LUISS

Double Degree in Corporate Finance, M.Sc.

Course of Corporate Governance

Indentifying the Mechanisms behind the Impact of Corporate Environmental Performance on Financial Performance

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Academic Year 2022/2023

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Abstract

This thesis contributes to the ongoing debate on the relationship between corporate environmental performance and financial performance by providing insights into the mechanisms that drive the relationship. Based on the main theoretical frameworks in the respective field a fixed-effects regression model shows the positive impact of carbon performance on return on assets. By categorizing and comparing companies according to their carbon performance, it can be found that companies with better carbon performance outperform their industry peers in terms of returns on assets while maintaining fewer assets than their competitors. Therefore, the fact that companies with better carbon performance outperform their industry peers is mostly driven by more efficient utilization of assets. Conducting a Granger causality test, no evidence for reverse causality can be detected.

1 Introduction

Undoubtedly, climate change is one of the most important challenges for humanity. Addressing this issue is, therefore, one of the top priorities among politicians, and supranational organizations. In 2015, 196 parties decided to unite against climate change by signing the Paris Agreement. The parties that signed this legally binding treaty committed to the goal of limiting the global average temperature increase to a maximum of 2°C compared to the pre-industrial level (United-Nations, 2015). According to European-Union (2023) one of the main drivers of climate change is greenhouse gas (GHG) emissions. More specifically, Environmental-Protection-Agency (2023) finds that carbon dioxide is accountable for 76% of those greenhouse gases and, therefore, one of the key fields of action to reach the Paris Agreement.

Since companies are a big pillar of Western society, the focus of public attention shifted towards the role companies play in causing climate change. To illustrate this importance: 71% of all GHG emissions since 1988 can be attributed to only 100 companies (Carbon-Disclosure-Project, 2017). Even if those companies are producers of fossil fuels, it shows the importance of the role that companies are playing in the emission of GHG and therefore also the importance of the role that companies have to play in reducing greenhouse gas emissions and reaching the anticipated goal of the Paris Agreements. As a consequence, corporate environmental performance attracted more public attention, not only among investors, for example, through the emergence of sustainable finance but also among academic research. In addition to the increased awareness, academic literature in general argues that companies have to play a role in addressing climate change. Based on the ideas of Freeman (1984) and Jensen (2001), companies serve many more purposes than solely increasing shareholder value. Therefore, companies are also expected to contribute to the global quest to reduce greenhouse gas emissions.

Already before the public interest in corporate environmental performance increased, scholars, were investigating this subject. Walley and Whitehead (1994) claim that corporate investments in carbon performance are detrimental to shareholder value, regardless of the importance of reducing emissions. Hence, they argue that companies are facing a trade-off between accepting a reduction in shareholder value and acting more sustainably. Porter (1991); Porter and van der Linde (1995) formulated a rebuttal to that theorem by arguing that companies have an inherent interest in reducing carbon emissions since emitting carbon is a waste of resources. Therefore, Porter and van der Linde (1995) postulate that reducing carbon performance is not detrimental to shareholder value, instead, they argue that reducing waste is a sign of improved resource efficiency and hence a potential lever of firm performance and therefore beneficial for shareholders. Even if those theories were formulated years ago, their relevance increased considerably due to the urgency of climate change. To nudge businesses to contribute to addressing the issue of climate change, there has to be either public pressure or inherent incentives for the companies, that exceed the altruism and intrinsic motivation of contributing to the global quest to reach the Paris Agreement.

A broad stream of academic literature emerged that particularly focuses on understanding corporate behavior regarding carbon performance and disclosure and understanding the potential inherent incentives for companies to prioritize carbon policies. A multitude of early conceptional studies started to shed light on the topic (Ambec and Lanoie, 2008; Orlitzky et al., 2003; Margolis and Walsh, 2003; Aragón-Correa and Sharma, 2003; Horváthová, 2012). Moreover, a broad variety of more quantitative studies started to analyze the available data (Busch et al., 2022a; Delmas et al., 2015; Sharfman and Fernando, 2008; El Ghoul et al., 2011; Barnett and Salomon, 2012). Over the course of time, the literature mainly separated into studies that focus on carbon disclosure (CD) and studies that focus on corporate environmental performance (CEP). Due to the broad variety of studies, many theoretical considerations emerged, in an attempt to explain the observed phenomena, starting with the resource-based theory based on Porter and van der Linde (1995) and then expanding to various other theories (Ambec and Lanoie, 2008).

In general, there are many studies that focus on the effect that CEP has on financial performance (Busch and Hoffmann, 2011; Delmas et al., 2015; Horváthová, 2010; Busch et al., 2022a; Yu et al., 2018) and there are many studies focusing on more specific impacts, such as on labor productivity or cost of capital (Delmas and Pekovic, 2013; Bui et al., 2020; Gerged et al., 2021; Woo et al., 2014). However, to the best of my knowledge, there is no study that combines empirical findings systematically with the conceptual literature. When assessing the impact on financial performance, studies focus on composite financial measures, such as Tobin's Q and return on assets, and therefore there is currently no uniform tendency about which conceptual theory provides an explanation for the impact CEP has on corporate financial performance (CFP). Thus, it remains ambiguous how and why CEP might influence CFP.

For instance, although Delmas et al. (2015) find a relationship between CEP and CFP, they provide no explanation of why this relationship exists in the first place or how CEP affects CFP. Horváthová (2010) finds a positive association between CEP and CFP and concludes that the theory based on Porter and van der Linde (1995) might be the explanation for the detected relationship, without specifically investigating the theory in depth. Downar et al. (2021) find a small but insignificant increase in revenues after the implementation of carbon disclosure and thus conclude that improved public perception leads to increased revenues. Moreover, Alsaifi et al. (2020) find that if carbon disclosure reflects actual carbon performance, it has a positive impact on financial performance. Thus, they conclude that carbon disclosure is a channel to suggest to investors a superior cost consciousness, so firms might be able to yield improved financial performance. Trinks et al. (2020) rely on a more narrow approach and find a positive impact of CEP on productivity, suggesting that the resource-oriented theory might serve as an explanation for the relationship between CEP and CFP. To conclude, thus far, the existing theoretical frameworks have been utilized to explain and justify the outcome of empirical tests, however; no study systematically applies the existing theories and attempts to investigate the channels through which the impact of CEP on CFP is present in a holistic approach.

Therefore, this thesis contributes to existing research in two ways. Firstly, this thesis investigates, how CEP is affecting CFP. Previous studies have been focusing on detecting the relationship between CEP and CFP, therefore, the main focus of this thesis is not only to detect the relationship but to systematically analyze the mechanisms behind the influence of CEP on CFP in order to contribute to the academic debate and provide clarity on the link between the existing conceptual frameworks and the empirical findings. Secondly, identifying the mechanisms that drive the impact of CEP on CFP leads to a deeper understanding of the effect that CEP has on CFP and therefore to an improved foundation for managerial decision-making. Hence, this thesis provides the answer to the questions of how corporate environmental performance affects corporate financial performance and whether this impact shows evidence for a causal relationship.

To answer this question, a sample based on the Stoxx Europe 600 from 2013-2022 is used. First, the existing theoretical concepts are reviewed and analyzed in order to develop hypotheses on how CEP can affect CFP. To investigate the initial relationship between CEP and CFP, a fixed-effects linear regression model is used. After investigating this relationship, the observed companies are divided into distinct groups, categorized by the overall environmental performance of the companies. Based on those subsamples, comparisons of various metrics and characteristics that drive corporate financial performance can be conducted in order to understand how companies that perform well environmentally differ from companies with poor environmental performance. Further, an approach based on the Granger causality model is used to investigate any potential causal relationship between CEP and CFP. The Granger causality model primarily relies on the utilization of time lags of the main independent variable in order to investigate the impact of observations in the previous years on a dependent variable in later periods.

This thesis is divided into seven Chapters. Chapter 2 provides a brief overview of the existing literature to introduce the main theories that have emerged from it; those theories are the foundation for the hypotheses. Chapters 3 and 4 present the dataset and the empirical methodology. In Chapters 5 and 6, the obtained results are described and discussed before the thesis is concluded in Chapter 7.

2 Literature Review and Hypotheses

The relationship between carbon policies and corporate financial performance (CFP) has been extensively examined in the academic literature. Numerous studies have employed various approaches to investigate the impact of carbon environmental performance on CFP and related topics. However, the findings remain inconclusive, leading to ongoing discussions in the field. In this section, a concise overview of the existing academic literature is provided. Therefore, the Chapter focuses on three main components: Firstly, the theoretical foundations are structured and presented. Secondly, the main outcome of previous empirical studies is presented and discussed. Thirdly, the theoretical foundations and the empirical findings from previous studies are synthesized into hypotheses to approach the research questions.

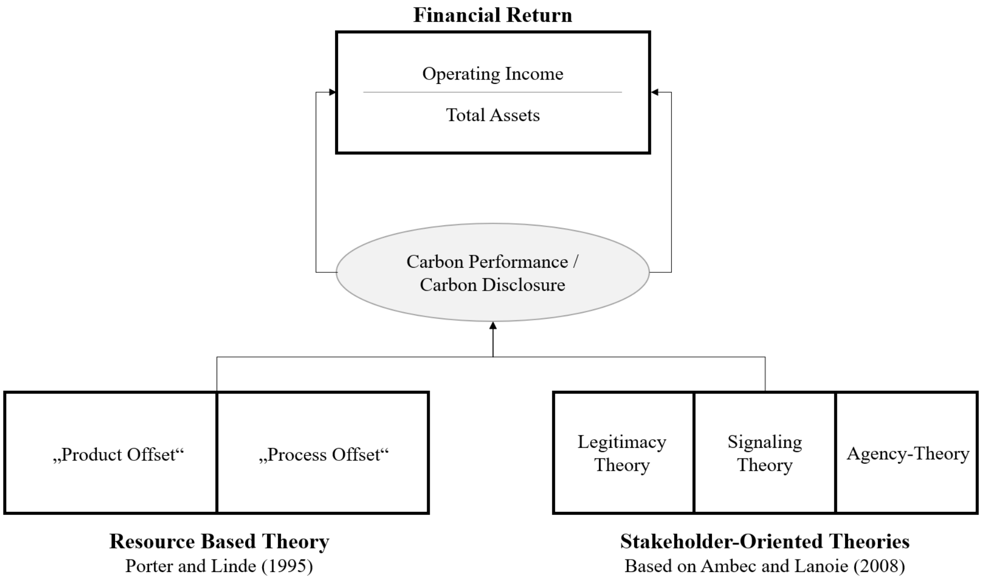
Regarding carbon policies, the previous literature focuses on two main aspects of corporate behavior: carbon disclosure and corporate environmental performance. Investigations of carbon disclosure primarily focus on the provision of information to the public. Previous studies in this field investigate the impact of non-financial disclosure on the cost of capital (Dhaliwal et al., 2011; Bolton and Kacperczyk, 2021; Bui et al., 2020; Gerged et al., 2021; Lemma et al., 2019), the efficiency of disclosure in explaining the underlying carbon performance (Luo and Tang, 2014), the impact of effective governance on CD (Ben-Amar and McIlkenny, 2015), or the impact of CD on financial performance (Downar et al., 2021; Alsaifi et al., 2020; Siddique et al., 2021; Jouvenot and Krueger, 2019; Zhou et al., 2018). The investigation of CEP focuses mostly on performance aspects, for example, the measurement of carbon performance (Busch et al., 2022b), the outcome of carbon initiatives (Damert et al., 2017) the general impact of CEP on CFP (Busch et al., 2022a; Delmas et al., 2015; Trinks et al., 2020) or more specific topics such as the impact of carbon performance on labor productivity (Delmas and Pekovic, 2013; Woo et al., 2014).

2.1 Conceptional Literature

Porter and van der Linde (1995) laid the theoretical and conceptual foundation for the investigation of the impact that CEP might have on CFP. They argue that if political regulations for corporate environmental standards are defined efficiently, those regulations can have a positive impact on the competitiveness of companies. This can lead to an improvement in the competitive position of a company and, therefore, to higher financial returns. Porter and van der Linde (1995) claim further that environmental regulations can impact financial performance by fostering innovation. They identify two main mechanisms behind that potential impact, called "process offsets" and "product offsets". "Process offsets" imply that companies use the pressure to innovate to find ways to use their resources more efficiently. Accordingly, Porter and van der Linde (1995) and Shrivastava and Hart (1995) define carbon emissions as waste and, therefore, a sign of efficiency. Thus, they argue that a decrease in carbon emissions means a decrease in waste and therefore more efficient production, which eventually leads to a better competitive position and higher financial returns.

"Product offset" innovation is based on the concept that companies improve the design of their products and therefore innovate the products as such to generate less waste during production, decrease the use of resources, and potentially increase the value of the product for the company's clients (Porter and van der Linde, 1995). To conclude, Porter and van der Linde (1995) claim that in terms of the impact on financial performance, carbon policies can yield two major outcomes, increased efficiency or increased value creation through the higher utility of the products for customers or lower costs of production.

Figure 1: Conceptual Frameworks



Source: Own Illustration, based on Porter and van der Linde (1995); Porter (1991); Ambec and Lanoie (2008); Zhang and Liu (2020)

However, there have been contradicting views in the past. Walley and Whitehead (1994) argue that environmental initiatives are associated with high costs and, therefore, are primarily additional costs for the firms instead of opportunities to increase financial performance. Accordingly, Palmer et al. (1995) argue that environmental projects have to be subject to careful cost-benefit analyses in order to avoid negative effects on CFP. Based on those considerations, more conceptual frameworks emerged. Ambec and Lanoie (2008) show in their conceptual framework specific mechanisms of how environmental performance can affect financial performance. They elaborate on the concept of Porter and van der Linde (1995) and show how the increase in efficiency can work.

In addition to those considerations, other streams emerged, primarily out of the CD-related literature. Ambec and Lanoie (2008) based their framework on corporate stakeholders and investigated the potential effects that carbon performance has on corporate key stakeholders. Therefore, some scholars argue that the effect of carbon policies on CFP might be driven by the interaction with stakeholders instead of the company's ability to produce more efficiently. This theoretical stream comprises three general theories (Zhang and Liu, 2020). The legitimacy theory based on Dowling and Pfeffer (1975) and Freeman (1984) explores corporate decisions that are driven by the pursuit of companies to act according to the prevailing values of their stakeholders and their environment. This leads to the fact that the company aligns its decision-making with the goals that are being pursued by society. Therefore, in this case, companies try to actively increase their carbon performance by reducing greenhouse gas emissions (Zhang and Liu, 2020).

