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Do Markets Reward Green Investing?

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Abstract

This master essay provides an elaborate study of the relationship between the environmental and the financial performance of corporations with focus on the European market. It aims to identify the nature and significance of this relationship, using a sample that is taken from different business sectors across 17 European countries over the seven-year period from January 2010 to December 2016. The analysis is based on a database of four environmental indicators-criteria chosen to rank and distinguish the 171 studied firms according to their environmental performance, combined with a dataset of financial stock returns and accounting data. Two types of econometric analyses are performed in this study, each addressing the same relationship of interest, but in a different manner: a two-step cross sectional analysis of the individual monthly stock returns, where environmental performance is reflected in explanatory variables for stock returns, and a portfolio analysis where portfolios with constituents of different environmental performance are constructed and compared. The results from the first analysis suggest that there is a positive influence of the environmental performance of the industry within which European enterprises operate on their financial performance, while the results extracted from the second analysis show significant positive performance only for portfolios constructed based on the environmental performance of firms, regardless industry.

Key-words

Environmental performance, Environmental responsibility, Financial performance, Green Investing

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1. Introduction

The primary purpose of this master essay is to further study the relationship between corporate environmental performance and corporate financial performance, focusing on the developed European market. We aspire to reach significant, up-to-date results that will qualify as contribution to the general field of research that studies finance in relation to addressing environmental issues, a discipline that is considered to be still in its infancy.

Global concern for the environment is a relatively new and fast-growing issue that is gaining more and more importance as years go by. In the context of Corporate Environmental Responsibility (CER), a constantly increasing number of companies adopt environmental practices and conduct their operations in a way that minimizes the implications on natural environments, regardless the additional financial burden this entails. There are many factors that contribute to CER. From the scope of government policies and regulations, an intensification of environmental policies has been observed globally. The primary reason for this trend relies on the insurance of sustainable growth and improvement of environmental outcomes by increasing the opportunity costs of pollution and environmental damage (Tomasz Koźluk and Vera Zipperer, 2014). Additionally, in the last few years, constant efforts have been made to build mechanisms that promote the importance of transparency when it comes to environmental decision making, such as the Toxics Release Inventory (TRI) Program and the European Pollutant Release and Transfer Register (E-PRTR). Another key factor that motivates CER is reputation. In recent decades, the concept of environmental responsibility has in fact grown considerably among investors, creating a trend based on the belief that environmental responsibility is beneficial for the financial health of corporations when prioritized ahead of short-term profits. It is, thus, believed that complying to this trend, in the sense of undertaking environmental efforts, is important as it hedges against reputational risks and strengthens shareholder trust. (Blazovich, Smith & Smith, 2013; Eri Nakamura, 2011).

For the reasons mentioned above, firms have an incentive to reconsider their environmental awareness, improve their environmental performance[1] and disclose more information in order to

[1] Environmental performance is defined by an organization's interaction with the physical environment principally through the usage and consumption of natural resources, the amount of pollutants released in the atmosphere and the hazardous waste disposal (Ziegler et. al., 2007)

signal their good environmental performance. This increase in the availability and disclosure of environmental information seems to be influencing investors' decisions even more by allowing them to better assess the environmental impact of their investments and it raises a general interest in environmentally-responsible enterprises (Muhammad, 2014). But how do these enterprises perform financially? Many argue that CER involves implementing production techniques and imposing restrictions on the input selection that can be costly for the firms that adopt it, causing a competitive disadvantage and consequently damaging their financial performance. However, firms that make efforts to reduce their environmental impact not only earn public approval, which can potentially increase their sales, but also engage in a more efficient use of resources as a part of CER and thus have greater potential for sustainable growth.

Keeping the above tradeoff in mind, we focus our attention on green investing, a part of responsible investing that has become a global trend over the last few decades, as more and more investment companies and banks decide to "go green", while an increasing number of smaller investors also choose to invest responsibly by screening out industries and firms that are believed to have negative impact on the environment. We suspect that this trend can be potentially reflected in the stock market through an increase in the demand of the stocks of environmentally responsible firms, increasing their value and, combined with the other benefits of CER, ultimately causing them to perform better financially. Hence, the main objective of this research is to isolate the effect of the environmental factor on the performance of stocks and study its significance, combining and comparing a variety of environmental performance measures. Based on this objective we formulate and examine the following research questions, expecting positive results: How does the environmental performance of European corporations affect their financial performance? Does green investing yield higher returns?

Following the methodology of Ziegler et. al. (2007), we attempt to tackle the problem of measuring corporate environmental performance by principally constructing two types of variables: the one is based on industry level average environmental performance and the other is based on firm level relative environmental performance. Monthly returns for 171 European firms are collected for this study, focusing on a seven-year period from January 2010 to December 2016. The alternative methods implemented to analyze the data serve in capturing the different levels of the relationship, as well as assessing the power and the consistency of the results. First, a two-step cross-sectional analysis is conducted, and the average stock returns are regressed on the environmental performance variables mentioned above together with control variables to help us analyze the effect of the environmental performance on the performance of the stocks (Ziegler et. al., 2007). Subsequently, a portfolio analysis takes place in which portfolios of stocks, constructed according to the environmental performance in both industry and firm level, are regressed using the multifactor asset pricing model introduced by Fama and French (1993).

The results from the first analysis suggest that the high average environmental performance of the industry in which firms operate has a positive and significant impact on their financial performance, as expressed by the average monthly stock returns, while the second type of environmental performance was found insignificant. According to the results from the portfolio analysis, both industry-oriented and firm-oriented environmental portfolios for high performance exhibit positive stock performance in terms of the excess return potential they provide, however, in contradiction with the first analysis, only the firm-oriented portfolio results are significant.

Thereinafter, this essay is structured as follows: in section 2 a review of the literature is provided. In section 3 we describe the data used in the analysis while in section 4 we focus on the methods and models that we used to examine the relationship of interest and finally reach the results mentioned in section 5. Finally, section 6 involves a summary of the main points and the conclusions, while the appendix section contains the relevant tables and graphs discussed throughout the analysis.

2. Literature Review

Limited prior research has been conducted specifically examining the effect of environmental factors on the financial performance of corporations, while most of the background literature we came across focuses on social performance in its whole. As many researchers support, the results from these studies have been so far rather conflicting due to the existence of an obvious tradeoff: firms that are actively trying to control their impact on the natural environment are more likely to achieve sustainable growth driven by the better usage of resources, however adopting environmentally friendly techniques can be particularly costly. In addition, the results are usually affected by the lack of credible data and the subjectivity of the different rankings (Cohen, Fenn and Konar, 1997). In this section, we provide a detailed literature review in which we bring several preceding research papers to attention, selected for their focus on studying the influence of the environmental identity of corporations on their financial performance, usually through comparisons between “green” and “non-green” industries, firms or portfolios of firms.

2.1. Methodological approaches

Various methodological approaches have been introduced by previous literature, relevant to our analysis, for studying the environmental aspect of corporate financial performance. Hereinafter, we describe the predominant ones: accounting based studies, event studies and portfolio analyses.

2.1.1. Accounting based approach

Hart and Ahuja (1996) present an accounting-based analysis to investigate the effect of a reduction in emissions on the economic performance of firms. They run multiple linear regressions to determine the effect of emission reduction on return on sales (ROS), return on assets (ROA) and return on equity (ROE). The independent variables include the emission reduction, along with other control variables such as R&D intensity, capital intensity and leverage. Notably, only the manufacturing and mining industries are selected for the empirical research. Considering that several other industries, such as chemicals and transportation contribute to the general increase of the emissions, this research has limited data because two industries are not enough to represent the whole sample data needed and thus the validity of results is questionable. Other similar papers include Blazovich, Smith & Smith (2013), Hayam Wahba (2008), Andrew A. King and Michael J. Lenox (2001) and Blazovich and Smith (2011), where different conclusions are drawn from the studies. Smith & Smith (2013) for example report no significant relationship between environmental performance and economic performance, while Andrew A. King and Michael J. Lenox (2001) and Hart and Ahuja (1996) find significant evidence between pollution reduction and financial gain. However, accounting based models, though convenient, can sometimes be problematic. The problem lies on the fact that it is rather difficult to determine the right explanatory variables for the financial performance, let alone the possible presence of omitted variable bias in the regressions. Moreover, the various accounting measures can be easily manipulated by the management, thus leading to unreliable results. Therefore, we have chosen to exclude this option from our research and use stock price data instead, because, as an approach, it has stronger theoretical and empirical foundation. Following the efficient market hypothesis, stock prices make unbiased estimates of a company's assets, since share price depicts the present value of all future cash flows of a firm (Konar and Cohen, 1997), while the selected accounting data provide only historical performance.

