, Emission Reduction and Product Innovation scores of ESG based portfolios from 2009 to 2018.



6. Conclusions

This paper addresses the performance of portfolios of European green and non-green energy stocks from 2009 to 2018. We form green and non-green value-weighted portfolios based on all constituents from the "Energy - Fossil Fuel" and "Renewable Energy" tabs in the Eikon database as well as the altenergystocks.com website. We also form portfolios based on the categories of the Environmental ASSET4 ESG Pillar, namely the Environmental pillar and the Emission Reduction, Resource Reduction and Product Innovation categories, and compared the performance of high-rated portfolios against low-rated portfolios considering 30% and 50% cut-offs. Long-short portfolios (long in green or high-rated and short in non-green or low-rated portfolios were also formed in

order to compare the differences in performance from investing in these portfolios. Portfolio performance is evaluated using the four-factor model (Carhart, 1997) in an unconditional and conditional setting.

Our results show that, for the most part, green energy portfolios are very similar to non-green portfolios in terms of performance, with our results not showing any statistical difference between green and non-green portfolios. As for the ESG based portfolios, their performance is also very similar between high and low-rated portfolios, but when considering the full and 2014 to 2018 periods, using the MSCI Energy EU benchmark, we observe some high-rated portfolios significantly outperforming the low-rated portfolios. Also, there are instances where we observe low-rated portfolios significantly outperforming high-rated portfolios formed on the Environmental Pillar dimension.

It is also important to note that when considering the subperiods, in almost any case, we document a slight improvement in the abnormal performance estimates for green and high-rated portfolios and, in cases where the estimates deteriorate, the non-green and low-rated portfolios estimates usually deteriorate more, even though most of the differences between green (high-rated) and non-green (low-rated) portfolios are not significant.

The green energy portfolios show, overall, a similar performance when compared to the non-green energy portfolios. Also, both green and non-green portfolios' alphas are similar to those obtained with the KF benchmark but are usually higher than those of the specialized benchmark. And when considering the ESG based portfolios, the high and low-rated portfolios show similar alphas when compared to the KF benchmark, while the high-rated portfolios show overall higher performance than the MSCI Energy EU benchmark. Overall, our results suggest that forming portfolios based on green energy screening does not hurt portfolio performance compared to investing in non-green energy firms. Our results seem to be consistent with the studies of Anderloni & Tanda (2017) and Ng & Zheng (2018), suggesting similar performance between green and non-green energy stocks**.**

Our results are of interest for investors, businesses and regulators. To investors, our results suggest that they can invest in environmentally friendly energy companies without paying a green premium. Hence, investors can play an active role in transitioning

from carbon-intensive fossil fuels to renewable and clean energy sources without sacrificing financial performance. These results also encourage policymakers/regulators concerned with the reliance on fossil fuel energy to promote industries (such as renewable energy) that may help to achieve the goals of reducing greenhouse gas emissions and contribute to converge to a sustainable economy. It is also worth noting that despite the substantial decline in global energy demand following the global coronavirus pandemic that unfolded in December 2019, leading many countries to implement lockdown and confinement measures, renewable energy has so far been the source of energy most resilient to the Covid-19 crisis (IEA, 2020).

The results in this research may be affected by the shocks in oil prices and recent changes in investment behavior favoring non-polluting green firms and divesting from non-green energy firms. Future research may be able to consider these factors. Furthermore, an opportunity for future research is to evaluate the performance of ASSET4 ESG rated firms and comparing them to non-rated ones.

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