The signaling theory emerged from the investigation of voluntary disclosure. This stream claims that companies are trying to signal their superior performance to the market and their main stakeholders. This, in turn, leads to voluntary disclosure of carbon-related information under the condition that the company's carbon performance is in fact good. However, if the company's carbon performance is poor, the likelihood of disclosing the information should be considerably lower. This theory is often connected to greenwashing, therefore, it should primarily lead to short-term financial results (Zhang and Liu, 2020).

The last theory stream focuses on a perspective driven by agency theory. It claims, that disclosing carbon-related information leads to a decrease in information asymmetry and therefore a decrease in agency costs (Zhang and Liu, 2020).

To conclude, as displayed in Figure 1, there are two main branches of theory that are attempting to explain the impact of CEP on CFP. The literature stream based on Porter and van der Linde (1995) argue that companies with superior carbon performance are able to operate more efficiently and resource-effectively. However, the second literature stream argues that companies with superior carbon performance have improved relationships with their stakeholders; therefore, the potential positive impact of CEP on CFP is based on improved interaction with stakeholders.

2.2 Empirical Literature

In general, quantitative studies that investigate the nexus around CEP and CFP are based on three different kinds of methodological approaches: event studies (Downar et al., 2021; Alsaifi et al., 2020), portfolio analyses (Anquetin et al., 2022), and regression analyses (Busch et al., 2022a; Delmas et al., 2015; Trinks et al., 2020; Horváthová, 2012; Siddique et al., 2021). For event studies, researchers observe and investigate specific events in order to evaluate the reaction of their observed subjects to an external shock, such as the reaction to an oil spill (Patten, 1992) or the reaction to new environmental laws (Alsaifi et al., 2020). Portfolio analyses compare metrics for sub-portfolios in order to investigate how companies in distinct groups behave (Jeroen et al., 2005; Anquetin et al., 2022).

As with the conceptional thoughts about the impact of carbon policies on CFP, the empirical methodologies and results remain ambiguous (Busch and Lewandowski, 2018). Busch and Lewandowski (2018) and Velte et al. (2020) provide an overview of the empirical results regarding the impact of CEP on CFP. Velte et al. (2020) and Zhang and Liu (2020) provide a comprehensive overview of the results of the carbon disclosure studies. Busch and Lewandowski (2018) find that around 67.6% of the observed studies find a positive correlation between CEP and CEP, around 23.5% find a negative correlation, and the reminder observed no correlation. Horváthová (2010) observes a similar pattern, with 54.7% of studies indicating a positive relationship between CEP and CFP, 15.6% showing a negative relationship, and the remainder finding no significant results.

Among others Trinks et al. (2020) and Horváthová (2012) find a positive impact of carbon efficiency on ROA; Trinks et al. (2020) however also report no significant impact of carbon efficiency on market valuation of the investigated companies. Konar and Cohen (2001) find a negative impact of the amount of released toxic waste on the market valuation and therefore conclude that market participants do value environmental performance, especially for high-emission industries. Delmas et al. (2015) on the other hand, find that carbon emissions do increase the returns in the short term, indicating a lack of short-term payoffs, but decrease the market value in the long run, implying that the market values carbon efficiency in the long run. On the other hand, Busch et al. (2022a) finds a negative impact on both, return on assets and market valuation and concludes that there is still a lack of financial incentives for companies to improve their carbon performance.

Hence, there is both, a broad body of research developing conceptual frameworks that give theoretical insights into the theoretical impact of CEP on CFP and a strong foundation of literature that empirically investigates the relationship. However, the link between conceptual frameworks and empirical findings remains ambiguous. Busch et al. (2022a) explains the negative impact of CEP on CFP with a lack of investor pressure on the subsequent companies and, therefore, with a lack of incentives for companies to improve their CEP. Horváthová (2010) finds that CEP has an impact on CFP in the long run and therefore derives that the theory based on Porter and van der Linde (1995) requires time to amortize the costs of the initiatives to increase CEP in the first place. Delmas et al. (2015) on the other hand provide no potential explanation for their empirical findings.

Even though Servaes and Tamayo (2013) pursue a similar approach by investigating the channels by which corporate social responsibility can influence firm value with a specific focus on the role of customer awareness, to my knowledge, there is no study that investigates the mechanisms that drive the potential impact in an empirical manner and that therefore combines both the conceptual frameworks and the empirical findings systematically in a holistic approach.

2.3 Hypotheses Development

To contribute to closing the identified connection between conceptual and theoretical studies, four hypotheses are investigated. As mentioned in the literature review, a multitude of studies have investigated this issue. Therefore, in line with the theories based on the efficiency arguments of Porter and van der Linde (1995) and the stakeholder theories that emerged from Dowling and Pfeffer (1975), Freeman (1984), and Ambec and Lanoie (2008) I am expecting a positive impact of CEP on CFP, regardless of the mechanisms behind the impact. This expectation is also supported by the majority of empirical studies (Busch and Lewandowski, 2018; Horváthová, 2012). Regarding the particular impact, there are multiple performance indicators that can be utilized to assess CFP (Busch and Lewandowski, 2018; Velte et al., 2020). Studies find mixed effects for different financial indicators; therefore, for the purposes of this study, the term corporate financial performance is disentangled into two dimensions. First, when analyzing the relationship between CEP and CFP from a resource-oriented point of view, as it is claimed by Porter and van der Linde (1995); Porter (1991) effects do not necessarily capitalize on shareholder value immediately. Thus, in line with the resource-based theory, it can be hypothesized that the observed firm is able to use its assets efficiently and therefore yields a high return on its assets. Busch and Lewandowski (2018) and Horváthová (2010) find that this claim is supported by the majority of empirical studies, such as Trinks et al. (2020) and Horváthová (2012). Therefore, it can be hypothesized that companies with a better CEP yield a higher ROA.

H1a: Companies with better corporate environmental performance yield a higher ROA

Second, based on stakeholder-oriented theories, the relationship between CEP and CFP is mainly visible in the external relationships of a company, for example, by signaling performance to the market and therefore to the company's shareholders. The main rationale for shareholders is their interest in returns on their capital and the stock's performance. Moreover, previous studies found that shareholders value the environmental performance of companies (Patten, 1992; Konar and Cohen, 2001). Thus, in line with the findings in previous studies, as, for instance, Delmas et al. (2015) and Konar and Cohen (2001) I expect companies with better environmental performance to have a higher market valuation and therefore a higher Tobin's Q.

H1b: Companies with better corporate environmental performance yield a higher Tobin's Q

After finding evidence for the general relationship between CEP and CFP, the driving mechanisms for this relationship are investigated. The ROA has been the primary measure of CFP for this empirical field so far (Busch and Lewandowski, 2018; Velte et al., 2020) and since the ROA is an accounting-based ratio, the drivers for the return on assets are reliably observable. The driving mechanisms behind, for example, market valuation or stock market performance, are more opaque. Therefore, ROA is used as a starting point, to analyze the driving mechanisms behind the relationship. Generally, ROA is computed by dividing operating income by total assets. Thus, it can be interpreted in two ways:
I) ROA can be a measure to assess the return a company is able to generate by using its assets, or
II) ROA can be a measure to assess the level of assets a company needs to generate a specific level of profit.

Connecting the ROA to the theories, it can be inferred that the resource-based theory can be mainly associated with the asset base of a company. Porter and van der Linde (1995) argue that the quest to improve CEP leads to innovation within the company, which can lead to an increase in efficiency and a decrease in waste. If companies operate more efficiently, they require fewer assets, both in terms of short-term assets, such as materials, and fixed assets, such as production capital. Therefore, companies are expected to yield similar or even higher returns on assets than their peers. Thus, companies reduce the denominator in the return of assets, the asset base, and therefore increase the overall performance. Hence, based on the resource-based theory, I expect to find that companies with better CEP need a significantly lower asset base for their operations compared to their peers, driven by the ability to conduct their operations more efficiently.

H2: Firms with superior CEP require fewer assets to yield similar or higher returns on assets than their peers

According to the external theories that focus on the relationship between the firm and its stakeholders, the impact of CEP on CFP is mostly driven not by the efficiency of a company but by the public perception a firm has among its key stakeholders. According to their conceptual frame, Ambec and Lanoie (2008) propose that the main stakeholders of companies are shareholders, employees, regulators, consumers, and other stakeholders. Due to the differences between those stakeholder groups, the impact those groups have on companies differs.

Regarding shareholders and capital providers in general, Bui et al. (2020) and Gerged et al. (2021), for example, find that both GHG emission and disclosure have a negative effect on the cost of equity and the cost of capital in general. Bui et al. (2020) find that companies with lower carbon intensity are rewarded by lower cost of capital, whereas companies with higher carbon intensity get penalized by higher cost of capital. In addition, Kleimeier and Viehs (2016) find that companies with higher carbon emissions are penalized by increased costs of debt. In terms of impact on employees, Woo et al. (2014) and Delmas and Pekovic (2013) find that pursuing environmental actions improves labor productivity. In their study designs, they find that incorporating environmental standards and pursuing actions to improve environmental performance leads to increased labor productivity. Regarding the stakeholder group of customers, Servaes and Tamayo (2013) show that companies with high customer awareness and better CSR performance yield higher returns on their assets since they are able to charge higher prices for their products. Therefore, observing the relationships with stakeholders and the potential effects that an improved perception of corporate stakeholders can have, the following can be concluded:

Improved perception by capital providers leads to lower costs of capital and thus to lower financing costs or improved availability of capital (Bui et al., 2020; Gerged et al., 2021; Kleimeier and Viehs, 2016); superior perception by employees leads to higher labor productivity and therefore either lower labor costs or higher product output (Delmas and Pekovic, 2013; Woo et al., 2014); and improved customer perception leads to the ability to charge higher prices for the respective products and services (Servaes and Tamayo, 2013). All the effects that improved perceptions of the stakeholders have, ultimately capitalize, either in revenues or costs for a company and therefore in the operating profit, Hence, according to the stakeholder-based theories, it can be hypothesized that the effect of CEP on the CFP is primarily driven by operating profit due to the improved relationship with corporate stakeholders.

H3: Firms with superior CEP yield higher operating profits than their peers

Testing these assumptions sheds light on the connection between theoretical concepts of the impact of CEP on CFP and empirical findings. Moreover, to understand the mechanisms more in detail, it has to be investigated whether the carbon performance of a company has a causal relationship with the aforementioned drivers of return on assets. Nelling and Webb (2009) investigate the causal relationship between CSR activities and financial performance as such by investigating whether CSR performance in the past serves as a predictor for financial performance in later periods. They find no significant evidence for a causal relationship between CSR performance in the past and the return on assets for companies. Based on this approach, it is tested whether carbon performance in the past can be seen as a predictor of superior financial performance.

H4a: The carbon performance in the past serves as a predictor for higher returns on assets compared to industry peers

H4b: The carbon performance in the past serves as a predictor for higher efficiency and therefore lower levels of assets compared to industry peers

H4c: The carbon performance in the past serves as a predictor for higher operating profits compared to industry peers

3 Data and Variables

3.1 Data

To address the research question, a European dataset is used. Previous studies mostly focused on multinational settings or on the USA (Velte et al., 2020; Horváthová, 2012). Even though investigations for European samples also exist, they appear to be underrepresented in the literature compared to global or, for instance, US-based samples.

The sample employed in this study consists of companies listed in the Stoxx Europe 600, that provide a comprehensive overview of the European firms with the highest market capitalization. To minimize biases arising from crises such as the COVID-19 pandemic or other exceptional events, a panel data set is used. Consequently, the sample contains a time series spanning from 2013 to 2022, providing ten years of data. Moreover, since the hypotheses are based on theories that emerged from literature streams regarding carbon performance and carbon disclosure, the sample consists only of companies that disclosed their GHG emissions over the whole time span. This also ensures a balanced dataset for the investigation of the carbon performance impact. All companies that did not disclose their CO2 emissions in any given year are excluded from the sample.

Consistent with prior studies, industries within the Stoxx Europe 600 that are not associated with significant carbon emissions have been excluded to prevent result distortion (Luo, 2019; Busch et al., 2022a; Siddique et al., 2021). Specifically, in this thesis, the financial industry, real estate companies, technology companies, and healthcare companies have been omitted. By doing so, the analysis maintains its focus on industries where carbon emissions play a substantial role. In total, this leads to a sample of 174. In line with previous studies, the lagged versions of the independent variable and most of the control variables are used. Therefore, 9 years of data are investigated, leading to 1,566 firm-year observations.

The data used for financial performance, carbon performance, and control variables were obtained from the Refinitiv dataset. The industry clusters are based on the Thomson Reuters Industry Classification (TRIC). Table 1 provides an overview of the sample composition as of December 31, 2022.

In terms of geographical distribution, the majority of observed companies are located in the United Kingdom, accounting for 32.18% of the sample. France has the second-largest number of companies at 16.09%, while the remaining companies are evenly distributed across other European countries.

Regarding industry sectors, the largest proportion of firms falls within the consumer-based sector, constituting 38.51% of the overall sample. Accordingly, 20.69% of the companies are in the consumer cyclical sector, while 17.82% are involved in consumer non-cyclical products. The second-largest number of observations is in the industrial sector, accounting for 27.01% of the sample. Consequently, the majority of the companies in the sample are manufacturing firms. Additionally, non-manufacturing industries are represented, such as basic material companies (18.97%), companies in the utilities sector (10.92%), and energy companies (4.60%).