2.1.2. Event study approach

The effect of environmental responsibility in a company's financial performance has also been investigated using the event study methodology. According to McWilliams, Siegel and Teoh (1999), event studies are mainly used to address management issues. The standard process of event study is based on the market index model and daily value-weighted returns of the firm. Applying the market model or CAPM, expected returns are achieved through a simple OLS estimation and the abnormal returns are concluded through the difference between these expected returns and the actual returns from the event window. There are a few environmentally related studies that use this methodology. Konar and Cohen (1997) for instance, conduct an event study to test the effect of toxic release inventory (TRI) emissions disclosure in firm behavior in response to negative abnormal market returns. The results confirm that there is a higher reaction to unexpected TRI emissions, rather than spills that are anticipated to be large. Hamilton (1995) provides a similar study with the same conclusion where evidence of a significantly negative relationship between TRI emissions and abnormal returns is found. Other publications also implement event studies, including Klassen & McLaughlin (1996), Connors, Elizabeth, Gao, Lucia S. (2011) and Lundgren & Olsson (2010), however their results are usually mixed or inconclusive. Irrespective of their environmental approach, these publications do not provide direct empirical evidence of the specific relationship between environmental performance and economic performance. We choose to avoid event studies due to their sensitivity to research design issues found in McWilliams and Siegel (1997). Problems with this methodology include controlling for the effects of outliers, the sample size, the length of the event window as well as the explanation of abnormal returns which may lead to false inference about the significance of the events and the validity of the theory being tested. According to King and Lenox (2001), event studies do not control for the possibility that the effect of the event is temporary and stock prices may return to their pre-event levels after a few days. Furthermore, prior literature implementing this approach secludes only one single environmental event (such as TRI emissions) within a short timeframe where event studies examine unobservable differences among firms. This could indicate that event studies can only control the effect of events which are partially environmental and do not capture the whole picture. (King and Lenox, 2001)

2.1.3. Portfolio analysis approach

Other publications, like those of Cohen et al (1997) and Schröder (2004) choose to study the relationship between environmental and financial performance by constructing different portfolio investments using environmental criteria. In more detail, Cohen et al (1997) generate two portfolios based on the pollution levels of the constituents along with other environmental variables, and compare them in terms of their financial performance using both accounting returns and stock market returns as dependent variables. Schröder (2004), on the other hand, focuses on analyzing the performance of socially responsible investment funds, by using measures like the Sharpe Ratio and Jensen's alpha and by implementing three estimation approaches where he principally regresses the funds' excess returns on benchmark indices.

2.1.4. Cross-sectional analysis of individual historical returns based on asset pricing models

Ziegler, Schröder and Rennings (2007) implement a new empirical approach, which is based on modern asset pricing models, like the Fama and French multifactor model. This model examines the role of the undiversifiable risk in joint with two additional risk factors in explaining the average stock returns. Fama and French (1993) suggest that there are several cross-sectional patterns in stock returns which cannot be explained by CAPM that are related to firm specific characteristics like leverage, firm size, book-to-market equity and earnings/price. Additionally, book-to-market and firm size are able to absorb effects of leverage and E/P effects in the average returns and therefore a three-factor model is able to capture these patterns with a strong explanatory power. Mimicking portfolios are used as a next step in the three-factor model through the joint ranking of book-to-market and firm size. From these portfolios, value-weighted returns are calculated for the two explanatory variables in order to capture the additional risk factors and also several portfolios are built to represent the dependent variable. The conclusion from Fama and French (1993) state that there is a negative relationship between relative profitability and book-to-market, and a positive correlation with firm size. This model can be applied for portfolio formation, as well as performance evaluation using the three risk factors for data that contains only stocks. Ziegler et al. execute the multifactor model for their empirical analysis, however individual stock returns are used as a dependent variable instead of portfolios to discern the environmental performance in firm and industry level more clearly. The conclusions from the paper report a significantly positive effect of the environmental performance on stock performance on industry level. On the other hand, the corporate relative environmental performance has no effect on stock performance. According to these results investors would increase their returns on their portfolios if they invested in green industries, but no particular value would be added or decreased if they invested in "greener" corporations in comparison to others within the same industry.

2.2. Measurements for Environmental Performance

Regarding the environmental performance variables, it is noticeable that previous literature has an extensive focus on one singular partial environmental indicator, such as TRI emissions. This variable is used in the majority of considered research essays, including Konar and Cohen (1997), Hamilton (1995), Klassen & McLaughlin (1996) and Connors, Elizabeth; Gao, Lucia S. (2011). However, according to Ziegler. et. al., TRI emissions are not a strong environmental performance measure because non-toxic waste such as CO_2 is not taken into consideration and environmental management is not included. Thus, correct conclusions cannot be drawn. Cohen et all (1997), on the other hand, make use of a variety of environmental performance variables, additionally to the toxic chemical releases, including oil and chemical spills as well as environmental legal proceedings and penalties. Other environmental performance measures can also be found in literature. Russo and Fouts (1997), for instance, make use of environmental ratings information such as compliance with regulations, environmental expenditures and waste reduction, while Wagner (2005) combines input-based measures (energy and water use) with output-based measures (emissions). These types of measures are considered of very good quality, however available information is almost absent. Finally, some publications, like Wahba (2008) and Canon and Ayerbe (2006), focus solely on environmental management systems and more specifically on possessing or not ISO 14001 certification.

Considering the above, we focus on the approach used in the work of Ziegler, Schröder and Rennings (2007). Environmental performance is measured in two separate dimensions, including an industry level average and a company level relative performance measure to allow for comparisons among industries and companies within an industry separately. This approach is also previously implemented by other publications, such as Andrew A. King and Michael J. Lenox (2001), while it should be mentioned that the environmental information is taken from an assessment performed by Swiss bank Sarasin & Cie, which ranks companies into five categories based on their environmental performance.

2.3. Influences on our analysis

Our analysis is mainly inspired by the research work of Ziegler, Schröder and Rennings (2007). The Fama and French multifactor model is chosen among the other mentioned approaches, as this methodology is overall better than the CAPM since it takes into consideration two additional risk factors. Moreover, this approach is more accurate than the accounting-based methodology because it is not subject to manipulation as it uses market stock performance. Unlike event studies, this methodology allows us to consider more than one environmental components and address environmental performance in a more complete way. Additionally, to test the consistency of our results, we incorporate a portfolio analysis to the empirical study. Inspired by the approach of Cohen et al (1997), where portfolios of high and low polluting industries are constructed and compared, which we combine with the two-dimension environmental performance measure proposed by Ziegler et al. (2007), we build six portfolios concerning high, medium and low environmental performance in both industry and firm within given industry level. The purpose of these two different approaches is to investigate and compare potential differences in the results. To our knowledge, no recent study has been performed regarding the effects of environmental performance in the financial performance of a firm, therefore we aim to implement a contemporary analysis to examine for updated results and possible changes from previous conclusions regarding this topic.

We calculate the environmental criteria by taking into account four basic environmental components and conclude three environmental performance ranks: *High, Medium* and *Low*. The core interest of our study lies on the environmental performance factor; therefore, social performance is excluded. Furthermore, special importance is given to the environmental management systems, in order to investigate whether acquiring an efficient environmental management certificate has any potential impact on stock performance. As suggested by Ziegler et al. (2007), a more recent data sample is selected, hoping for updated results. Finally, it is important to note that Renewable Energy, a relatively new industry that is experiencing outstanding growth, is not included in the data sample chosen by Ziegler et al. (2007), due to non-availability of historical information. We have included this industry as a part of our study because we believe it can be a significant contribution to the results.

3. Data

In this section, we briefly describe the data used for the purposes of this research. We start with the environmental data category, which includes reported data regarding four environmental indicators and continue with the financial data category, including both stock market and accounting data.

3.1. Environmental Data

The environmental performance of corporations is determined by their impact on ecosystems, land, air and water, as a result of the intensive use of natural resources, the amount of pollutants released and the amount of hazardous waste disposed (Ziegler et al., 2007). Based on this principle, we attempt to evaluate and rank the environmental performance of European corporations using environmental indicators available in Thomson Reuters Eikon database. The firms which participate in our analysis were selected for geographical reasons and for reasons of availability of reported environmental information. Regarding this information, due to confined relative disclosure, we had to limit our options to a group of four fundamental environmental criteria, which capture various aspects of the impact that facilities have on the environment in terms of environmental releases and resource consumption. The criteria are the following:

- *Hazardous waste*: the total amount of hazardous waste produced by a facility, divided by its revenue
- *Greenhouse gas emissions*: the total CO_2 and CO_2 equivalents emissions produced by a facility, divided by its revenue
- *Water use*: a facility's total water withdrawal, divided by its revenue
- *Energy use*: a facility's total direct and indirect energy consumption, divided by its revenue

We use ratios of emissions, waste disposal and natural resources consumption over revenues instead of the reported levels in order for these factors to be comparable across firms. We have also gathered information regarding the possession of an *ISO 14000* or *Environmental*

Management System (EMS) certificate, which concerns the adoption of efficient environmental management. These systems mean to provide the necessary tools for assessing, documenting, and managing environmental performance in an attempt to take corporate environmental responsibility one step further than just complying with the current environmental legislation. Other environmental criteria such as land use, discharge into water system and waste recycling ratio are also considered important but cannot be included in the analysis due to the lack of reported information.

The environmental indicators above are collected for enterprises with headquarters in 17 European countries: France, United Kingdom, Switzerland, Germany, Spain, Sweden, Italy, Finland, Denmark, Austria, Norway, Netherlands, Belgium, Poland, Portugal, Ireland and Hungary. The allocation of firms among the countries is illustrated in Graph A1 of the Appendix. The enterprises belong to 11 chosen industries, which are displayed in Table 1 below along with the number of units per industry and the average of environmental indicators described in the next section.