Table 1: Sample Distribution by Industry and Country

	Country	Basic Materials	Consumer Cyclicals	Consumer Non-Cyclicals	Energy	Industrials	Utilities	Total	% of Total
1	Austria	2	0	0	1	0	1	4	2.30%
2	Belgium	2	0	1	0	0	0	3	1.72%
3	Denmark	1	1	2	1	2	0	7	4.02%
4	Finland	2	0	0	1	2	1	6	3.45%
5	France	2	8	5	1	11	1	28	16.09%
6	Germany	6	4	2	0	2	0	14	8.05%
7	Ireland	1	0	1	0	0	0	2	1.15%
8	Luxembourg	1	0	0	1	0	0	2	1.15%
9	Netherlands	1	1	3	0	2	0	7	4.02%
10	Norway	1	0	2	1	1	0	5	2.87%
11	Poland	1	0	0	0	0	0	1	0.57%
12	Sweden	2	4	1	0	7	0	14	8.05%
13	Switzerland	3	2	2	0	5	0	12	6.90%
14	United Kingdom	8	15	11	1	14	7	56	32.18%
15	Spain	0	1	0	0	0	5	6	3.45%
16	Portugal	0	0	1	0	0	1	2	1.15%
17	Italy	0	0	0	1	1	3	5	2.87%
18	Total	33	36	31	8	47	19	174	100.00%
19	% of Total	18.97%	20.69%	17.82%	4.60%	27.01%	10.92%	100.00%	

3.2 Measures of Financial and Environmental Performance

The study mainly requires measures for CFP and CEP. In terms of financial performance, existing studies have utilized various approaches, including accounting-based measures, market-based measures, and composite measures (Busch and Lewandowski, 2018; Velte et al., 2020). For instance, Alsaifi et al. (2020) create a composite financial performance indicator (FPI) by combining ten financial performance indicators, incorporating both market- and asset-based measures. However, as highlighted by Velte et al. (2020) and Busch and Lewandowski (2018), the majority of previous studies rely on financial measures that clearly distinguish between asset- and market-based ratios. In alignment with previous research in this field, this study employs return on assets (ROA) and Tobin's Q as measures of financial performance (Brouwers et al., 2018; Trumpp and Guenther, 2017; Horváthová, 2012; Siddique et al., 2021; Busch and Hoffmann, 2011; Gallego-Álvarez et al., 2015; Delmas et al., 2015). ROA, as a short-term performance measure, captures the immediate effects of CFP and CEP on operating income or assets. It is calculated by dividing the operating income from core business activities (excluding extraordinary effects) by the total assets of the company. To evaluate long-term performance, Tobin's Q is employed as a market-based indicator to show the market valuation by approximating the valuation of intangible assets (Konar and Cohen, 2001). Consistent with prior studies, Tobin's Q is defined as the ratio of a company's market value to its replacement costs, calculated as the market capitalization divided by the book value of the company (Konar and Cohen, 2001; Delmas et al., 2015; Busch et al., 2022a).

To evaluate carbon performance, previous studies have employed various measures (Velte et al., 2020; Busch and Lewandowski, 2018). While some studies have relied on third-party assessments, such as the Carbon Disclosure Project (CDP) (Siddique et al., 2021; Luo and Tang, 2014; Lemma et al., 2019; Kleimeier and Viehs, 2016), others have opted for actual reported greenhouse gas (GHG) emissions instead of using an index. Regarding GHG emissions, researchers have utilized the reported emissions in metric tons, measures such as carbon emission intensity, or indicators that consider industry averages. For example, Brouwers et al. (2018) calculates carbon emissions scaled by revenues for each company, comparing them to the median emissions-to-revenues ratio of companies in the same industry. In contrast, Horváthová (2010) assesses plant-based toxic waste using data from the European pollutant release and transfer register. Busch and Lewandowski (2018) shows that the majority of studies rely on emission ratios instead of absolute emission levels. Accordingly, this thesis uses emission ratios as an indicator for carbon intensity.

There are two primary approaches for calculating carbon intensity. For instance, Ganda (2018) scales greenhouse gas (GHG) emissions by assets, while Trumpp and Guenther (2017), among others, use carbon emissions scaled by revenues. Given that the objective of this study is to assess the impact of actual CEP on CFP, the approach of scaling GHG emissions by revenues at the company level is adopted. According to Porter and van der Linde (1995), GHG emissions serve as indicators of inefficiency in the production process. Regarding the aim to detect potential sources of inefficiency, scaling carbon intensity by revenues is more appropriate than by assets since revenues are directly linked to real monetary output, whereas assets are not necessarily a direct measure of the created output. Scaling GHG emissions by assets would unfairly penalize companies that achieve similar revenue-based output with lower asset levels. Therefore, to account for variations among companies, GHG emissions are scaled by revenues.

In terms of assessing the numerator in carbon intensity calculations, GHG emissions can be categorized into different scopes. Scope 1 emissions pertain to emissions directly produced by a company during its operations, while Scope 2 emissions encompass indirect emissions resulting from electricity and heat usage, among other factors. Scope 3 emissions cover additional emissions like those from contractor-owned vehicles and business travel. For this study, the CO2 emissions are determined by Scope 2 emissions in order to evaluate the emissions for which a company can be held accountable, including the use of resources such as electricity and heating, which is in line with most of the previous studies (Busch and Lewandowski, 2018). The inverse carbon intensity is used to derive a measure of carbon performance (Busch et al., 2022a). Consequently, it is expected that a higher CEP will have a positive impact on CFP. A summary of the measures is displayed in Table 2.

3.3 Control Variables

To mitigate the concern of omitted variable bias, a comprehensive set of seven additional control variables that are anticipated to influence the dependent variable is included in the model. These control variables contain firm characteristics as well as financial indicators. First, in line with the majority of prior studies, firm size is included as a control variable. Firm size is measured by the natural logarithm of assets for the respective firms (Delmas et al., 2015; Horváthová, 2012; Trumpp and Guenther, 2017; Brouwers et al., 2018). The logarithm is used since the distribution of assets varies broadly, not only across industries but also across companies within a particular industry. In this context, size is not only associated with higher availability of funds but also with increased public interest in the firm. Therefore, larger firms are likely more susceptible to public scrutiny (Siddique et al., 2021). Prior research suggests that size has a positive effect on financial performance and is therefore assumed to be one of the key determinants of financial performance. Leverage describes the financing risk of a company; the greater the leverage, the greater the risk of bankruptcy and, consequently, the greater the risk for capital providers, which leads to more challenging relationships with banks and suppliers. Hence, leverage is anticipated to have a negative effect on CFP. Leverage is calculated as total debt divided by total capital. (Delmas et al., 2015; Trumpp and Guenther, 2017; Alsaifi et al., 2020; Busch et al., 2022a). Further, Lee et al. (2015) and McWilliams and Siegel (2000) argue that the majority of previous studies that investigate the impact of CEP on CFP suffer from an omitted variable bias since those studies fail to include R&D expenditures, which are a major predictor for future financial returns. To address this concern, R&D expenditures are included in the model. R&D is measured by R&D expenses scaled by revenues and is expected to have a positive impact on CFP.

Beta serves as another measure of systematic risk that potentially affects corporate returns. Beta is expected to have a negative impact on CFP. Consistent with Trinks et al. (2020) price-to-book value is incorporated as an additional control variable to account for its relevance as a risk factor (Fama and French, 1993). Moreover, the model also controls for capital intensity (Delmas et al., 2015; Busch et al., 2022a; Brouwers et al., 2018; Griffin et al., 2017). Capital intensity is calculated by dividing capital expenditures by assets (Trumpp and Guenther, 2017). Capital intensity is an indicator of the amount of financial resources a company invests to increase or improve its assets. Capital intensity is therefore anticipated to have a positive effect on CFP (Busch et al., 2022a). Lastly, a control variable for liquidity is incorporated, following the approach of previous studies (Trumpp and Guenther, 2017; Busch et al., 2022a). Liquidity is measured as the ratio of cash flow from operations to revenues. Liquidity indicates the amount of available financial slack for investments in growth. Moreover, the greater the generated cash flow from operations, the smaller the probability of failure. This can lead to improved lending conditions and, consequently, improved financial performance. Therefore, liquidity is expected to have a positive impact on CFP.

Consistent with the omitted variable bias, endogeneity is an often-criticized aspect of the literature within the nexus between CEP and CFP. In general, endogeneity exists when the explanatory variable is correlated with the error term. A confounding variable, which is an exogenous variable that interacts with both the dependent and independent variables, is the main cause of this. The presence of a confounding variable can lead to an omitted variable bias for the model since the factor that influences both the dependent and the independent is not part of the control variables. For the relationship between CEP and CFP, one potential factor beyond the described control variables that could be a source of endogeneity is the quality of management since strong management capabilities could influence the CFP and the CFP simultaneously (Busch et al., 2022a). Thus, following the mitigation strategy of previous studies (Busch et al., 2022a; Delmas et al., 2015; Brouwers et al., 2018; Trumpp and Guenther, 2017; Siddique et al., 2021), both the control variables and the main independent variable are lagged by one year. In addition, CEP is expected to have a delayed impact on CFP (Horváthová, 2010). This expectation is also reflected in the utilization of the lagged control and independent variables. Hence, for all variables, except for PBV and Beta, the lagged version is used. For PBV and Beta, the latest value is used since those measures rely on current market data and might be externally distorted between years. A summary of the control variables is displayed in Table 3.

Table 2: Dependent Variables and Measures

Panel A: Financial Performance - Dependent Variables

Variable	Computation	Literature
Return on Assets	$\frac{OperatingProfits}{TotalAssets}$	Velte et al. (2020)
Tobins Q	$\frac{MarketCapitalization}{BookValue}$	Delmas et al. (2015)
Asset Turnover	$\frac{TotalSales}{(TotalAssets_{StartPeriod}+TotalAssets_{EndPeriod})/2}$	
Abn. Return on Assets	$ROA_t - \frac{1}{n}\sum_{i=0}^{n-1} ROA_{ind.,t}$	
Abn. Total Assets	$TotalAssets_t - \frac{1}{n}\sum_{i=0}^{n-1} TotalAssets_{ind.,t}$	
Abn. Current Assets	$Curr.Assets_t - \frac{1}{n}\sum_{i=0}^{n-1} Curr.Assets_{ind.,t}$	
Abn. Fixed Assets	$Fix.Assets_t - \frac{1}{n}\sum_{i=0}^{n-1} Fix.Assets_{ind.,t}$	
Abn. Profit	$Profit_t - \frac{1}{n}\sum_{i=0}^{n-1} CurrentAssets_{ind..,t}$	
Abn. Asset Turnover	$Turnover_t - \frac{1}{n}\sum_{i=0}^{n-1} Turnover_{ind..,t}$	

Panel B: Environmental Performance - Independent Variables

Variable	Computation	Expected Impact	Literature
Carbon Intensity (CI)	$\frac{CO2EmissionsScope2}{TotalSales}$	-	Velte et al. (2020)
Abnormal Carbon Intensity	$CI_t - \frac{1}{n}\sum_{i=0}^{n-1} CI_{ind.,t}$	-	
Environmental Performance	$-\frac{CO2EmissionsScope2}{TotalSales}$	+	Busch et al. (2022a)

Note: Expected impact on financial performance. Literature states examples. Additional sources are mentioned in the text.

Table 3: Control Variables

Variable	Computation	Expected Impact	Literature
Size	$ln(TotalAssets + 1)$	+	Delmas et al. (2015)
Leverage	$\frac{TotalDebt}{TotalCapital}$	-	Busch et al. (2022a)
R&D Intensity	$\frac{R\&DExpenditures}{TotalSales}$	+	Lee et al. (2015)
Prive to Book Value (PBV)	$\frac{MarketValue_{Share}}{BookValue_{Share}}$	+	Trinks et al. (2020)
Beta	$\frac{Covariance_{Rm,Re}}{Variance}$	-	Siddique et al. (2021)
Capital Intensity	$\frac{CapitalExpenditures}{TotalAssets}$	-	Delmas et al. (2015)
Liquidity	$\frac{OperatingCashFlow}{TotalSales}$	+	Busch et al. (2022a)
Growth	$(\frac{TotalSales_t}{TotalSales_{t-1}} - 1)$	+	Busch et al. (2022a)

Note: Expected impact on financial performance. Literature states examples. Additional sources are mentioned in the text.

4 Methodology

This thesis aims to answer the question about the mechanisms by which CEP can influence CFP. Therefore, after exploring the findings of previous studies in that field and developing hypotheses for the potential drivers, the methodology section explains how the hypotheses are investigated. Since the hypotheses are based on financial data, a quantitative approach is suitable to investigate the obtained dataset and draw the corresponding conclusions. Therefore, the methodology section explains the framework for the quantitative investigation and is divided into three parts:

I) The methodology to detect the initial relationship between CEP and CFP;
II) The methodology to identify the mechanisms that drive the impact of CEP on CFP;
III) The methodology to investigate potential causal effects of CEP on CFP.

4.1 Relationship between CEP and CFP

Hypotheses 1a and 1b are the foundation for this thesis. The main question that is answered in this thesis is not whether there is a relationship between CEP and CFP, since this question was already widely covered in previous studies. The main question is how CEP influences CEP. Although, as explained in the literature review, the significance of the relationship between CEP and CFP is already established in the literature, it has to be tested for the sample in order to lay the foundation for further investigations. Therefore, the investigations of H1a and H1b follow the investigations in previous studies. Therefore, Hypotheses 1a and 1b are tested by utilizing a linear regression, the corresponding models are displayed in the following:

Hypothesis 1a:

$$ROA_{i,(t)} = \alpha_0 + \alpha_1 CEP_{i,t-1} + \alpha_2 Size_{i,t-1} + \alpha_3 Leverage_{i,t-1} + \alpha_4 R\&D_{i,t-1} + \alpha_5 PBV_{i,t} + \alpha_6 Beta_{i,t} + \alpha_7 CAPIN_{i,t-1} + \alpha_8 Liquidity_{i,t-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \epsilon_i \quad (1)$$

Hypothesis 1b:

$$TobinsQ_{i,(t)} = \alpha_0 + \alpha_1 CEP_{i,t-1} + \alpha_2 Size_{i,t-1} + \alpha_3 Leverage_{i,t-1} + \alpha_4 R\&D_{i,t-1} + \alpha_5 PBV_{i,t} + \alpha_6 Beta_{i,t} + \alpha_7 CAPIN_{i,t-1} + \alpha_8 Liquidity_{i,t-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \pi_i \quad (2)$$

with ϵ, π being the error term. γ_y, δ_c and ρ_i reflect the year, country and industry effects.