Table 1: Facility allocations in industries

The table reports the allocation of facilities among the industries and the equally weighted average of the four environmental indicators for each industry.

Industries	*Number of Units*	*Industry Average*
Banking Services	30	0.033
Technology Equipment, Software & IT	4	0.304
Machinery, Tools, Heavy vehicles	20	0.394
Healthcare	17	0.422
Consumer non-cyclicals	13	0.545
Transportation	8	0.769
Renewable Energy and Environmental Services & Equipment	7	1.725
Fossil-fuel Energy	15	4.925
Chemicals	24	5.397
Mineral Resources	19	6.390
Utilities	14	32.854
	171	

Four years of historical environmental information are available in Thomson Reuters Eikon database. Nevertheless, there are no significant differences in the firms' environmental impact through time, in other words there are no differences which would affect the ranking process. Therefore, we have decided to use the last fiscal year's environmental information both for reasons of simplicity and to allow the selection of a wider time-period for our analysis.

However, there still are some unresolved issues that may compromise the objectivity of the analysis. First of all, due to non-availability of information that would allow us to measure the impact of a company's products on the environment, the analysis focuses on the production process alone. Another issue could be related to the fact that we have chosen the sample of companies based on the disclosure of environmental data, to be able to perform the necessary calculations. However, we should not ignore the possibility that, in some cases, reporting is a way for firms to signal their quality, and consequently environmentally "bad" firms are more likely to be among the non-reporting firms. Therefore, we intend to be careful with the interpretation of the results as it is possible that we have included the elite of each industry due to information asymmetry.

3.2. Financial Data

The analysis focuses on a 7-year period, from January 2010 to December 2016. We deliberately exclude previous years to rule out the effect of the financial crisis of 2008 on the returns, since stock prices during this period experienced extreme shocks in the markets which would probably distort the final results of the empirical analysis. The data is mainly taken from developed European countries, as information for emerging markets is distinctly absent. The cross-section initially included 198 companies, however due to some notable outliers and lack of historical data, 20 companies are ruled out of the sample. Moreover, all Greek companies are excluded due to lack of historical data for July 2015, when Greek banks shut down to prevent financial system from collapsing and consequently trading of Greek stocks and bonds was halted. We use historical, monthly stock price data for these firms, obtained from Thomson Reuters Eikon, which are transformed into monthly logarithmic returns as a measure of stock performance, and therefore financial performance, of the European enterprises, as shown in equation below:

$$r_{i,t} = \ln(\frac{P_{i,t}}{P_{i,t-1}})$$

Where $P_{i,t}$ denotes the price of the stock of firm i at month t.

We have selected one common market index, *FTSEurofirst 300*, as our market portfolio, historical data of which we gathered from Capital IQ database. We have also selected the *1-month T-Bill return* as our risk-free rate, obtained from the Kenneth R. French Data Library. Additionally, we have gathered historical market capitalization and Price-to-Book ratios which we will subsequently use in the construction of mimicking portfolios for the risk factors included in our time-series regression models. During this process, we have excluded seven more firms which reported negative total equity in their balance sheets, as suggested by Fama and French (1993), to avoid negative Price-to-Book values. Therefore, our final cross-section consists of 171 firms, which belong to the 11 industries of Table 1, established in 17 European countries.

4. Methodology and models

The first part of this section consists of a preliminary analysis which deals with the construction of variables that reflect the environmental performance of the European stock corporations in our sample by implementing a ranking methodology based on the principles introduced by Ziegler et al (2007). The second part of this section refers to the construction of the risk factors, as it is suggested by Fama and French (1993), while the third part includes two separate empirical methods: a two-step cross-sectional analysis of the influence of the environmental performance of European firms on their financial performance based on the multifactor model applied on the individual stock returns, and a portfolio analysis with focus on risk sensitivity, also based on the same multifactor model, where the environmental aspect is captured by the different environmental performance of the constituents of each portfolio. The fourth and final part of this section describes the required diagnostic tests on the data.

4.1. Construction of Environmental Performance Variables

In this part of the study, our aim is to construct two types of environmental performance measures, inspired by Ziegler et al (2007): the first type captures the average environmental performance of the industry in which a firm belongs while the second type captures the relative environmental performance of the firm within its own industry. To achieve this task, we first need to rank the firms and the industries on the basis of their environmental performance, by first calculating the average of the four environmental ratios mentioned above for each firm and then using these values to obtain an industry average for each one of the selected industries. A low average value indicates a low environmental impact, while a high resulting value would suggest a big “loss” in environmental performance, in terms of which we rank the selected firms and subsequently industries into *High*, *Medium* and *Low*. More specifically, the higher the average of the four aggravating factors, the lower the performance of the corresponding industry or firm. Percentile ranking is used to establish breakpoints that allow us to distinguish among these three categories of environmental performance. After sorting the values from smallest to largest, both among firms in the same industry and among the eleven industries, we use a 33.3% threshold of acceptance for a firm or industry to be included in the high-performance group, a 66.7% threshold for the medium performance group while all firms or industries beyond this threshold are considered of low environmental performance. The industry ranking is better illustrated in Table 2 below.

Table 2: Industry ranking according to the environmental performance

The table reports the ranking of the industries according to their average environmental performance and the benchmarks established using the 33.3% and 66.7% percentiles.

	Benchmarks	
	33.3% Percentile	*66.7% Percentile*
High environmental performance Industries		
Banking Services	0.018	0.035
Technology Equipment, Software & IT	0.024	0.408
Machinery, Tools, Heavy vehicles	0.102	0.221
Medium environmental performance Industries		
Healthcare	0.122	0.413
Consumer non-cyclicals	0.147	0.628
Transportation	0.214	0.511
Renewable Energy and Environmental Services & Equipment	0.086	1.530
Low environmental performance Industries		
Fossil-fuel Energy	1.008	1.695
Chemicals	1.023	5.043
Mineral Resources	2.708	6.489
Utilities	0.746	21.796

Note: The ranking of the firms within each one of the 11 industries is performed similarly

In mathematical notation:

- Ranking of firms $i = 1, 2, \ldots 171$ within each given industry $k = 1, 2, \ldots 11$:

  If $\overline{X_i} \leq 33.3\%\ percentile \Rightarrow i\ exhibits\ high\ environmental\ performance$

  If $33.3\%\ percentile < \overline{X_i} \leq 66.7\%\ percentile \Rightarrow$
  $i\ exhibits\ medium\ environmental\ performance$

  If $\overline{X_i} > 66.7\%\ percentile \Rightarrow i\ exhibits\ low\ environmental\ performance$

- Ranking of industries $k = 1, 2, \ldots 11$*:*

  If $\overline{Y_k} \leq 33.3\%\ percentile \Rightarrow k\ exhibits\ high\ environmental\ performance$

  If $33.3\%\ percentile < \overline{Y_k} \leq 66.7\%\ percentile \Rightarrow$
  $k\ exhibits\ medium\ environmental\ performance$

  If $\overline{Y_k} > 66.7\%\ percentile \Rightarrow k\ exhibits\ low\ environmental\ performance$

Where $\overline{X_i}$ is the average of the four environmental indicators for each firm $i = 1, 2, \ldots 171$, and $\overline{Y_k} = \frac{\overline{X_1} + \overline{X_2} + \cdots + \overline{X_{n_k}}}{n_k}$ with n_k being the number of firms within each industry $k = 1, 2, \ldots 11$.

However, we acknowledge the fact that the four environmental indicators chosen for this study are of different nature and magnitudes, and consequently they require different handling, making them incomparable with each other and therefore averaging them could lead to distorted results. By scaling them with revenues we have managed to make them comparable across the firms of the sample, however, they remain incomparable with each other. Therefore, we could accurately compare the environmental impact of the firms based on each criterion separately but not collectively. To overcome this hurdle, we decided to test the effect of the mismatch of the environmental data on the ranking process, since dealing with it directly was infeasible, by additionally performing four individual rankings for the four different environmental criteria. The resulting breakpoints are approximately the same as the ones obtained from the collective ranking and therefore no corruption is caused to the initial ranking by the existence of these differences, which allows us to follow an integrated approach on assessing the environmental impact of firms.

Based on this ranking process and inspired by the methodology used by Ziegler et al (2007), this analysis makes use of six dummy variables, each expressing the three categories of environmental performance, *High*, *Medium* and *Low*, both in industry level and firm within a given industry level. The dummy variables are constructed as follows, for the $i = 1, 2, \dots, 171$ firms:

- High environmental performance of industry dummy:

$$D_i^{Hind} = \begin{cases} 1 & if\ i\ belongs\ in\ high\ env.performance\ industry \\ 0 & otherwise \end{cases}$$

- Medium environmental performance of industry dummy:

$$D_i^{Mind} = \begin{cases} 1 & if\ i\ belongs\ in\ medium\ env.performance\ industry \\ 0 & otherwise \end{cases}$$

- Low environmental performance of industry dummy:

$$D_i^{Lind} = \begin{cases} 1 & if\ i\ belongs\ in\ \ low\ env.performance\ of\ industry \\ 0 & otherwise \end{cases}$$

- High environmental performance firm dummy:

$$D_i^{Hfirm} = \begin{cases} 1 & if\ i\ is\ a\ high\ env.performance\ firm \\ 0 & otherwise \end{cases}$$

- Medium environmental performance firm dummy:

$$D_i^{Mfirm} = \begin{cases} 1 & if\ i\ is\ a\ medium\ env.performance\ firm \\ 0 & otherwise \end{cases}$$

- Low environmental performance firm dummy:

$$D_i^{Lfirm} = \begin{cases} 1 & if\ i\ is\ a\ low\ env.performance\ firm \\ 0 & otherwise \end{cases}$$

Additionally, we are including an *ISO 14000/ EMS* dummy variable which will help us observe the effect of acquiring an efficient environmental management certification on the performance of the stock, and how significant this effect is:

$$D_i^{ISO} = \begin{cases} 1 & if\ i\ is\ ISO\ 14000\ or\ EMS\ certified \\ 0 & otherwise \end{cases}$$

Finally, we are using country dummies as control variables for country-specific effects on returns. To examine the influence of the country of origin on the performance of the firms participating in this analysis, we perform this time an additional ranking, of the countries in terms of their environmental performance, from the highest (expressed with low average values of the environmental criteria) to the lowest performance (high average values). To help us capture any existing country-specific correlation between environmental and market performance, the average of historical returns of each country's stock market index is used. The relevant information is reported in Table 3:

Table 3: Country ranking according to the environmental performance

The table reports the ranking of the countries according to their average environmental performance and the average of the historical returns calculated for each country's stock market index. The historical financial data is collected on monthly basis for the same seven-year period (2010-2016).

Countries	*Average Environmental Performance*	*Stock Market Index (average returns, %)*
Portugal	0.161	-0.055%
Denmark	0.463	1.257%
Ireland	1.048	1.044%
Switzerland	1.279	0.325%
Italy	1.281	N/A
United Kingdom	1.609	0.453%
Netherlands	1.798	0.479%
Sweden	2.361	0.779%
Norway	3.376	N/A
Hungary	3.460	0.658%
Germany	4.405	0.912%
Belgium	4.525	0.498%
Poland	4.890	N/A
France	7.673	0.354%
Austria	8.658	0.211%
Spain	8.812	-0.116%
Finland	18.713	0.493%

Subsequently, in Table 4, we plot the average environmental performance values together with the mean market returns into a correlation matrix. The results show negative correlation of -0.278 which indicates that countries with high market performance may also exhibit high environmental performance, however the correlation observed in this specific sample is rather low.

Table 4: Country environmental performance and stock market performance correlation matrix

The table presents a correlation matrix, expressing the correlation between the average environmental performance and the average stock market performance of the countries. The country-specific environmental performance average is calculated by dividing the companies in our sample into groups based on their country of origin.

	Average Environmental Performance	*Stock Market Index (average, %)*
Average Environmental Performance	1	
Stock Market Index (average, %)	-0.278	1

4.2. Construction of Risk Factors

The analysis makes extensive use of time-series regressions of the stock returns of both firms and portfolios of firms. We are implementing the Fama and French (1993) multifactor asset pricing model, as an improved version of CAPM. The CAPM alternative is ruled out because it takes into consideration only the undiversifiable risk related to the market factor and it has been proved to be inadequate when it comes to capturing the cross-sectional variation of the returns, while the two additional risk factors suggested by Fama and French appear to enhance the model's explanatory power (Fama and French, 1993). Therefore, the first stage is preparatory and concerns building the mimicking portfolios for the two additional risk factors suggested by Fama and French (1993): *Size*, as expressed by market capitalization, and *Book-to-Market* value of equity ratio.

The mimicking portfolios are built using the selected market index, following the lead of Ziegler et al (2007), instead of using the global mimicking portfolios available at Kenneth R. French Data Library, in order to achieve higher relevance, since our sample consists exclusively of European stock corporations. After obtaining and filtering the constituents of FTSEurofirst 300, using the

Capital IQ database, we collect yearly market capitalization and Price-to-Book data from Thomson Reuters Eikon. Following the Fama and French (1993) methodology, for each one of the 7 years of our analysis, we rank the market index constituents twice, once in terms of their size (market capitalization) from smallest to biggest and then in terms of their Book-to-Market ratio from lowest to highest. In the first case, we divide our sample of companies into two size-groups, small and big, based on their median, while for the second case, we use percentiles to split our companies into three Book-to-Market groups, low, medium and high. Using these breakpoints, we can now construct the six portfolios of firms suggested by Fama and French: SL, SM, SH, BL, BM and BH. Each year the 171 firms in the sample are reallocated to these portfolios and nested IF functions are used to assign a portfolio to each firm, ending up with six groups of firms for each of the seven years of the analysis and then we construct value weighted returns for the firms in each of the six portfolios. As Fama and French (1993) suggest, value weighted returns can be used to control for the fact that big stocks behave in a different way than small stocks and consequently to minimize the variance of the firm-specific factors inside the common risk factors. According to the authors, big firms have small return variance, therefore, assigning a bigger weight to bigger firms contributes to reducing the variance of the mimicking portfolio. Finally, for the construction of the SmB and HmL portfolios, the purpose of which is to mimic the risk factor related to size and Book-to-Market respectively, we subtract the simple average of the corresponding portfolios, as illustrated below:

$$SmB = \frac{SH + SM + SL}{3} - \frac{BH + BM + BL}{3}$$

$$HmL = \frac{SH + BH}{2} - \frac{SL + BL}{2}$$

4.3. Empirical Models

This section describes the econometric models used in the individual stock analysis and the portfolio analysis implemented in this study, which aim to explain the statistical relationship of interest.

4.3.1. Individual Stock Return Analysis

To perform the two-step cross-sectional analysis of the individual stock returns we follow the methodology implemented by Ziegler et al (2007), which is closely related to the methodology introduced by Fama and MacBeth (1973). In the first step, each stock's time series of returns is regressed against the three factor time series, the market portfolio, the SmB mimicking portfolio related to size and the HmL mimicking portfolio related to Book-to-Market ratio, to determine the coefficients-exposures to the factors. In the second step, the cross-section of average stock returns is regressed against these factor exposures, along with our environmental variables of interest, to provide us with coefficients for each factor, reflecting the premium expected for one unit exposure to each risk factor, and of course the coefficients of the environmental dummy variables, which is the foremost aim of this study since they reflect the relationship between stock and environmental performance of firms.

Time series regressions

We use simple OLS time series regressions of each stock's returns as a starting point to obtain coefficient estimates for the mimicking risk factors, which are known to capture the exposures of each firm's stock to the systematic risk factors. These estimates will be subsequently included as explanatory variables in the next step of the analysis which is the cross-sectional regression of the time average of the stock returns. The Fama and French three-factor model in equation (1) below describes time-series regressions of the individual stock excess returns corresponding to the $i = 1, 2, \dots, 171$ firms in our sample, for the time period of $t = 1, 2, \dots, 84$ months.

$$r_{it}^{e} = \alpha_i + \beta_{1i} r_{mt}^{e} + \beta_{2i} SmB_t + \beta_{3i} HmL_t + \varepsilon_{it} \tag{1}$$

The excess returns used in the model are constructed as follows:

$$r_{it}^{e} = r_{it} - r_{ft}$$

$$r_{mt}^{e} = r_{mt} - r_{ft}$$

In the end of this procedure we obtain the coefficient estimates: $\widehat{\beta_{1\iota}}$, $\widehat{\beta_{2\iota}}$ and $\widehat{\beta_{3\iota}}$ which vary cross-sectionally among the $i = 1, 2, \dots, 171$ firms of our sample.

Cross-sectional regression

The second step includes running the cross-sectional regression of the time average of stock returns on the environmental dummy variables constructed in 4.1, the estimated risk-factor parameters obtained from the time-series regressions as well as country dummies as control variables. We choose to use dummy variables for each country to control for country-specific effects on average returns. Overall, from this analysis we expect to draw conclusions about the influence of environmental performance on the performance of stock returns.

The model is given by equation (2) in matrix notation:

$$\overline{r_i} = \lambda_0 + \lambda_1\widehat{\beta_{1i}} + \lambda_2\widehat{\beta_{2i}} + \lambda_3\widehat{\beta_{3i}} + \lambda_4 D_i^{Hind} + \lambda_5 D_i^{Lind} + \lambda_6 D_i^{Hfirm} + \lambda_7 D_i^{Lfirm} + \lambda_8 D_i^{ISO} + \boldsymbol{\lambda D_i^{Country}} + \varepsilon_i \quad (2)$$

In equation (2), $\overline{r_i}$ is the time average of the monthly returns calculated as follows:

$$\overline{r_i} = \frac{1}{T}\sum_{t=1}^{T} r_{it}$$

where $t = 1, 2, \dots, 84$. D_i^{Hind} , D_i^{Lind} , D_i^{Hfirm} and D_i^{Lfirm} are dummy variables constructed and described in section 4.1. The dummies for medium environmental performance of industries and firms within a given industry, D_i^{Mind} and D_i^{Mfirm}, are dropped to avoid multicollinearity among the independent variables of the regression, the so called dummy variable trap. These two categories are inherently defined by the other dummy variables, since zero values of both low and high environmental performance of the industry dummies would automatically indicate medium environmental performance of the industry. The same holds for the dummies representing the environmental performance of firms. Moreover, $\widehat{\beta_{1i}}$, $\widehat{\beta_{2i}}$ and $\widehat{\beta_{3i}}$ are the estimated exposures to the market, size and Book-to-market factor respectively. Finally, $\boldsymbol{D_i^{Country}}$ is a $K \times N$ matrix with $K = 16$ countries -out of 17 countries in total; Hungary is dropped to avoid dummy trap- and $N = 171$ cross-sectional units.