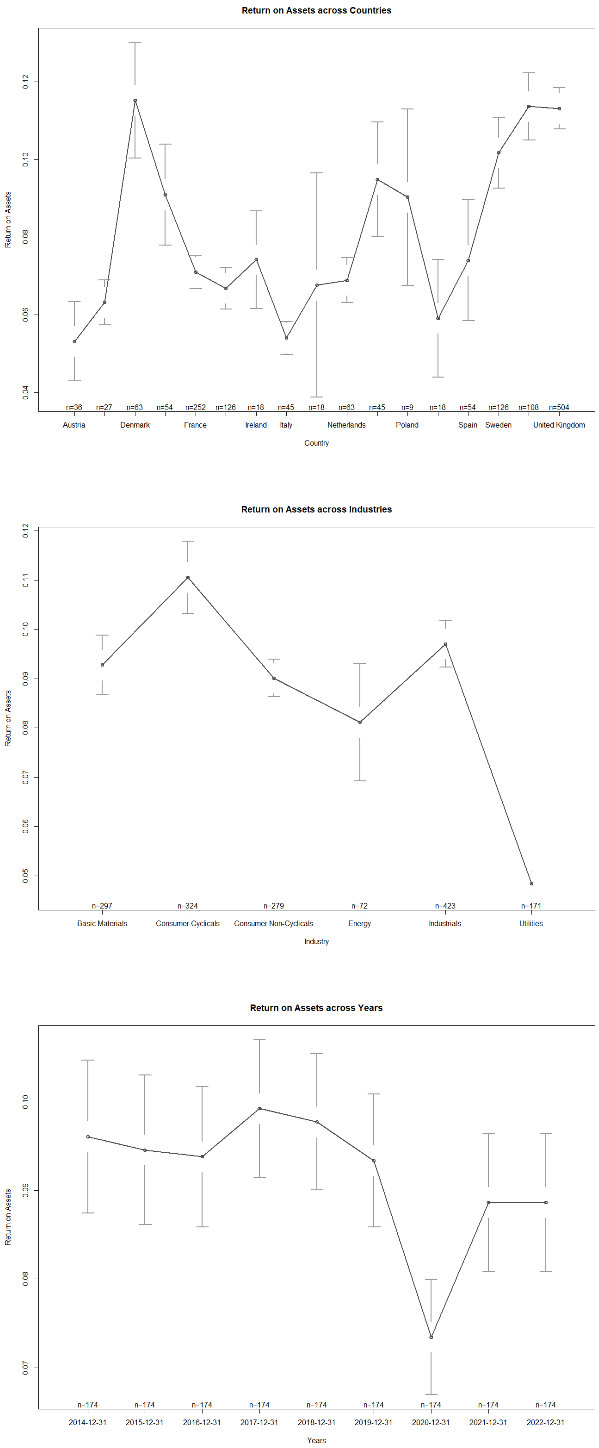
To set up the model, multiple factors have been considered. Since the selected sample is a panel data set, the suitability of a pooled ordinary least squares (OLS) model compared to a random-effects or fixed-effects model has been tested. The pooled OLS model does not account for heterogeneity across countries, years, or other factors.

As observable in Figure 2, the dependent variable is visibly heterogeneous across different countries. The lowest average return on assets is present in Austria, with roughly 5%, whereas Danish firms have an average ROA of roughly 11 %. In other countries, the average ROA is between approximately 7% and 12%. Figure 2 displays a similar pattern when comparing the ROA across industries. In the utilities sector, firms yield an average ROA of around 5%, whereas Customer-Cyclicals- firms are able to create on average around 11% of return on their assets. Lastly, Figure 2 shows that the effects are not consistent over time. The highest average return on assets can be observed in 2017, with around 10%. However, in 2020, the return was substantially lower. The sample firms averaged a return of around 7.5% on their assets. This pattern was expected since the COVID-19 crisis had a recognizable impact on corporate performance in 2020. Moreover, it can be observed that the standard deviation of ROA is higher than in the previous figures. This can also be explained by the aforementioned factors since the average ROA differs considerably across industries and countries.

To conclude, a pooled OLS model is not appropriate to investigate this sample since the assumption that the dependent variable is homogenous across various factors is visibly not true for the investigated sample. Thus, a model that takes specific effects for countries, time, and industries into consideration is used. This observation was confirmed by an F-test for individual effects. Therefore, in the next step, it is tested whether a fixed-effects or a random-effects model is more appropriate to produce reliable results. A Hausman test has been performed to compare the fixed and random effects models. The results of the Hausman test confirm that there are significant fixed effects within the panel. Thus, a fixed-effects model is used, which is, among others, in line with Busch et al. (2022a), Nelling and Webb (2009), and Delmas et al. (2015).

To ensure the validity of the models and limit potential heteroscedasticity concerns, robust error terms are calculated for the model. Moreover, the necessary transformations of the variables are executed (provided in Appendix A.1).

Figure 2: Heterogenity of ROA across Countries, Industries and Years



4.2 Mechanisms behind the Relationship between CEP and CFP

To test Hypotheses 2 and 3, a different approach is utilized. First, an alternative concept is introduced. Instead of relying on the CEP or the ROA as in the first section, the abnormal performance is used to benchmark the respective measure with the industry. (Brouwers et al., 2018). To create abnormal measures, year-industry averages are computed and deducted from the respective company's performance. For example, if a company reports a return of 10% on its assets in a certain year but the average of the firm's industry in this particular year is 8%, then the company is able to yield a 2% abnormal return compared to its peers and is therefore outperforming the industry average.

After computing the abnormal performance, the sample is divided into multiple subsamples. Based on their average abnormal carbon performance over the course of the last ten years, companies are divided into CEP Ranks. The CEP Rank is determined by averaging the abnormal CEP over the entire time period. For each industry and year, the GHG emissions are divided by revenues to determine the average carbon intensity. To address the potential issues of outliers and establish the robustness of this approach, the benchmarked return has been calculated with the median performance as well instead of the average performance (Brouwers et al., 2018). This approach shows consistent results. Then, firms are divided into distinct portfolios according to their carbon rank. Rank 4 displays the benchmark companies that operate within the industry's median abnormal carbon intensity. Companies in CEP Rank 3 and 5 are in the 25th and 75th percentiles of their industry, while companies in CEP Rank 2 and 4 are among the 10% best and worst companies in their industry, respectively. Companies that significantly outperform or underperform their industry are positioned at CEP Ranks 1 and 7. Since the companies are ranked according to their abnormal carbon performance, this setting also implicitly controls for the average level of carbon performance in the industry of the respective company.

Table 4: CEP Ranks

CEP Rank	Performance	Number of companies
Rank 1	1st Percentile	3
Rank 2	10th Percentile	22
Rank 3	25th Percentile	17
Rank 4	Median	15
Rank 5	75th Percentile	54
Rank 6	90th Percentile	36
Rank 7	99th Percentile	27

Next, it is determined whether the companies within those carbon portfolios differ significantly from each other in terms of financial performance and several other drivers of this performance. In this case, the abnormal performance is also used to assess the financial performance and the drivers. In other words, instead of comparing the accounting-based measures, it is investigated whether the used measures are higher or lower compared to the company's industry peers; therefore, methodologically, the different subgroups are compared, and patterns in the differences between those sub-groups are investigated. The computed abnormal measures can be found in Table 2. Since the whole sample is divided into seven subsamples, the number of observations per subsample decreases. Moreover, the compared metrics - abnormal ROA, abnormal assets, abnormal asset turnover, and abnormal profit - are not normally distributed. This fact violates the assumption of using a statistical t-test or an ANOVA; instead, the comparison is conducted using a one-sided Wilcoxon test to determine if the characteristics of the companies in these subsamples differ significantly.

4.3 Investigation of Causality

To investigate if there is evidence for a causal relationship between CEP and CFP, an approach in line with Nelling and Webb (2009) and based on Granger causality models are applied. According to this approach, it can be assumed that if carbon performance in the past has had a significant impact on the return on assets in later periods, there might be a causal relationship (Granger, 1969). The control variables and the measure of carbon performance remain constant. To investigate if CEP leads to a competitive advantage, as Porter and van der Linde (1995) claim, the return on assets is used as the main dependent variable. Moreover, the effect on total assets is investigated.

In addition to the results of the regression, the models are expanded, and formal Granger causality tests are executed. Within the formal Granger causality tests, abnormal ROA, abnormal total assets, and abnormal operating profits are used as dependent variables. Moreover, the time horizon of the lags is expanded to five years. The Granger causality test conducts a regression model using multiple time lags for the explanatory variable. If a significant result is obtained, it can be concluded that the past values of an explanatory variable can be used to support the prediction of the dependent variable and therefore infer a causal relationship. However, when detecting a significant relationship between two variables, reverse causality remains a concern. To mitigate this concern, the test can be executed inversely to observe whether the initial dependent variable can in fact serve as a predictor for the initial explanatory variable. If significant results can only be obtained in one direction, it is unlikely that the relationship is impacted by reverse causality.

Therefore, Hypotheses 4a, 4b, and 4c are tested by utilizing a linear regression, the corresponding models are displayed in the following:

Hypothesis 4a:

$$\begin{aligned} ROA_{i,(t)} = \alpha_0 + \alpha_1 ROA_{i,t-1} + \alpha_2 ROA_{i,t-2} + \alpha_3 CEP_{i,t-1} + \alpha_4 CEP_{i,t-2} + \\ \sum Control_{it-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \epsilon_i \end{aligned} \quad (3)$$

Hypothesis 4b:

$$TotalAssets_{i,(t)} = \alpha_0 + \alpha_1 TotalAssets_{i,t-1} + \alpha_2 TotalAssets_{i,t-2} + \alpha_3 CEP_{i,t-1} + \alpha_4 CEP_{i,t-2} + \sum Control_{it-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \epsilon_i \quad (4)$$

Hypothesis 4c:

$$OperatingProfit_{i,(t)} = \alpha_0 + \alpha_1 Op.Profit_{i,t-1} + \alpha_2 Op.Profit_{i,t-2} + \alpha_3 CEP_{i,t-1} + \alpha_4 CEP_{i,t-2} + \sum Control_{it-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \epsilon_i \quad (5)$$

with $\sum Control_{it-1}$ as control variables held constant to equation (I) and (II) ϵ, π being the error term. γ_y, δ_c and ρ_i reflect the year, country and industry effects.

5 Results

5.1 Descriptive Statistics

Table 5 displays the summary statistics for the obtained sample within the whole period of observation between 2013 and 2022. It displays both performance indicators, ROA and Tobin's Q, as well as CEP and the control variables. The results of the investigation of Hypotheses 1a and 1b are the foundation for the investigation of the remaining hypotheses. Therefore, both the sample and the results that are obtained in the first investigation are extensively compared to previous papers to ensure the validity of the findings and, therefore, the validity of the foundation for the remaining investigations.

In the sample, the mean ROA is 9.245% with a standard deviation of 5.329. The minimum ROA equals 0.02% and the maximum ROA is 35.873%. The average ROA differs slightly from other studies. Siddique et al. (2021) reports a return on assets of 10.4 % and Busch et al. (2022a) find a ROA of 7.1% Horváthová (2010) and Brouwers et al. (2018) find an average ROA of 5%. This deviation can be explained by the varying time frames. Horváthová (2010) and Brouwers et al. (2018) are relying on older samples that include the period of the financial crisis, which leads to a lower average ROA. Siddique et al. (2021) uses a sample from 2011–2015, which excludes the period of the financial crisis; however, the effect of the COVID-19 crisis is also not included in their sample. The standard deviation is in line with previous studies. For Tobin's Q, the sample shows a mean of 1.376. For Tobin's Q, a similar pattern can be observed: studies that include the financial crisis find a slightly lower Tobin's Q; for studies that exclude both the financial crisis and the COVID-19 pandemic, the observed Tobin's Q is marginally higher.

The standard deviation in the sample for this study is higher compared to previous studies. While the investigated sample shows a standard deviation of 1.147, Busch et al. (2022a) report a standard deviation of 0.799, and Siddique et al. (2021) display a standard deviation of 1.052. The CEP has an average of -0.276 and a standard deviation of 0.624. Previous studies that utilize the same indicator for their CEP assessment find similar values. Busch et al. (2022a) report a carbon intensity of 0.227 with a standard deviation of 0.529, and Trumpp and Guenther (2017) find a CEP of -0.295 with a standard deviation of 0.686. Regarding the control variables, the average size is 16.329 with an SD of 1.304, which is in line with Trumpp and Guenther (2017) and Busch et al. (2022a), however, it differs from other studies. Delmas et al. (2015) and Siddique et al. (2021) utilize a sample with smaller companies and thus find an average size of 8.53 and 10.679. The mean leverage equals 25.4% with an SD of 0.149, which is consistent with previous studies (Siddique et al., 2021; Busch et al., 2022a; Trumpp and Guenther, 2017; Brouwers et al., 2018). The R&D intensity equals an average of 1.2% with an SD of 0.018. The mean capital intensity is 0.095. Siddique et al. (2021) reports a mean capital intensity of 0.098. The mean liquidity is 0.148, which equals a cash flow of 14.8% of revenues; the SD is 0.106. Thus, overall, the descriptive data of the obtained sample is in line with previous studies. Table 6 shows the correlation data for the main variables. As expected, the correlation between the return on assets and Tobin's Q has a coefficient of 0.73 and is highly significant. Since Tobin's Q and ROA serve as distinct dependent values, no multicollinearity issues arise out of this correlation. CEP is negatively correlated with size, showing a coefficient of -0.14. Trumpp and Guenther (2017) and Siddique et al. (2021) report a similar pattern for the relationship between carbon performance and size. However, the correlation that Trumpp and Guenther (2017) find in their sample is not significant. The result is in line with expectations. Moreover, CEP is positively correlated to R&D expenditures, which might suggest that firms with a higher emphasis on R&D activities perform better in terms of their carbon emissions or, on the other hand, that companies with more extensive research are able to maintain an improved CEP. Lastly, the correlation suggests that both ROA and Tobin's Q are positively correlated to CEP with a correlation coefficient of 0.19 respectively 0.20, which is the first indicator to support the hypothesis that firms with a better CEP tend to perform financially better than their peers.

Table 5: Summary Statistics

Statistic	ROA (%)	Tobins Q	CEP	Size	Leverage	R&D	PBV	Beta	CAPIN	Liquidity
N	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740	1,740
Mean	9.245	1.376	−0.276	16.329	0.254	0.012	3.338	1.006	0.092	0.148
St. Dev.	5.329	1.147	0.624	1.304	0.149	0.018	3.083	0.386	0.220	0.106
Min	0.020	0.086	−8.632	12.491	0.000	0.000	0.000	0.000	0.000	−0.971
Max	34.873	8.216	−0.001	20.060	0.856	0.128	53.360	3.050	2.860	0.738

Note: ROA = Return on Assets, CEP = Corporate Environmental performance (inverse Carbon intensity), Size = log of Assets, R&D = Research and Development Expenditures scaled by revenues, CAPIN = Capital Intensity (capital expenditures scaled by assets), Liquidity = Operating Casflow scaled by revenues,

Table 6: Correlation Matrix - Pearson Coefficients

	ROA	TobinsQ	CEP	Size	Leverage	R&D	PBV	Beta	CAPIN	Liquidity
ROA	1.00									
Tobins.Q	0.73***	1.00								
CEP	0.20***	0.22***	1.00							
Size	-0.41***	-0.46***	-0.16***	1.00						
Leverage	-0.29***	-0.25***	-0.11***	0.27***	1.00					
R.D.Sales	0.04	0.24***	0.12***	0.01	-0.04	1.00				
PBV	0.47***	0.57***	0.22***	-0.27***	0.01	0.08***	1.00			
Beta	-0.10***	-0.27***	-0.07**	0.04	-0.05	-0.03	-0.25***	1.00		
CAPIN	-0.02	-0.00	-0.01	0.03	0.01	0.00	0.01	-0.00	1.00	
Liquidity	0.18***	0.12***	-0.09***	0.09***	0.34***	0.00	0.05*	-0.18***	-0.02	1.00

Note: *p<0.1; **p<0.05; ***p<0.01

5.2 Results Hypotheses 1a and 1b

In accordance with previous research (Busch et al., 2022a; Siddique et al., 2021), the independent variables have been transformed to satisfy the regression's normality assumption (provided in Appendix A.1). Therefore, for CEP and for R&D expenditure, a square root transformation has been used. Leverage, capital intensity, liquidity, and growth have been log-transformed. Due to the square root transformation of CEP, a negative coefficient indicates a positive relationship with the dependent variable.