4.3.2. Portfolio analysis

In this part of our study, we perform a portfolio analysis. We run time-series regressions of six different portfolios, the construction of which is based on the environmental performance of the firms, as it is determined in section 4.1. The portfolios are value weighted in an effort to minimize their variance since, according to Fama and French (1993), big firms -firms with high market capitalization- tend to exhibit smaller return variance than small firms. The portfolios are constructed using the excess returns of the firms in each environmental category as follows:

- Portfolio 1: firms which belong to the high-performance industries
- Portfolio 2: firms which belong to the medium-performance industries
- Portfolio 3: firms which belong to the low-performance industries
- Portfolio 4: firms that achieve high environmental performance within the industry they belong
- Portfolio 5: firms that achieve medium environmental performance within the industry they belong
- Portfolio 6: firms that achieve low environmental performance within the industry they belong

The time-series regressions of these portfolios are also performed according to the Fama and French multifactor asset pricing model. The objective is to observe which factors explain better the variability of returns, and study and compare the different environmental portfolios based on the opportunities they provide for outsized risk adjusted returns. The above process is described by the regression model in equation (3):

$$r_{jt}^{e} = \alpha_j + \beta_{1j} r_{mt}^{e} + \beta_{2j} SmB_t + \beta_{3j} HmL_t + \varepsilon_{jt} \tag{3}$$

Where r_{jt}^{e} is the time series of excess returns for each environmental performance based portfolio $j = 1, 2, 3, 4, 5, 6$ for a time period of $t = 1, 2, \dots, 84$ months.

4.4. Potential problems, tests and remedies

Along with the basic econometric analysis, several diagnostic tests needed to be performed on the data to test our models for various misspecifications. The estimation of the parameters is achieved through the implementation of the classical OLS model in both time-series, cross-sectional regressions. Usually a joint F- statistic and R^2 are two simple indicators to measure how well the model fits the data. However, considering the importance of the validity of the regressions we have run, it is necessary to ensure that the assumptions of the OLS method hold in our regressions. We test for potential violations of these assumptions in order to have a deeper knowledge of how well our models work. In this final section of the methodology we describe the potential violations that could come up while performing the regression analysis, how they can be tested and the resulting consequences if they are left ignored.

As it is known, the first OLS assumption holds whenever an intercept term is included in the regressions. For this reason, we start the standard diagnostic tests directly form the second assumption (Brooks, 2014), the violation of which indicates heteroskedasticity, due to non-constant variance of error terms. In presence of heteroskedasticity, though the OLS estimation would probably still give unbiased results, it could most likely lead to wrong inference. Autocorrelation, encountered only in time-series regressions, could also constitute a problem, therefore it is essential to investigate for this potential violation in the time-series regressions in both our analyses, to evade possible wrong inferences. Another important potential issue in the regression can manifest the presence of endogeneity. Simultaneity or endogeneity prevails when the relationship between the explained and explanatory variable is not determined by one equation. This means that there is a suspicion for a reciprocal dependency between the two variables. Ziegler et. al. (2007) and Cohen et al. (1997) both mention such a potential relationship between the average individual stock performance and the environmental performance, where the latter would be an influencing factor in the average monthly stock returns, but an inverse relationship might also exist. This potential problem can be a significant cause of parameter estimation bias, therefore testing and remedies are crucial for the analysis. The last of the diagnostic tests examines the normality of the data. We search for a violation of the last assumption that the disturbances are normally distributed. If this assumption is violated, we cannot conduct an OLS estimation and instead other models should be considered.

Additional issues can affect the precision of OLS estimation, including non-linearity and multicollinearity. Giving attention to non-linearity, we investigate for the relationship between the dependent variable and independent variables to test for a possible non-linear relationship. If the examination detects a presence of non-linearity, the parameters cannot be estimated by OLS. Multicollinearity is another significant problem that results from a high correlation between two or more explanatory variables. In our study, we suspect a probable high correlation between firm related and industry related environmental performance variables, as well as control country variables with size (bigger companies operate in more developed countries). Multicollinearity will only be considered an issue if the correlation between the explanatory variables is 0.8 and above, since it would lead to questionable inferences.

5. Results

In this section, we present and discuss the estimation results obtained from the two different approaches implemented in this study, in a way that aims to empirically evaluate the effect of environmental performance on stock performance.

5.1. Individual Stock Return Analysis Results

We first present the results from the individual stock return analysis, starting with some descriptive statistics.

5.1.1. Descriptive Statistics

Table 5 and Table 6 below report descriptive statistics of the risk factors and descriptive statistics of the financial variables used in the cross-sectional regression, respectively. We can observe that the mean of the average returns of the 171 sampled firms is equal to 0.17% which is lower than the mean of the market returns, namely 0.37%. The mean of the returns yielded from the size-related mimicking portfolio is even smaller, only 0.13%, while the Book-to-Market-related portfolio has a negative mean of -1.10%. This result shows that the book-to-market risk factor historical values are predominantly negative. The median is overall consistent with the mean values, where book-to-market is again below zero. The dispersion of the variables according to the range measure is seemingly not large. The outcome implies that no outliers are present in our data, however the kurtosis values of below three show inconsistency in the results. This might be indicative of non-normality in the series, and thus further examination is required. Exploring Table 6 in more detail, we now focus on the reported cross-sectional means of the risk factor sensitivities. Positive values of the means show that the market, size and book-to-market risk factors have an overall positive effect on the firms' individual returns. Furthermore, it can be deduced that the market risk factor has the highest mean value of 0.9017, which implies a higher impact on the returns than that of the size and book to market risk factors.

Table 5: Descriptive statistics - Time-series regressions

The table shows the descriptive statistics of the risk factors found in the multifactor model, namely the Market factor, and the Book-To-Market and Size related factors.

	Mean	*St. Error*	*Median*	*St. Dev.*	*Variance*	*Kurtosis*	*Skewness*	*Min*	*Max*
Market	0.0037	0.0041	0.0089	0.0372	0.0014	0.5571	-0.5033	-0.1125	0.0798
SmB	0.0013	0.0020	0.0018	0.0186	0.0003	-0.3180	-0.0681	-0.0447	0.0394
HmL	-0.0110	0.0046	-0.0091	0.0426	0.0018	0.2348	0.0477	-0.1260	0.1032

Table 6: Descriptive statistics - Cross-sectional regression

The table reports the descriptive statistics of the financial variables found in the cross-sectional regression. This table includes the dependent variable, i.e. the average stock returns ($\overline{r_\iota}$) and the independent variables, namely the estimated coefficients $\widehat{\beta_{1\iota}}$, $\widehat{\beta_{2\iota}}$ and $\widehat{\beta_{3\iota}}$ of market, size and BM related risk factors respectively.

	Mean	*St. Error*	*Median*	*St. Dev.*	*Variance*	*Kurtosis*	*Skewness*	*Min*	*Max*
$\overline{r_\iota}$	0.0017	0.0010	0.0038	0.0128	0.0002	12.7419	-2.6746	-0.0827	0.0283
$\widehat{\beta_{1\iota}}$	0.9017	0.0243	0.8855	0.3179	0.1011	0.2429	-0.0068	-0.0364	1.7407
$\widehat{\beta_{2\iota}}$	0.5307	0.0607	0.4812	0.7935	0.6296	0.1462	0.3728	-1.1019	3.2734
$\widehat{\beta_{3\iota}}$	0.2599	0.0413	0.1952	0.5396	0.2912	-0.1376	0.6104	-0.6031	1.6894

5.1.2. Regression Results

The output of the final cross-sectional regression is hereby reported in Table 7, found in the end of this subsection. From the results, we can observe that the coefficient of the market exposure, $\widehat{\lambda_1} = 0.0013$, is positive but insignificant. The coefficients of the exposures of the size-related and Book-to-market-related risk factors respectively, appear to be negative and significant, namely $\widehat{\lambda_2} = -0.0034$ and $\widehat{\lambda_3} = -0.0148$, indicating that high sensitivity to those types of risk punishes returns. These results are in line with those reported in Ziegler et al. (2007), however they are highly contradictive from those discovered by Fama and French (1993). Focusing on the environmental performance dummy variables, we can see that the coefficient estimate obtained for D_i^{Hind}, $\widehat{\lambda_4} = 0.0081$, is positive and significant at 1% level of significance. This outcome suggests that high environmental performance of the industry in which a firm belongs affects positively the average returns, and thus the financial performance of firms. In other words, the European stock market seems to reward investing in green industries. The rest of the environmental variables are insignificant, including all the firm-specific environmental performance dummies and the efficient environmental management dummy variable, D_i^{ISO}, which appears to have a positive yet insignificant effect on the average returns. Finally, the overall explanatory power of the model as expressed by R-squared is below 50%, with $R^2 = 42{,}14\%$.