Table 7: Regression 1: CEP on CFP

	Dependent variable:	
	ROA	Tobins Q
	panel linear	*panel linear*
	(1)	(2)
CEP (inverted sign)	-0.036***	0.060
	(0.009)	(0.009)
Size	-0.034***	-0.296***
	(0.006)	(0.006)
Leverage	-0.090***	-0.518***
	(0.030)	(0.030)
R&D Intensity	-0.136***	-0.966**
	(0.052)	(0.052)
PBV	0.001***	0.024***
	(0.0008)	(0.0008)
Beta	-0.010***	-0.115***
	(0.005)	(0.005)
Capital Intensity	-0.004	0.055
	(0.003)	(0.003)
Liquidity	0.272***	2.080***
	(0.005)	(0.005)
Growth	0.020***	0.146***
	(0.004)	(0.004)
Year Fixed Effects	Yes	Yes
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	1,566	1,566
R^2	0.217	0.179
Adjusted R^2	0.108	0.066
F Statistic (df = 9; 1375)	42.252***	33.398***

Note: Numbers in parentheses are heteroscedasticity-robust standard errors. ROA = Return on Assets, CEP = Corporate Environmental Performance, sign has been inverted due to square-root transformation, PBV = Price to Book Value

*p<0.1; **p<0.05; ***p<0.01

The results of investigating Hypotheses 1a and 1b are shown in Table 7. First, the R^2 value of the model with ROA as the dependent variable is 0.217. This value surpasses the R^2 of previous investigations; Busch et al. (2022a), for instance, report an R^2 of 0.156 using a comparable setting. Since Lee et al. (2015) and McWilliams and Siegel (2000) highlighted the additional explanatory power of the lagged R&D expenditures on the return on assets, the incorporation of R&D expenditures in the model may be one explanation for the increased R^2 value. The square-root transformed CEP has a highly significant effect on ROA. Regarding the coefficient, it can be estimated that a 10% increase in corporate environmental performance results in a 0.13 percentage point increase in ROA. Consequently, as anticipated, a positive effect of CEP on ROA can be observed in line with previous research (Horváthová, 2010; Trinks et al., 2020). Regarding the control variables, size has a negative effect on ROA in this context. However, previous studies show ambiguous results for the impact of size, some show significant positive impact whereas others find no significant impact at all. In addition, leverage and beta have a significant negative effect on ROA, indicating that increased firm risk degrades short-term financial performance. In accordance with expectations, R&D expenditures and liquidity have a positive effect on return on assets, indicating that if firms have access to funds and invest those funds in research and expansion, they are rewarded on average with improved financial performance.

When Tobin's Q is used as the dependent variable, CEP has no noticeable impact comparable to the results of Trinks et al. (2020). The outcome for the control values is comparable to the impact on the return on assets. It can be deduced that investments in R&D, past growth, and the availability of liquidity are rewarded with a higher market valuation, whereas size and risk, both in terms of leverage and beta, are detrimental to the market valuation.

Figure 14 (see Appendix) illustrates the sensitivity of CEP across industries; therefore, subsamples are constructed to control for the robustness of these findings across industries. The high-emission subsample consists of industries with higher average emissions, namely the utility sector, the energy sector, and the basic materials sector. Consumer cyclicals, consumer non-cyclicals, and industrials are represented in the low emission sample. Table 8 presents the results for subsamples with ROA as the dependent variable, whereas Table 9 applies the same logic while using Tobin's Q as the dependent variable. Both tables display consistent effects for the control variables. For the ROA-based model, it can be observed that the impact of CEP on ROA is not significant when the company operates in a low-emission industry; however, the results remain robust when the company operates in a high-emission industry, which is similar to the results of Patten (1992). They showed that the impact of CEP on CFP is especially pronounced in industries with high emissions, although they find this effect for the impact on Tobin's Q. The Tobin Q results are robust. There is no significant effect of CEP on Tobin's Q across all subsamples.

To conclude, the investigation of the relationship between CEP and CFP reveals a significant positive impact of CEP on the return on assets. This finding indicates that companies with better carbon performance, or, in other words, lower carbon intensity, exhibit a higher return on assets. This result holds true for the total sample and high-emission industries; when observing only low-

Table 8: Regression 2: CEP on CFP (ROA) - Industry Subsamples

	Dependent variable:		
	ROA		
	panel linear		
	Total Sample	Low Emission Industry	High Emission Industry
	(1)	(2)	(3)
CEP (inverted sign)	-0.036***	-0.028	-0.034***
	(0.009)	(0.069)	(0.011)
Size	-0.034***	-0.034***	-0.03^***
	(0.003)	(0.007)	(0.013)
Leverage	-0.090***	-0.085***	-0.086**
	(0.030)	(0.036)	(0.045)
R&D Intensity	-0.136***	-0.148***	-0.109
	(0.005)	(0.055)	(0.119)
PBV	0.001***	0.001***	0.006***
	(0.0008)	(0.0008)	(0.022)
Beta	-0.010***	-0.008**	-0.010
	(0.005)	(0.005)	(0.011)
Capital Intensity	-0.004	-0.005	-0.004
	(0.003)	(0.004)	(0.007)
Liquidity	0.272***	0.286***	0.251***
	(0.050)	(0.073)	(0.064)
Growth	0.020***	0.020***	0.018**
	(0.004)	(0.005)	(0.006)
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	1,566	1,026	540
R^2	0.217	0.221	0.197
Adjusted R^2	0.108	0.108	0.065
F Statistic	42.252*** (df = 9; 1375)	28.208*** (df = 9; 895)	12.587*** (df = 9; 463)

Note: Numbers in parentheses are heteroscedasticity-robust standard errors. ROA = Return on Assets, CEP = Corporate Environmental Performance, sign has been inverted due to square-root transformation, PBV = Price to Book Value
*p<0.1; **p<0.05; ***p<0.01

emission industries, the coefficient turns insignificant. However, no impact of CEP on Tobin's Q can be detected. The findings are in line with previous papers. For instance, Horváthová (2010) and Trinks et al. (2020) find similar evidence that CEP influences ROA positively. Patten (1992) also confirm the finding that the influence is especially pronounced for high-emission industries.

Table 9: Regression 2: CEP on CFP (Tobin's Q) - Industry Subsamples

	Dependent variable:		
		ROA	
		panel linear	
	Total Sample	Low Emission	High Emmission
	(1)	(2)	(3)
CEP (inverted sign)	0.047	-0.009	0.091
	(0.009)	(0.069)	(0.010)
Size	-0.251***	-0.272***	-0.318***
	(0.006)	(0.007)	(0.013)
Leverage	-0.538***	-0.531***	-0.353
	(0.030	(0.036)	(0.045)
R&D Intensity	-0.999**	-2.404***	2.170***
	(0.052)	(0.055)	(0.119)
PBV	0.024***	0.016***	0.148***
	(0.0008)	(0.0007)	(0.002)
Beta	-0.122***	-0.100***	-0.129**
	(0.005)	(0.005)	(0.010)
Capital Intensity	0.071	0.057	0.056
	(0.004)	(0.004)	(0.007)
Liquidity	2.090***	2.720***	1.292***
	(0.051)	(0.073)	(0.064)
Growth	0.065	0.174**	-0.065
	(0.004)	(0.005)	(0.006)
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	1,566	1,026	540
R^2	0.171	0.197	0.322
Adjusted R^2	0.056	0.080	0.210
F Statistic	31.513*** (df = 9; 1375)	24.392*** (df = 9; 895)	24.388*** (df = 9; 463)

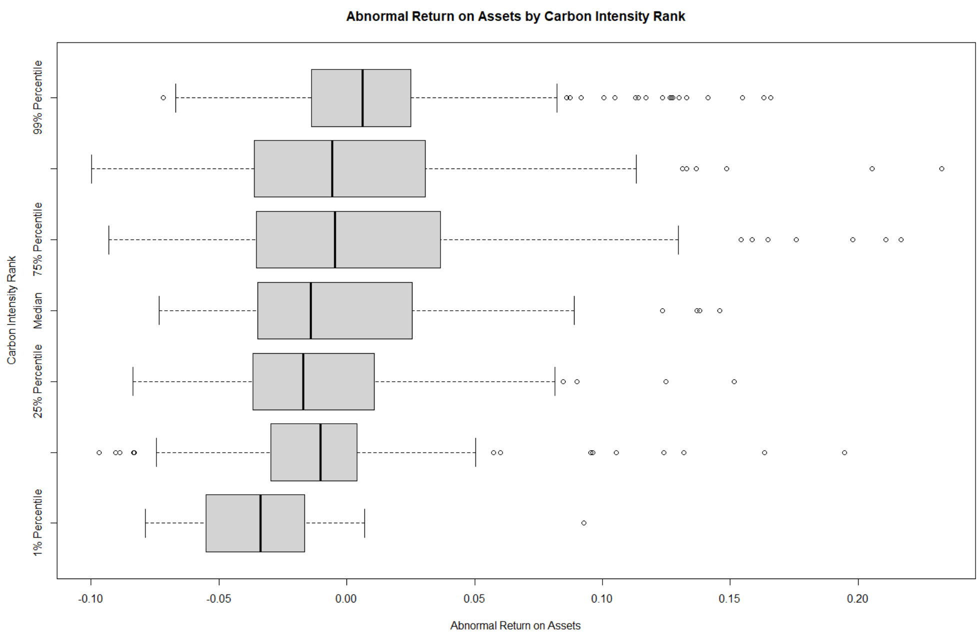
Note: NNumbers in parentheses are heteroscedasticity-robust standard errors. ROA = Return on Assets, CEP = Corporate Environmental Performance, sign has been inverted due to square-root transformation, PBV = Price to Book Value
*p<0.1; **p<0.05; ***p<0.01

5.3 Results Hypothesis 2 and Hypothesis 3

Although neither the total sample nor an industry subsample reveals a connection between CEP and market valuation, there is a significant relationship between CEP and ROA. Therefore, the next phase consists of investigating the variables that influence the impact of CEP on ROA, as stated in the previous Chapters.

Figure 3 depicts the pattern for the return on assets. The observed firms have been categorized and ranked according to their abnormal CEP and compared to firms in the same industry and in the same years, as explained in Chapter 4. Therefore, firms with a high abnormal CEP are ranked higher than firms with a lower abnormal CEP. Based on this information, the firms' ability to generate abnormal returns on assets is investigated. Observing the average, it is evident that the ability to generate abnormal returns on assets decreases as carbon performance decreases. While firms in the 99th percentile of CEP achieve an average at least normal returns on assets, companies in the 1st percentile on average perform worse than their industry counterparts. This pattern is consistent across all CEP categories, except for CEP Ranks 3 and 2. This strengthens the initial hypothesis that firms with superior environmental performance tend to have superior financial performance. The summary statistics for the consolidated high and low CEP Ranks can be found in Table 13 and Table 14 in the Appendix.

Figure 3: Abnormal ROA by CEP Rank



To assess the mechanisms that drive the impact on ROA, financial variables have been compared across the different CEP Ranks, starting with the abnormal return on assets and continuing with the differences in the main drivers for the return on assets, benchmarked by the industry assets. The main investigated drivers are total assets, asset turnover, and operating income. Table 10 summarizes the p-values of the one-sided Wilcoxon test. Based on the findings of the previous investigation, firms with a higher CEP Rank are expected to have a significantly higher abnormal ROA than firms with a lower CEP Rank. Regarding Hypothesis 2, which is derived from the resource-based theory, introduced by Porter and van der Linde (1995), firms with a higher CEP Rank are expected to operate on a smaller, and therefore more efficient asset base compared to their industry peers. Thus, the abnormal total assets are expected to be significantly lower than the abnormal total assets of firms with a lower CEP Rank. Therefore, asset turnover is expected to be higher for companies with a higher CEP Rank. However, if Hypothesis 3 holds true and the impact of CEP on the ROA is driven by external stakeholders, the operating income is expected to be significantly higher for companies with a higher CEP Rank.

In Table 10, Panel A shows that the abnormal return on assets for companies within the best 1% of CEP is significantly higher compared to all other CEP Ranks. Moreover, it can be observed that companies in CEP Rank 1 perform significantly worse in comparison to all other CEP Ranks. This indicates that companies that strongly outperform and underperform their peers in terms of carbon performance also significantly outperform and underperform their peers in terms of financial returns on their assets. Moreover, it becomes evident that companies in CEP Ranks and 6 have a significantly higher financial performance than companies that have a lower carbon performance than the median of their peers (CEP Rank 3 or lower). This effect disappears with lower rankings. For instance, companies in CEP Rank 4 and CEP Rank 3 show no significant difference in their financial performance compared to other companies below the median of CEP performance. Those findings indicate the robustness of the previous investigations and show an observable pattern, which displays that companies with a better carbon performance are also performing better financially compared to their industry peers.

Panel B shows the pattern for abnormal total assets, determined by abnormal total assets. It is observable that the firms in CEP Rank 7 have significantly fewer abnormal assets than companies in lower CEP ranks, except for CEP Ranks 6 and 2. Moreover, for all CEP Ranks, companies have fewer assets than companies in CEP Rank 1. Similar to Panel A, a pattern can be detected. Firms that have a CEP performance below the median of their industry peers do not operate on significantly different asset bases than their industry peers. This pattern holds true for the abnormal asset turnover, strengthening the impression that firms with better carbon performance, compared to their peers, are able to operate with fewer assets while still yielding higher returns on assets. Companies with lower carbon performance, however, require more assets while, on average, underperforming financially compared to their industry peers.

In Panel C, the difference in terms of abnormal operating profits can be observed. According to the external theories and according to Hypothesis 3, companies in higher CEP Ranks are expected to yield higher abnormal profits than their peers. However, Panel C displays a contradicting finding. A result of "1" by the one-sided Wilcoxon test suggests that the average abnormal profit, in this case, is in fact not higher but lower for companies with a higher CEP ranking. Due to the lack of significant results, we can therefore infer that the average abnormal profit for companies with better environmental performance is not higher than for companies with lower environmental performance. When inverting the one-sided Wilcoxon test, it can be found that companies with lower CEP yield significantly higher abnormal profits than firms with better CEP, this means that companies that perform worse in terms of CEP are achieving on average significantly higher operating profits than their industry peers.

Table 10: Significance Levels for one-sided Wilcoxon Test between CEP Ranks

Panel A: Abnorm. ROA is significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.001***					
Rank 5	.003***	.779				
Rank 4	<.001***	.368	.208			
Rank 3	<.001***	.032***	.009***	.092		
Rank 2	<.001***	.029***	.006***	.190	.755	
Rank 1	<.001***	<.001***	<.001***	<.001***	.005***	<.001***

Panel B: Abnorm. Total Assets are significantly lower for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.995					
Rank 5	<.001***	<.001***				
Rank 4	<.001***	<.001***	.000***			
Rank 3	<.001***	<.001***	.032**	.967		
Rank 2	.140	.015	.966	1.000	1.000	
Rank 1	<.001***	<.001***	<.001***	.004***	.003***	<.001***

Panel C: Abnorm. Assets Turnover is significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	<.001***					
Rank 5	.196	.988				
Rank 4	<.001***	.056*	<.001***			
Rank 3	<.001***	.038***	<.001***	.637		
Rank 2	.271	.987	.209	1.000	1.000	
Rank 1	.014**	.555	.119	.866	.805	.055*

Panel D: Abnorm. Profits are significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.074*					
Rank 5	1.000	1.000				
Rank 4	1.000	1.000	1.000			
Rank 3	1.000	1.000	.899	.017		
Rank 2	.355	.790	.001***	<.001***	.001***	
Rank 1	1.000	1.000	.986	.392	.918	.999

Wilcoxcon test investigates the stated hypotheses. *p<0.1; **p<0.05; ***p<0.01

Therefore, the investigation of the impact mechanisms shows that companies that have a superior CEP tend to yield higher returns on assets than their peers, driven by a more efficient use of assets compared to their peers. It can also be inferred that superior CEP leads to inferior profits compared to their peers. However, the magnitude of the higher resource efficiency seems to offset the lower abnormal profits. Therefore, supporting evidence for Hypothesis 2 can be detected, whereas Hypothesis 3 can be rejected, indicating that the theory based on Porter and van der Linde (1995) appears to be a likely explanation for the mechanisms that drive the impact of CEP on CFP.

Table 11: Significance Levels for one-sided Wilcoxon Test between CEP Ranks, Asset Structure

Panel A: Abnorm. Fixed Assets are significantly lower for higher CEP Rank

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.987					
Rank 5	<.001***	<.001***				
Rank 4	<.001***	<.001***	<.001***			
Rank 3	<.001***	<.001***	.001***	.890		
Rank 2	.062*	.059*	.991	1.000	1.000	
Rank 1	<.001***	<.001***	<.001***	.003**	.015**	<.001***

Panel B: Abnorm. Current Assets are significantly lower for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.999					
Rank 5	.013**	<.001***				
Rank 4	<.001***	<.001***	<.001***			
Rank 3	.029**	<.001***	.174	.999		
Rank 2	.005***	<.001***	.351	1.000	.537	
Rank 1	<.001***	<.001***	<.001***	.015**	<.001***	<.001***

Wilcoxon test investigates the stated hypotheses. *p<0.1; **p<0.05; ***p<0.01

Corporate assets can be divided into short-term assets, such as inventories, and long-term assets, such as properties, plants, and equipment. Table 10 shows that companies with a higher CEP Rank require fewer assets to yield abnormal returns than companies with a lower CEP Rank. Thus, Table 11 provides an overview, comparing the abnormal fixed assets in Panel A and the abnormal current assets in Panel B. Table 11 shows a similar pattern to Table 10. Companies in CEP Rank 6 and 7 are able to operate on fewer current and fixed assets than their industry peers. The pattern holds partly true for companies in CEP Rank 5 and disappears for companies in the lower CEP Ranks. In other words, companies with a better carbon performance than the median of their industry peers have both fewer fixed assets and fewer current assets than their peers.

Due to the fact that the investigation of the mechanisms underlying the influence of CEP on CFP is currently built on descriptive statistics, two major theoretical limitations become apparent. First, endogenous factors that are not visible in the summary statistics and subsample comparisons may have an impact on the results. Second, the observed effects may be the result of reverse causality; it cannot be determined whether the superior carbon performance is the true cause of the observed effects. To address endogeneity issues, the observations in Tables 10 and 11 are based not only on a single year's observation but on the ten-year average observation. The fact that, for instance, the quality of management within a company influences both the environmental performance and the financial performance is a major concern (Busch et al., 2022a). Consequently, this concern can be mitigated by relying on the average value across multiple years. If poor management is the cause of poor carbon and financial performance, it can be assumed that management will be replaced. Over a period of ten years, it is expected that this issue has been addressed and can therefore be considered as accounted for in the results.

5.4 Results Hypotheses 4a, 4b, and 4c

To investigate the causal relationship between CEP and CFP, a second fixed effects regression model is employed with two-year time lags for CEP. If superior carbon performance is the cause of more efficient use of assets, then the historic CEP is expected to have an effect on the current asset base. In other words, if CEP is a predictor of efficiency, then reducing carbon emissions in the past is likely to have resulted in increased efficiency and, consequently, a decreased asset base today.

The outcomes of this regression are displayed in Table 12. The results exhibit that only the first lag of the inverted CEP show an impact on total assets and operating profit. This essentially means that higher CEP leads to higher operating profit and higher total assets, which shows ambiguous results compared to the initial findings which might be caused by the inclusion of lags of the dependent variable.

However, when extending the Granger tests by using abnormal values as dependent variables and when extending the time period to five years, different results can be observed. For the interaction between CEP, ROA, and operating profits, no significant relationship can be detected. However, in the interaction between the CEP for a period of five years and the abnormal assets for a company, a p-value of 0.037 can be detected. This shows a significant result for the explanatory power of previous CEPs for the future outcome of abnormal assets. Expanding this test for the distinction between abnormal current assets and abnormal fixed assets, the interaction with abnormal current assets shows no significant outcome, whereas the interaction with abnormal fixed assets shows a p-value of 0.013. This implies that previous values of CEP have no impact on future abnormal current assets, however, there is indeed explanatory power for future fixed assets. Performing inverse Granger tests, no significant results can be observed. Therefore, previous levels of CEP are useful to predict the future value of abnormal total assets and, more specifically, the future value of abnormal fixed assets. At the same time, previous values of abnormal (fixed) assets cannot be used to predict the future value of CEP. Hence, it is unlikely that reverse causality is present. When using other time frames, lower than five years, the effect

Table 12: Regression 4: Lagged CEP on Financial Indicators

	Dependent variable:		
	ROA	Total Assets	Operating Profit
	panel linear	*panel linear*	*panel linear*
	(1)	(2)	(3)
ROA t-1	0.631***		
	(0.051)		
ROA t-2	-0.141***		
	(0.031)		
Total Assets t-1		0.749***	
		(0.031)	
Total Assets t-2		-0.013**	
		(0.006)	
Operating Profit t-1			0.355***
			(0.060)
Operating Profit t-2			-0.076***
			(0.026)
CEP (inverted sign) t-1	-0.004	-0.083**	-0.209*
	(0.004)	(0.100)	(0.144)
CEP (inverted sign) t-2	0.001	0.009	-0.106
	(0.003)	(0.028)	(0.083)
R&D Intensity	-0.037	0.231	-0.611
	(0.030)	0.272)	(0.587)
Leverage	-0.019	-0.171**	-0.036
	(0.015)	(0.101)	(0.225)
PBV	0.0003	0.002	0.009*
	(0.0005)	(0.002)	(0.004)
Beta	-0.005*	0.028**	-0.023
	(0.004)	(0.018)	(0.063)
Capital Intensity	-0.004	0.003	-0.033
	(0.003)	(0.020)	(0.060)
Liquidity	0.038*	0.153	1.560***
	(0.024)	(0.207)	(0.575)
Growth	0.012***	0.089***	0.364***
	(0.003)	(0.025)	(0.056)
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	1,566	1,566	1,566
R^2	0.404	0.609	0.231
Adjusted R^2	0.321	0.555	0.123
F Statistic	84.676*** (df = 11; 1373)	214.281*** (df = 10; 1374)	37.420*** (df = 11; 1373)

Note: Numbers in parentheses are heteroscedasticity-robust standard errors. CEP = Corporate Environmental Performance, sign has been inverted due to square-root transformation, PBV = Price to Book Value

*p<0.1; **p<0.05; ***p<0.01

disappears. This leads to the conclusion that changes in CEP affect the amount of abnormal fixed effects in the long run. Although the effects are small, they support the conclusion that there might be a causal relationship in the long run.

6 Discussion

The investigations show mixed results. A significant impact of corporate environmental performance on return on assets can be found, indicating that improved corporate performance leads to an increase in ROA. This finding holds true for high-emission industries, confirming the findings of Patten (1992) that companies in industries, where carbon emissions play a bigger role, are more sensitive to carbon emissions with respect to the impact on financial performance. However, similar to Trinks et al. (2020) no relationship between carbon emissions and market valuation can be detected, neither for the whole sample nor for subsamples. Therefore, it can be inferred that investors are not significantly valuing the carbon emission performance of firms, but it seems likely that CEP is a driver of corporate efficiency, reflected in the return on assets. A closer investigation of this matter shows supporting results. First, it can be found that financial characteristics between firms differ significantly when observing different levels of CEP. Companies with the highest level of CEP compared to their peers report significant abnormal returns on assets compared to their industry peers. This result remains robust for all firms that perform better in terms of carbon emissions than the median of their industry. Firms that have lower carbon performance compared to their industry peers show no significant abnormal returns compared to their industry. It can also be stated that firms with higher carbon performance yield, on average, lower operating income than their peers. Consistent with those findings, it can be shown that the significantly higher returns on assets are driven by a more efficient asset base since those companies have significantly fewer abnormal total assets and higher asset turnovers compared to their peers while outperforming their industry financially. Observing the impact of lagged carbon performance on financial performance, no robust results, for the first two years, can be observed. However, when extending the time period to five years, CEP seems to serve as a predictor for abnormal assets, especially for abnormal fixed assets while the tests can rule out reverse causality. Thus small for a causal relationship between CEP and CFP can be found even though the direction is unclear. It remains unclear if improved CEP increases or decreases total assets in the long run. The theory and the findings for Hypotheses 1a and 2 suggest that improved CEP might decrease the level of abnormal assets in the future.

The findings, therefore, suggest that the main driver of the relationship between CEP and CFP is not linked to an improved relationship with corporate stakeholders but to improved operational efficiency. This conclusion can be strengthened by the fact that CEP has no detectable impact on the market valuation of the investigated firms. If stakeholders, like the regulators, society, and capital providers, have a better perception of the company, this improved perception would be expected to yield an increase in operating profit and in market valuation since stakeholders are more confident to invest in the company, either in terms of providing capital, increasing labor productivity, or increasing revenues. In fact, it is shown that better financial performance leads to lower abnormal profits within a firm's respective industry. This finding confirms that decreasing GHG emissions is a costly endeavor (Walley and Whitehead, 1994). However, firms with superior carbon performance compared to their peers also outperform their peers financially and carbon performance might serve as an approximation for a more efficient use of assets. Therefore, evidence in favor of H1a, H2, and H4b can be found, whereas H1b, H2, H4a, and H4c can be rejected, based on this investigation.

These findings have implications for the academic discussion on the nexus of carbon performance and for practitioners. For the academic discussion, this finding is another contributor to the literature stream based on the resource-based view established by Porter and van der Linde (1995). It strengthens the theory that Porter and van der Linde (1995) develop regarding the reason for the observed impact. It is likely that the positive impact is driven more by a more efficient use of assets than by an improved relationship with corporate stakeholders. The findings show that improved carbon performance serves as an indicator of how efficient and resource-efficient companies are currently performing regarding their operations. On the other side, it shows that maintaining a high carbon performance is costly in terms of profit compared to industry peers. Hence, the results help to structure the theoretical considerations and the observations made in previous studies. Based on this research, the externally oriented theories, focusing on stakeholders, may be particularly relevant for carbon disclosure topics; however, those theories only play a minor role in terms of the actual impact of carbon performance on financial performance. The performance impact appears to be primarily driven by efficiency. In other words, in further studies, theoretical considerations can be split: stakeholder-oriented theories are found to have appropriate explanatory power for the provision of information to stakeholders as disclosure, whereas resource-based theories are likely to explain the observed financial merits that an improved carbon performance brings along. Thus, it can be concluded that the main mechanism that drives the relationship between CEP and CFP is increased resource efficiency.

For practitioners, these findings can be encouraging. Generally speaking, improving carbon performance is a costly decision (Palmer et al., 1995; Walley and Whitehead, 1994) which can also be observed in this thesis. Although it cannot be concluded that improving carbon performance will yield higher market valuation or that it will necessarily cause an immediate increase in return on assets, it became evident that firms that take care of their carbon performance are likely to operate more efficiently in general. Therefore, reducing carbon intensity should not only be considered an altruistic endeavor but also an opportunity to review the efficiency of internal processes and general resource efficiency. Therefore, if practitioners follow the idea of Porter and van der Linde (1995), having a high abnormal carbon intensity compared to their industry peers might be an indicator of inefficiency in terms of waste and potentially superfluous assets. Walley and Whitehead (1994) claim that it is unlikely that investing in a reduction of carbon emissions is a win-win game where the investments will capitalize on increased financial returns.

This claim holds true; however, facilitating innovations to reduce carbon emissions is likely to yield other process improvements that can lead to an overall increase in efficiency, especially with the steadily increasing awareness about environmental performance. However, reflecting on the current level of public attention on environmental topics, the observed pattern regarding the impact mechanisms between CEP and CFP might change over time. It cannot be ruled out that stakeholder-based theories will play a bigger role in the future when seeking to understand the impact of CEP on CFP.