Table 7: Cross–sectional regression output

The table reports the estimated parameter coefficients of the final cross-sectional regression. R-Squared, t-Statistics. Standard Errors and Durbin-Watson test for autocorrelation are also part of the table. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels, respectively.

Dependent Variable:			Average monthly stock returns
Observations:			171
Variable	*Coefficients*	*Standard Error*	*t Stat*
Intercept	-0.0015	0.0083	-0.1805
$\widehat{\beta_{1\imath}}$	0.0013	0.0031	0.4375
$\widehat{\beta_{2\imath}}$	-0.0034***	0.0012	-2.8844
$\widehat{\beta_{3\imath}}$	-0.0148***	0.0020	-7.3416
D_i^{Hind}	0.0081***	0.0026	3.0470
D_i^{Lind}	0.0034	0.0023	1.4575
D_i^{Hfirm}	0.0027	0.0021	1.2890
D_i^{Lfirm}	-0.0012	0.0020	-0.6095
D_i^{ISO}	0.0035	0.0023	1.5364
Austria	0.0016	0.0089	0.1777
Belgium	0.0061	0.0089	0.6920
Denmark	0.0042	0.0090	0.4698
Finland	-0.0018	0.0088	-0.2003
France	0.0010	0.0088	0.1212
Germany	-0.0027	0.0084	-0.3232
Ireland	0.0019	0.0110	0.1763
Italy	-0.0004	0.0087	-0.0487
Netherlands	0.0036	0.0089	0.4021
Norway	0.0010	0.0090	0.1087
Poland	0.0112	0.0093	1.2036
Portugal	-0.0054	0.0096	-0.5638
Spain	0.0011	0.0083	0.1282
Sweden	0.0024	0.0087	0.2722
Switzerland	-0.0022	0.0082	-0.2646
UK	-0.0006	0.0082	-0.0769
R-squared	0.421		
Adjusted R-squared	0.326		
S.E. of regression	0.011		
Durbin-Watson stat	1.937		

5.1.3. Diagnostic test results

We conduct tests for a sample of six randomly chosen companies in the time-series regressions for the individual stock performance. The results show no evidence of heteroskedasticity, no significant multicollinearity, no presence of non-linearity on both 5% and 10% significance levels. It is noticed that all the companies have a normal distribution, except for the British company Centrica PLC, which belongs to the low environmental performance industry, utilities. However, we are aware that the tests are conducted in a small sample of firms and different results might conclude with different samples.

For the cross-sectional regression, a Hausman test for endogeneity is performed to inspect for a possible reciprocal relationship between economic performance and environmental performance. The results from the cross-sectional regression showed a positive and significant relationship between industry environmental performance and economic performance. Therefore, our suspicion lies on the dependency between these two variables. However, the outcome received from the Hausman test display a larger p-value than 5% and 10% significance level for the fitted values of the D_i^{Hind}variable, representing high environmental performance of industry, which implies that Hausman's null hypothesis of exogeneity cannot be rejected, therefore, based on these results, we find no evidence of dependency of the industry environmental performance on the average stock returns. Thus, OLS seems to be an appropriate regression model and no bias in the estimated coefficients should be found. The Hausman's test output is displayed in Table A1 of the Appendix.

5.2. Portfolio Analysis Results

In the sequel, we present the results from the portfolio analysis.

5.2.1. Descriptive Statistics

Table 8 reports descriptive statistics information for the portfolios included in the portfolio analysis. Inspired by Schröder (2004), we also calculate the Sharpe Ratio for each portfolio, as a first look at the performance of the portfolios. Sharpe ratio in our case is calculated as the mean of the excess log-returns of the portfolio divided by the total risk of the portfolio expressed by the standard deviation of the monthly log-returns. Sharpe ratio generally takes negative values when the average return is lower than the risk-free rate. The intuition is that the higher the Sharpe ratio, the more return the portfolio yields per unit of risk while the lower the Sharpe ratio, the more risk needs to be taken by an investor who wants to earn additional returns.

Table 8: Descriptive statistics – Portfolio analysis

The table shows descriptive statistics for the six environmentally ranked portfolios, including our calculations of the Sharpe Ratio.

	Mean	*St. Error*	*Median*	*St. Dev.*	*Variance*	***Sharpe Ratio***
Portfolio 1	-0.0010	0.0067	0.0044	0.0613	0.0038	**-0.0168**
Portfolio 2	0.0042	0.0033	0.0062	0.0300	0.0009	**0.1391**
Portfolio 3	-0.0002	0.0048	0.0052	0.0439	0.0019	**-0.0055**
Portfolio 4	0.0050	0.0040	0.0118	0.0369	0.0014	**0.1343**
Portfolio 5	0.0021	0.0061	0.0099	0.0562	0.0032	**0.0366**
Portfolio 6	0.0017	0.0030	0.0053	0.0274	0.0007	**0.0612**

We can see from the table that portfolio 1 and 3, constituted by the high and low environmental performance industries respectively, have negative Sharpe Ratios while the highest Sharpe Ratio values are achieved by portfolios 2 and 4. These first results seem to be contradictive with the results from the cross-sectional analysis of the individual stock returns, which show the variable representing the high environmental performance of industry to have a positive effect on returns.

5.2.2. Regression Results

In this section of the empirical results, we discuss the estimation outcomes from the portfolio analysis. The regression outputs of the six environmental performance-based portfolios, reported in Table 9 below, provide us with information about the abnormal return potential and the sensitivity to the risk factors of the different portfolios. More specifically, the intercept term in the regressions reflects the monthly unexplained returns, measuring the return in excess of that explained by the Fama and French risk factors. For the interpretation of the intercept, we can treat it as Jensen's alpha in order to draw conclusions about whether the six portfolios we have constructed underperform or overperform the factors. The beta-coefficients of the risk factors reflect the exposure of the portfolios to these factors, showing the magnitude of the reaction of the portfolio returns per unit change of each risk factor. The intuition is that portfolios with higher sensitivity to the risk factors would require lower prices and thus yield higher expected returns.

Table 9: Regression outputs – Portfolio analysis

The table reports the OLS parameter estimates regarding each portfolio. The R-squared, Standard Errors, t-Statistics and Durbin-Watson test are displayed within the regression outputs. The table is divided in two sections where (α) displays industry portfolios and (β) shows the company portfolios. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels respectively.

(α) Environmental performance of Industry

	Portfolio 1			*Portfolio 2*			*Portfolio 3*		
Variable	*Coeff.*	*S. E.*	*t Stat*	*Coeff.*	*S. E.*	*t Stat*	*Coeff.*	*S. E.*	*t Stat*
Alpha	0.004	0.003	1.403	-0.002	0.002	-1.277	-0.001	0.003	-0.394
Market	0.885***	0.081	10.979	0.837***	0.051	16.534	0.878***	0.079	11.131
SmB	0.091	0.136	0.669	-0.396***	0.086	-4.635	-0.100	0.133	-0.750
HmL	0.742***	0.071	10.510	-0.346***	0.044	-7.806	0.208***	0.069	3.015
R-squared		0.867			0.782			0.751	
Durbin-Watson		2.173			2.103			2.132	
Observations		84			84			84	

(β) Environmental performance of firms

	Portfolio 4			*Portfolio 5*			*Portfolio 6*		
Variable	*Coeff.*	*S. E.*	*t Stat*	*Coeff.*	*S. E.*	*t Stat*	*Coeff.*	*S. E.*	*t Stat*
Alpha	0.005***	0.002	3.076	0.003	0.002	1.173	-0.001	0.001	-0.665
Market	0.742***	0.048	15.583	1.101***	0.075	14.723	0.693***	0.035	19.858
SmB	0.034	0.080	0.423	-0.249*	0.126	-1.973	-0.078	0.059	-1.321
HmL	0.242***	0.042	5.809	0.414***	0.065	6.328	-0.001	0.306	-0.049
R-squared		0.872			0.864			0.875	
Durbin-Watson		2.400			2.062			1.839	
Observations		84			84			84	

Starting with portfolio 1, which consists of firms belonging to high environmentally performing industries, the regression output shows positive but insignificant alpha, and positive (and close to 1) and significant coefficients for the market and the Book-to-market factors. The size factor appears to have a positive, yet insignificant effect. The regression of portfolio 2 yielded a negative and insignificant intercept. It also yielded negative Book-to-Market and size coefficients and positive (and close to 1) beta coefficient. All factors are significant with zero p-values. The regression of portfolio 3 shows an alpha that is negative but insignificant while the coefficients of Book-to-Market and market factors are positive and significant. The coefficient of the size factor appears to be negative and insignificant. For portfolio 4, the results show significant and positive intercept term, though quite small in value ($\alpha = 0.005$), and significant market and Book-to-Market factor while the size factor appears to be insignificant. All factors are positive but below 1. The regression output for portfolio 5 reports an alpha that is positive (but insignificant), and lower than that of portfolio 4. The market and Book-to-Market factors show positive coefficients and zero p-values and are therefore significant at 5% significance level. On the contrary, the size factor obtains negative coefficient and is significant only at 10% significance level. Finally, according to the regression output of the sixth and last portfolio, alpha is negative but insignificant when the portfolio is regressed on the three risk factors. Only the market factor appears to be significant. It has positive coefficient in contrast with the other two factors which have negative coefficients.