The approach embodies several limitations and directions for further research. First, to evaluate the impact of external theories, operating income is used as a composite measure of stakeholder-induced income. As mentioned, treating stakeholders as a homogenous group that affects the operating income can serve as an approximation; however, in order to understand the impact that is driven by shareholders in more detail, those effects could be disentangled. Thus, further studies can expand this approach by not only relying on operating income as a composite measure but on multiple measures for each relevant group of stakeholders, such as labor productivity, cost of debt, cost of equity, and supplier impacts. Moreover, these results can be treated as insights into the characteristics that drive the relationship between CEP and CFP. The initial approach of using time-lagged variables of CEP in order to establish an assessment of potential causality can be extended in two ways. For example, a difference-in-difference approach can be used to compare two distinct samples where companies in one sample improve their carbon performance over the course of multiple years while the companies in the other sample maintain a constant CEP level. This approach could add more insights into questions about causality in the detected relationship. Hence, after identifying the mechanisms behind the impact of corporate environmental performance on carbon financial performance, the investigation of causality and the time horizon in which those effects capitalize is a main field for future research. Further, a mixed approach, consisting of a qualitative in-depth investigation of corporate carbon policies and the subsequent financial impacts can lead to a more detailed understanding of the topic.

This study is subject to empirical limitations. First, even though lagged variables have been used in the regression, the models might still suffer from an omitted variable bias. Moreover, as it has been pointed out by Busch et al. (2022b) the data for carbon emissions differs between different sources, therefore, the results might deviate when relying on carbon data provided by other sources. Furthermore, Anquetin et al. (2022) analyze the GHG data reported by Refinitiv and concludes that it deviates from other sources; therefore, they conclude that the data might suffer from a self-reporting bias since it is based on actual reported data of companies, so data quality can be an issue for this investigation. Lastly. the sample uses data between 2013 and 2022 and investigates 174 companies. Therefore, the sample size might be too small to reach general conclusions and the sample might not be able to capture all the recent tendencies. Due to the mentioned public awareness, a more recent sample might lead to results more in favor of the stakeholder-based theories.

7 Conclusion

This study examines the relationship between carbon emissions, environmental performance, and corporate financial performance. Using a fixed-effects regression model, evidence can be found that the obtained Stoxx Europe 600 sample between 2013 and 2022 exhibits a significant positive relationship between corporate environmental performance and return on assets. These findings are robust to various control variables. Furthermore, when dividing the sample into industries with high and low carbon emissions, the observed effect remains consistent for high-carbon emission industries while becoming insignificant for low-carbon emission industries. However, the data do not indicate a significant relationship between corporate environmental performance and the market valuation of companies, as measured by Tobin's Q.

Based on these results and building upon theoretical considerations outlined in previous research papers, it can be observed that companies with a carbon performance above the industry average not only outperform their industry counterparts in terms of return on assets but also exhibit significantly lower asset levels compared to the industry average. Additionally, the analysis showed that companies with higher carbon performance tend to yield, on average, lower operating profits than their industry peers, indicating that the enhanced carbon performance might be linked to increased costs. Therefore, the superior performance in terms of return on assets can therefore be attributed to the reduced asset levels, which suggest a more efficient utilization of resources.

Finally, by employing a regression model that incorporates two-year lags of carbon performance, no evidence for a causal relationship between carbon environmental performance, financial performance, superfluous assets, and abnormal operating profits can be detected. When expanding the Granger tests to a five-year setting, CEP appears to be a significant predictor for abnormal total assets. In conclusion, this study demonstrates that companies with superior carbon performance generally exhibit better financial performance, which is primarily attributed to their efficient utilization of assets. Therefore, it can be concluded that even though higher CEP comes with the cost of lower operating income it might lead to efficiency gains in the long run, in the sense that the lower operating profits can be offset. Thus, companies do not necessarily have an incentive to increase their carbon performance in order to yield immediate results, however, having a superior carbon performance can be interpreted as a sign of higher efficiency. Therefore, companies with inferior carbon performance should use this as a starting point to question their overall process efficiency and aim for improved carbon and financial performance in the long run.