The two high environmental performance portfolios, both in firm level and industry level, exhibit positive alphas, indicating abnormal returns. However, only in the case of portfolio 4, id est of firms that achieve high environmental performance within the industry they belong, this estimate is significant meaning that the model underestimates the returns for this portfolio. The portfolios representing low environmental performance of both firm and industry have negative alphas but insignificant. In the medium environmental performance category, in the case of the firm portfolio, alpha is positive yet lower than that of high environmental performance of firm portfolio and also insignificant while in the industry portfolio alpha is negative and insignificant. According to Schröder (2004), negative alphas are related to the cost of management.

By first observing the market portfolio, we can see that the beta-coefficients for all the portfolios are positive and significant. Only portfolio 5 (constituted by firms with medium environmental performance within the industry they belong) has a high beta coefficient higher than 1, indicating that is more volatile than the market, thus riskier, but provides potential for higher returns when the market goes up. The betas for the rest of the portfolios are very close to 1, with portfolio 6 (firms with medium environmental performance within the industry they belong) having the lowest beta, which is equal to 0.69. To interpret the coefficient estimates of the additional risk factors, we base our arguments on those of Fama and French (1993). In Table A2 of the Appendix, we can see that SmB portfolio is strongly uncorrelated with the other two factors and with portfolio returns. On the other hand, we can observe relatively high yet not alarming correlation between the HmL and market portfolio. We first address the size factor. Both high environmental performance portfolios, 1 and 4, exhibit $\widehat{\beta_{2J}} > 0$. In general, positive values of this coefficient indicate that we can expect higher returns when small stocks outperform large stocks, however the results here are insignificant. In contrast, medium and low environmental performance portfolios exhibit $\widehat{\beta_{2J}} < 0$, but only in the medium category, i.e. portfolios 2 and 5, these coefficients are significant. This could mean that higher returns are expected when large stocks outperform small stocks, suggesting that these portfolios mainly consist of large market capitalization stock corporations. Focusing on the Book-to-Market factor, the regressions produce significant results, with portfolio 6 as the only exception. For portfolios 1, 3, 4 and 5, we receive $\widehat{\beta_{3J}} > 0$, meaning that these portfolios tend to yield higher returns if stocks with high book-to-market ratio (value stocks) outperform those with low book-to-market ratio (growth stocks). Portfolio 1 has a high coefficient value $\widehat{\beta_{3J}} = 0.74$, which means that this portfolio consists mostly of value stocks. Only medium performance of industry portfolio 2 has negative and significant $\widehat{\beta_{3J}} = -0.35$, suggesting that this portfolio includes mainly growth stocks.

Finally, we shift our attention to the obtained R-squared values, in order to see the explanatory power of the model for each regression. Since we are using the same number of variables in every regression, we can just look at R-squared –adjusted R-squared is not needed. All six regressions have high R^2 indicating high explanatory power. The lowest is 75%. We can observe that it is higher for the firm-specific portfolios and slightly lower for the industry-specific portfolios.

5.2.3. Diagnostic test results

From the conducted diagnostic tests for the portfolio regressions, we have generally obtained satisfactory results, where no significant violation has been detected from the examination. Table A3 in the appendix shows the White's tests realized to discover a potential presence of heteroskedasticity in the regressions. The output depicts three types of tests, including F-statistic, Observed R-squared and Scaled explained SS. The p-values for all three tests are considerably larger than the significance level 5% for all portfolios, except the industry portfolios with high and low environmental performance. However, due to ambiguous results in both portfolios, we conclude that there is not enough evidence for a presence of heteroskedasticity. Durbin Watson and Breusch-Godfrey tests are also implemented, and the results show no evidence of autocorrelation in any of the portfolios. Explaining it more clearly, it can be seen that all DW tests from the regression outputs in Table 9 have values close to 2, which is further reinforced by Breusch-Godfrey tests, reported in Table A4 of the Appendix, with significantly large p-values. Graph A2 shows the Jarque-Bera tests for normality. We witness signs of non-normality only in the low environmental performance industry portfolio with a skewness of around -0.83 and kurtosis 5.96. This particular issue would have been avoided by taking out potential outliers from the sample. It has been decided however, to rule out this solution, because the removal of outliers can lead to an artificial improvement of the model's characteristics (Brooks, 2014). Therefore, we ignore this phenomenon as it is furthermore only present in one portfolio. In Table A5, tests for linearity are reported. We have conducted Ramsey RESET tests to examine the linearity in our regressions and again we did not encounter any evidence of non-linearity in any regressions in 5% and 10% level of significance. Lastly, the previously mentioned Appendix Table A2 depicts the correlation matrices and investigates for a potential presence of multicollinearity. Since none of the matrices show a correlation that is larger than 0.8 between the explanatory variables, evidence of multicollinearity is also ruled out.

6. Conclusions

From the very beginning, the center of interest of this master essay has been the role of CER in how companies perform financially. After performing a background research, it immediately caught our attention that, until recently, the empirical research conducted in this field of study has been rather confined, and the majority of the results were inconclusive or contradictory. Hence, our main objective has been to further investigate the effect that corporate environmental performance can have on corporate financial performance, using a more contemporary sample that would allow us to establish new empirical evidence.

The methods implemented and the variables chosen for this purpose were of both environmental and financial nature. The econometric analysis was theoretically based on a typical two-step cross-sectional analysis of the individual stock returns, while the environmental aspect was captured through a constructed measure of environmental performance that covered the dimensions of both the average environmental performance of the industry and the relative environmental performance of each individual firm within the context of their own industry. For an in-depth investigation, a portfolio analysis was additionally conducted to examine portfolios of different environmental performance levels for abnormal return potential, while the exposure of the portfolios to the different risk factors was also considered.

The findings from the main analysis suggested a significant and positive impact of the high average environmental performance of the industry on the average monthly stock returns, while the rest of the results did not provide any significant discovery. The results from the additional analysis showed that the two high environmental performance portfolios exhibited positive values of the Jensen's Performance Index, both in industry and firm level, however only in the case of the latter this value was significant allowing us to conclude that this portfolio, a portfolio consisting of value stocks predominantly, was more likely to offer the potential of earning excess returns that would be higher than those predicted by the model, while moving in harmony with the rest of the market. Although these last results do not exactly match with those received from the main analysis, this does not mean that the two approaches are conflicting and we prefer to look at these results as complementary to one another.

At this point, we would like to stress the fact that our study remains subject to the following restriction: even though we ruled out the possibility of a bilateral causality between the environmental and the financial performance of firms, the existence of such a relationship is in fact not that improbable. The intuition behind this suspicion is that companies which perform well environmentally may also appear to be performing well financially, simply due to the fact that financially stronger firms are more capable of taking over extra costs for reducing their environmental impact and thus improving their environmental performance.

In the study of Ziegler et al. (2007) the above suspicion is indeed mentioned and the potential existence of a reverse causation between environmental and financial performance, which could compromise the study's objectivity and consistency, is briefly discussed but not addressed. From our side, we decided that it was crucial to test our sample for endogeneity, receiving negative results. Nevertheless, the fact that we found no evidence of endogeneity in our sample, does not exclude the possibility of such a relationship being present in other occasions, thus this issue is left open to further examination.

Summing up, both analyses exhibited positive results with the difference that the first analysis allotted more significance to the effect of the industry while the second analysis showed significant results in individual firm level. To finally answer the foremost question of this thesis, if we focus on our empirical analysis in its entirety, we can conclude - yet with caution – that the European stock market appears to have a tendency to reward green investors, id est those investors who choose to hold a long position on stocks which belong in clean industries. In other words, the overall results point to the direction that the environmental performance of European stock companies does matter and can potentially influence their financial performance, represented by the performance of their stock.

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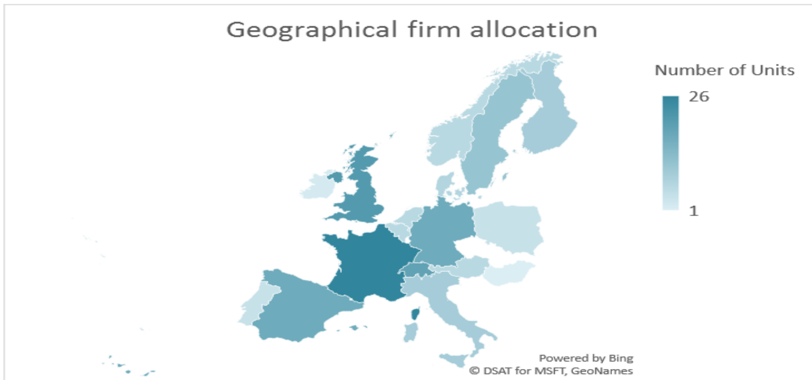
Appendix

Graph A1: Geographical illustration for the allocation of the firms in the sample



Graph A2: Jarque-Bera tests for normality - Portfolio analysis

The table reports the results from the normality by Jarque-Bera for each portfolio. The test takes into consideration the skewness and the kurtosis of the distribution. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels respectively.

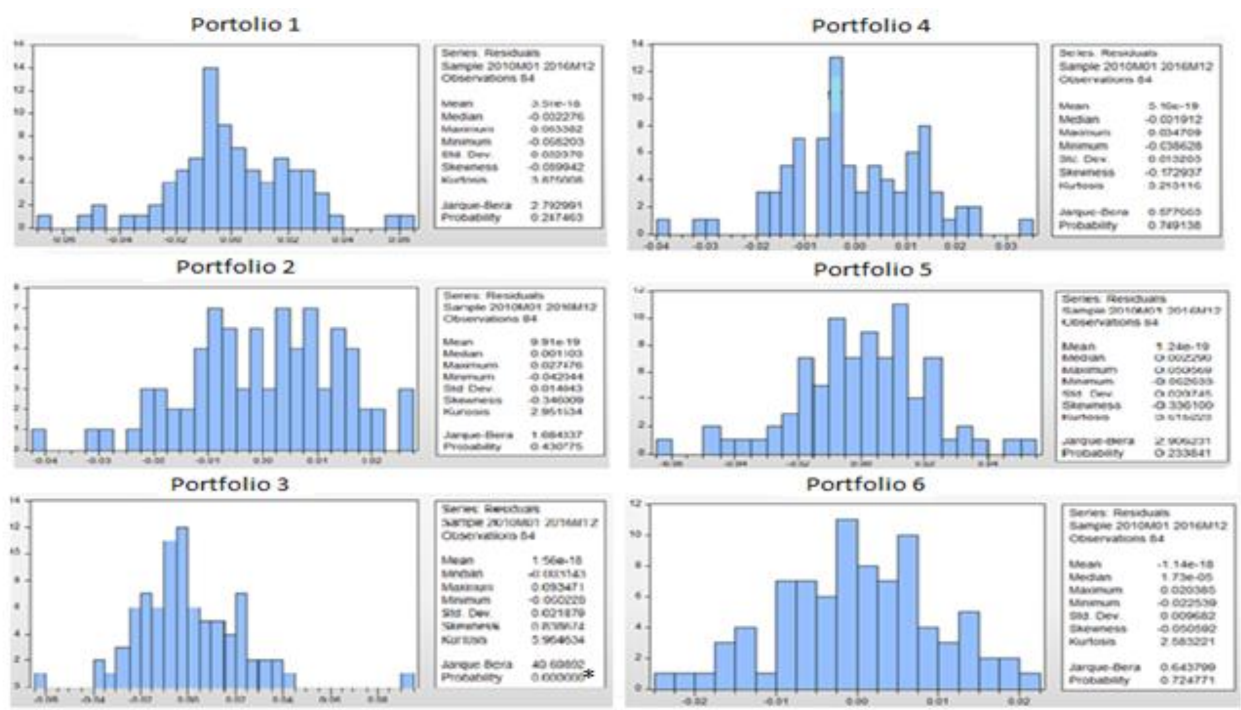


Table A1- Hausman test for endogeneity – Cross-sectional regression

The table reports the Hausman test for endogeneity, conducted for the final cross-sectional regression. Standard errors and t-Statistics for each parameter are shown. **Fitted $\boldsymbol{D_i^{Hind}}$** is a notation for the fitted values of the dummy variable representing the high environmental performance for industries. The p-value for the fitted value is equal to 0.260 and thus Hausman's null hypothesis for exogeneity cannot be rejected.

Dependent Variable:	Average monthly stock returns		
Observations:	171		
Variable	*Coefficients*	*Std. Error*	*t-Stat*
Intercept	-219.002	193.628	-1.131
$\widehat{\beta_{1\iota}}$	-50.298	44.472	-1.131
$\widehat{\beta_{2\iota}}$	2.545	2.253	-1.295
$\widehat{\beta_{3\iota}}$	-124.188	109.787	-1.131
D_i^{Hind}	0.0078	0.003	2.972
D_i^{Lind}	180.232	159.348	1.131
D_i^{Hfirm}	3.696	3.266	1.132
D_i^{Lfirm}	16.301	14.414	1.131
D_i^{ISO}	39.060	34.532	1.131
Fitted $\boldsymbol{D_i^{Hind}}$	339.908	299.811	1.131
Austria	64.229	56.786	1.131
Belgium	142.427	125.921	1.131
Denmark	129.402	114.406	1.131
Finland	16.062	14.202	1.131
France	109.867	97.137	1.131
Germany	103.999	91.953	1.131
Ireland	-24.919	22.034	-1.131
Italy	61.270	54.172	1.131
Netherlands	41.320	36.529	1.131
Norway	161.211	142.533	1.131
Poland	63.541	56.169	1.131
Portugal	141.795	125.372	-1.131
Spain	79.124	69.956	1.131
Sweden	-3.831	3.389	1.131
Switzerland	26.972	23.849	1.131
UK	69.999	61.889	1.131

Table A2: Correlation matrices for multicollinearity detection purposes – Portfolio analysis

The table reports the correlations between the variables of the portfolio analysis. A correlation between the risk factors that is larger than 0.80 implies multicollinearity, based on the rule of thumb.

Variables	*Portfolio 1*	*Market*	*SmB*	*HmL*
Portfolio 1	1.000	0.824	0.183	0.814
Market	0.824	1.000	0.142	0.549
SmB	0.183	0.142	1.000	0.154
HmL	0.814	0.549	0.154	1.000
Variables	*Portfolio 2*	*Market*	*SmB*	*HmL*
Portfolio 2	1.000	0.041	-0.175	0.732
Market	0.732	1.000	0.142	0.549
SmB	-0.175	0.142	1.000	0.154
HmL	0.041	0.549	0.154	1.000
Variables	*Portfolio 3*	*Market*	*SmB*	*HmL*
Portfolio 3	1.000	0.850	0.094	0.605
Market	0.850	1.000	0.142	0.549
SmB	0.094	0.142	1.000	0.154
HmL	0.605	0.549	0.154	1.000
Variables	*Portfolio 4*	*Market*	*SmB*	*HmL*
Portfolio 4	1.000	0.904	0.166	0.693
Market	0.904	1.000	0.142	0.549
SmB	0.166	0.142	1.000	0.154
HmL	0.693	0.549	0.154	1.000
Variables	*Portfolio 5*	*Market*	*SmB*	*HmL*
Portfolio 5	1.000	0.890	0.069	0.702
Market	0.890	1.000	0.142	0.549
SmB	0.069	0.142	1.000	0.154
HmL	0.702	0.549	0.154	1.000
Variables	*Portfolio 6*	*Market*	*SmB*	*HmL*
Portfolio 6	1.000	0.337	0.080	0.507
Market	0.337	1.000	0.142	0.549
SmB	0.080	0.142	1.000	0.154
HmL	0.507	0.549	0.154	1.000

Table A3: Heteroskedasticity tests – Portfolio analysis

The table reports three types of tests for the White's test for heteroskedasticity for each portfolio. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels respectively which express a rejection of the null hypothesis of the regression.

Dependent Variable: Squared residuals

Observations: 84

	Portfolio 1	*Portfolio 2*	*Portfolio 3*
F-Statistic	1.435	1.226	0.708
Observed R-Squared	12.484	10.902	6.658
Scaled Explained SS	16.278	9.648	14.991
	Portfolio 4	*Portfolio 5*	*Portfolio 6*
F-Statistic	0.796	1.110	1.142
Observed R-Squared	7.413	9.993	10.247
Scaled Explained SS	7.441	11.852	7.357

Table A4: Breusch-Godfrey tests for serial correlation – Portfolio analysis

The table reports the F-Statistic and the Observed R-Squared for the autocorrelation test on each portfolio. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels respectively.

Dependent Variable: Residuals

Observations: 84

	Portfolio 1	*Portfolio 2*	*Portfolio 3*
F-Statistic	0.846	0.559	1.603
Observed R-Squared	9.056	6.211	15.649
	Portfolio 4	*Portfolio 5*	*Portfolio 6*
F-Statistic	1.142	0.559	0.412
Observed R-Squared	11.784	6.212	0.888

Table A5: Ramsey RESET tests for non-linearity – Portfolio analysis

The table reports three conducted tests to detect potential presence of non-linearity in each portfolio regression. The notations (***), (**), (*) show significance at 1%, 5% and 10% levels respectively.

Observations: 84			
Degrees of freedom: 79			
	Portfolio 1	*Portfolio 2*	*Portfolio 3*
t-Statistic	0.495	0.110	1.124
F-Statistic	0.245	0.012	1.538
Likelihood Ratio	0.260	0.013	1.620
	Portfolio 4	*Portfolio 5*	*Portfolio 6*
t-Statistic	0.520	1.119	0.810
F-Statistic	0.271	1.252	0.656
Likelihood Ratio	0.287	1.321	0.695