A Appendix

A.1 Model Assumptions - Linearity

Figure 4: Variable Distribution - Return on Assets

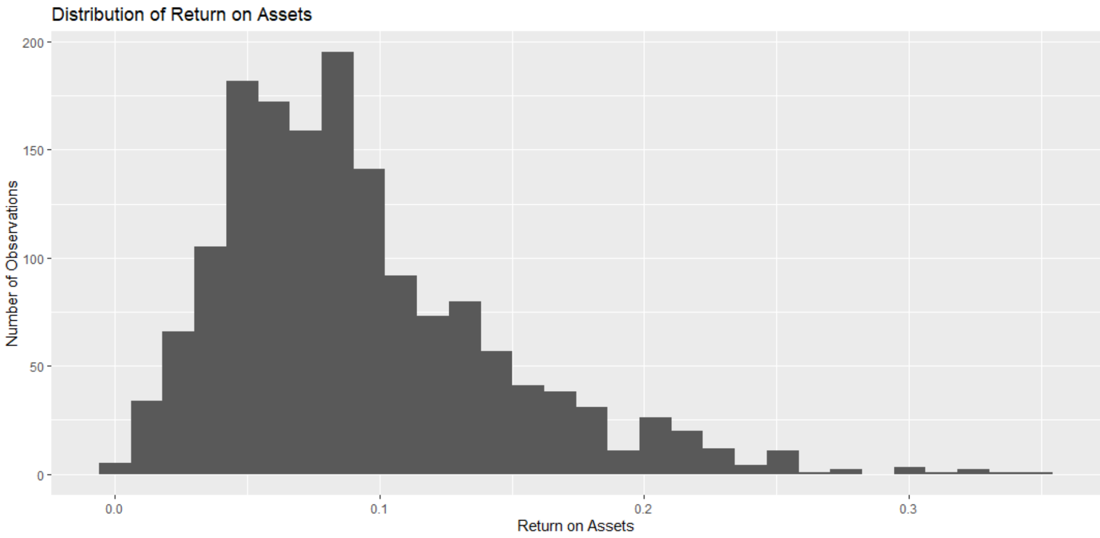


Figure 5: Variable Distribution - Size

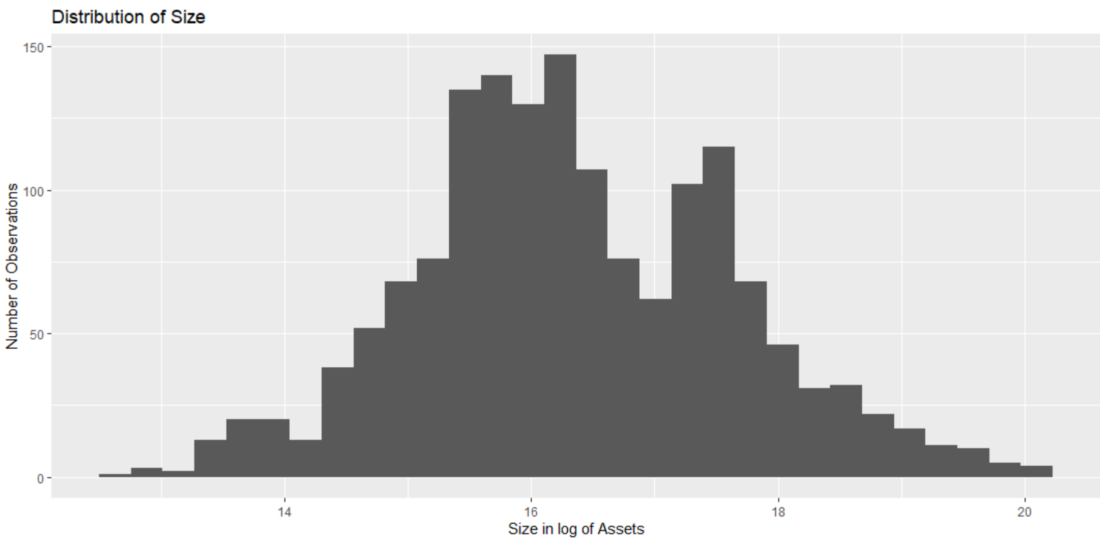


Figure 6: Variable Distribution - Tobin's Q

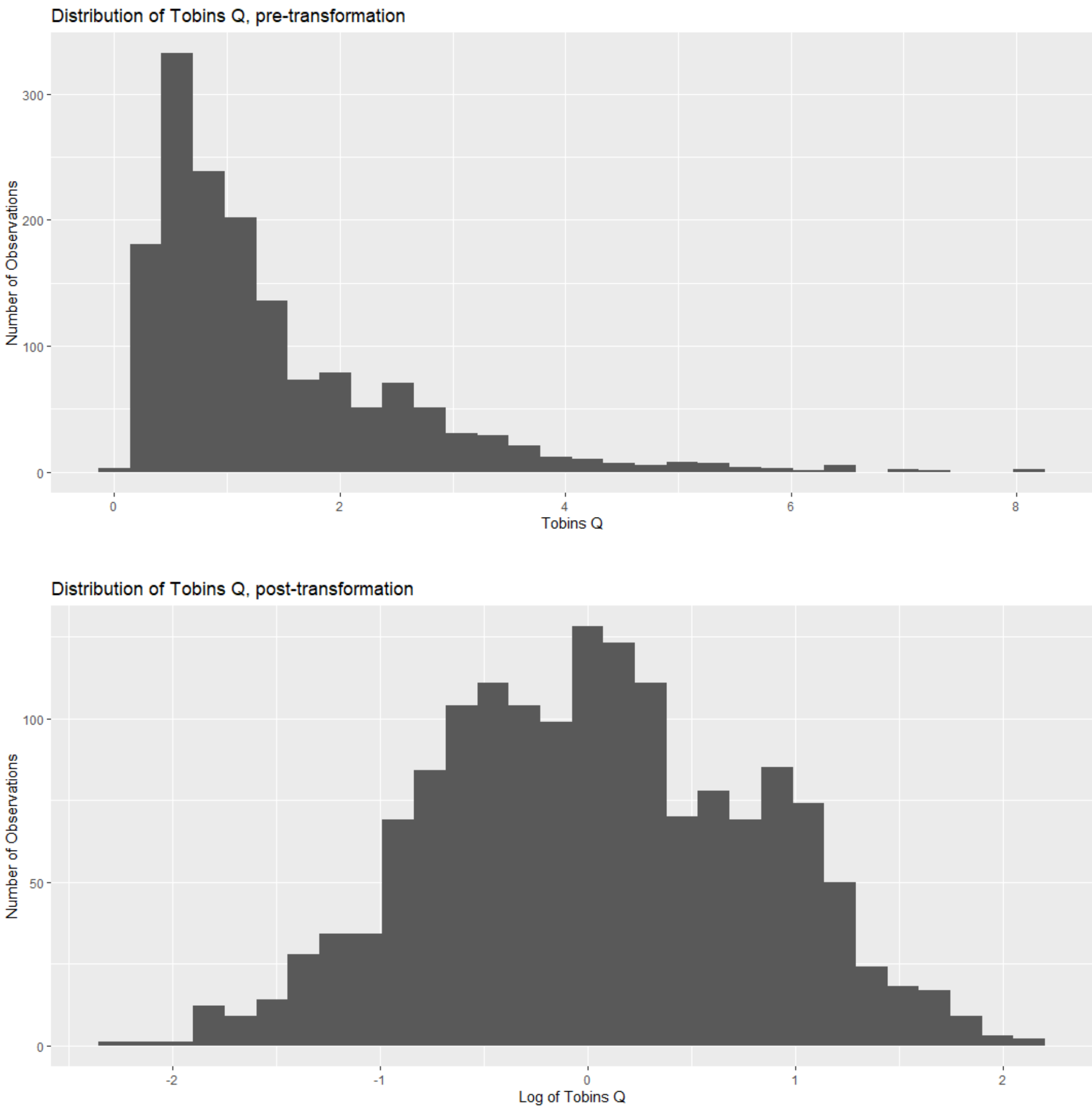


Figure 7: Variable Distribution - CEP

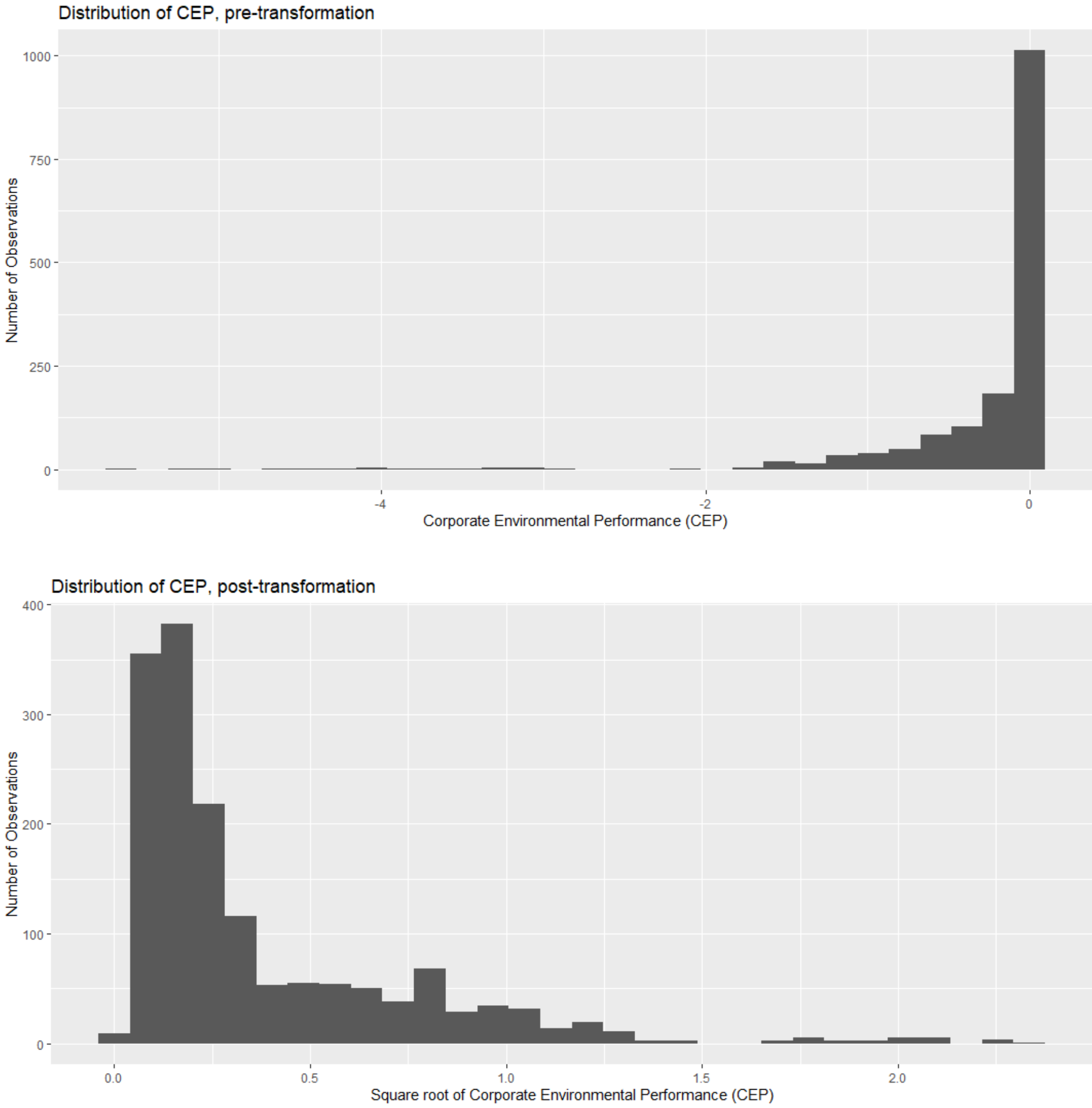


Figure 8: Variable Distribution - Leverage

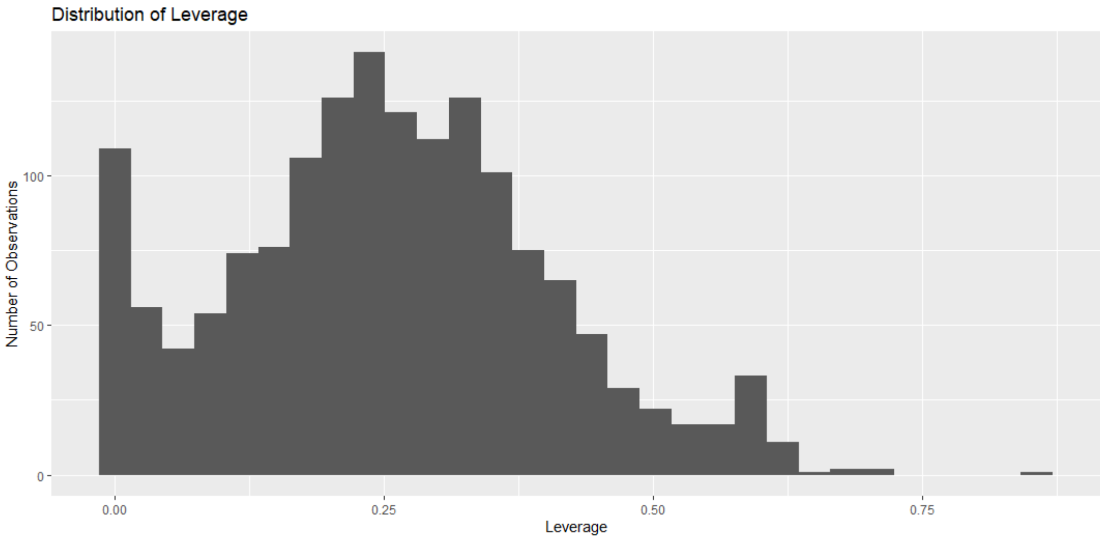


Figure 9: Variable Distribution - R&D Intensity

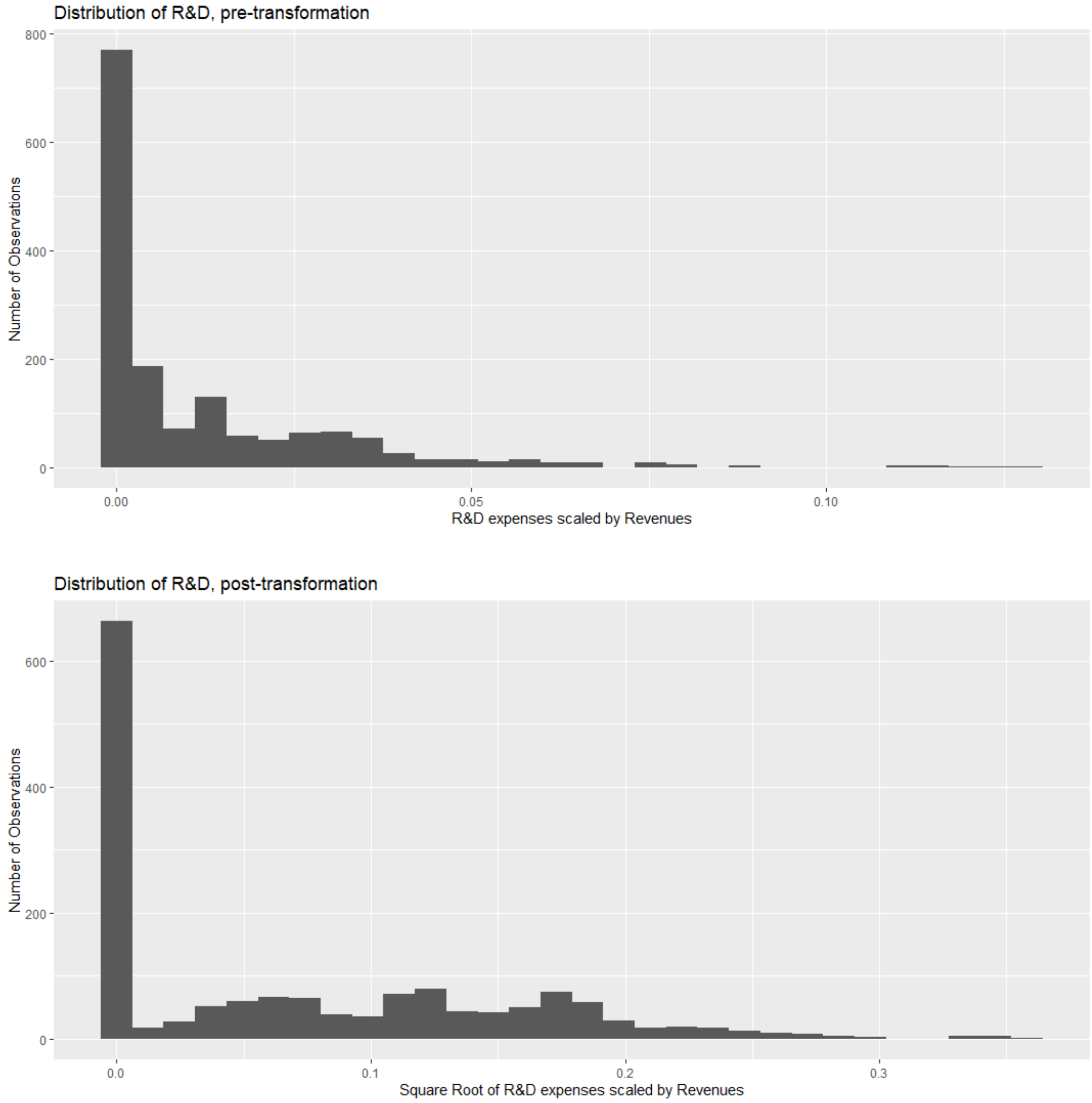


Figure 10: Variable Distribution - PBV

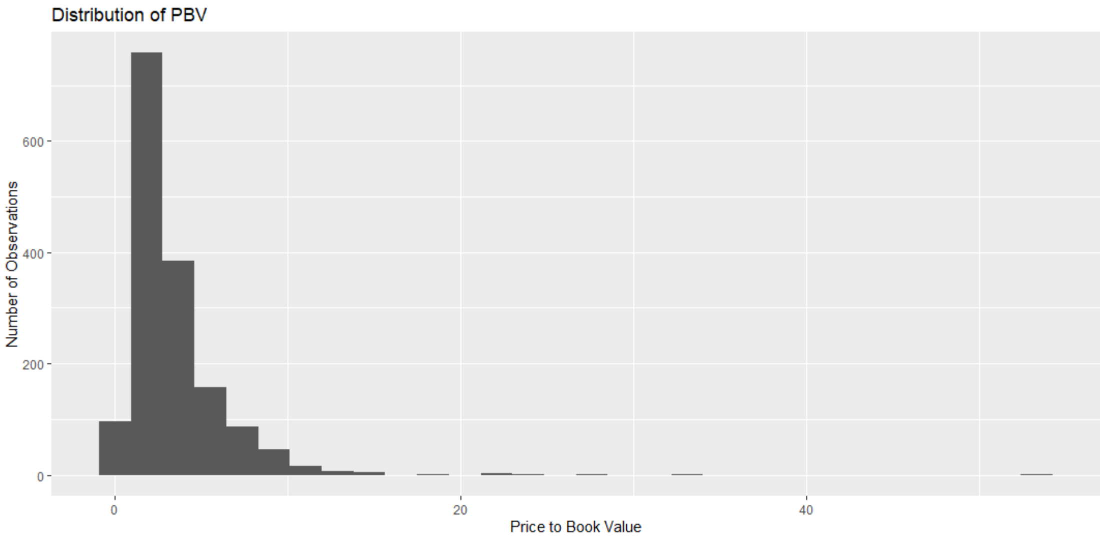


Figure 11: Variable Distribution - Beta

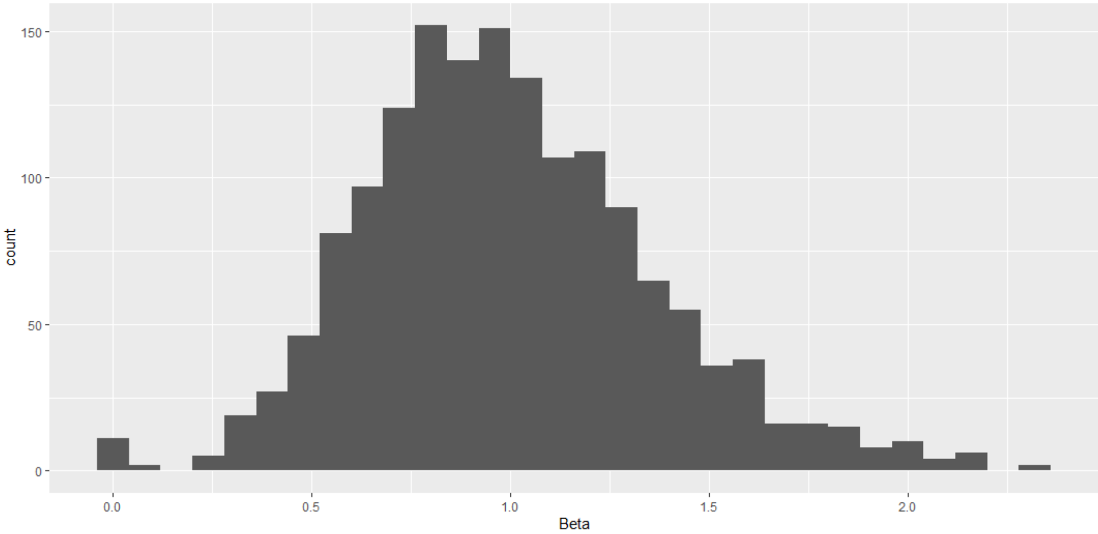


Figure 12: Variable Distribution - Capital Intensity

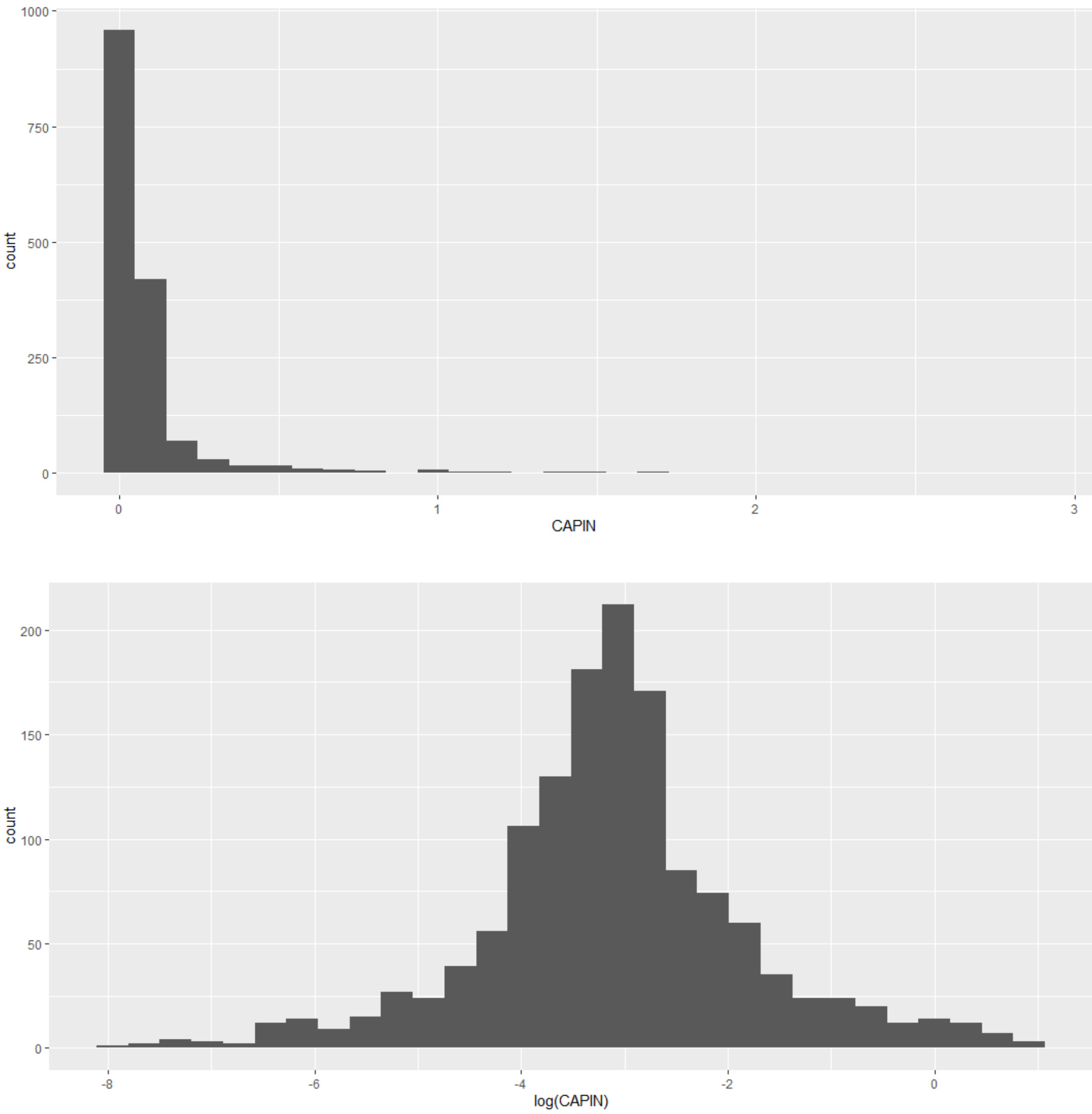
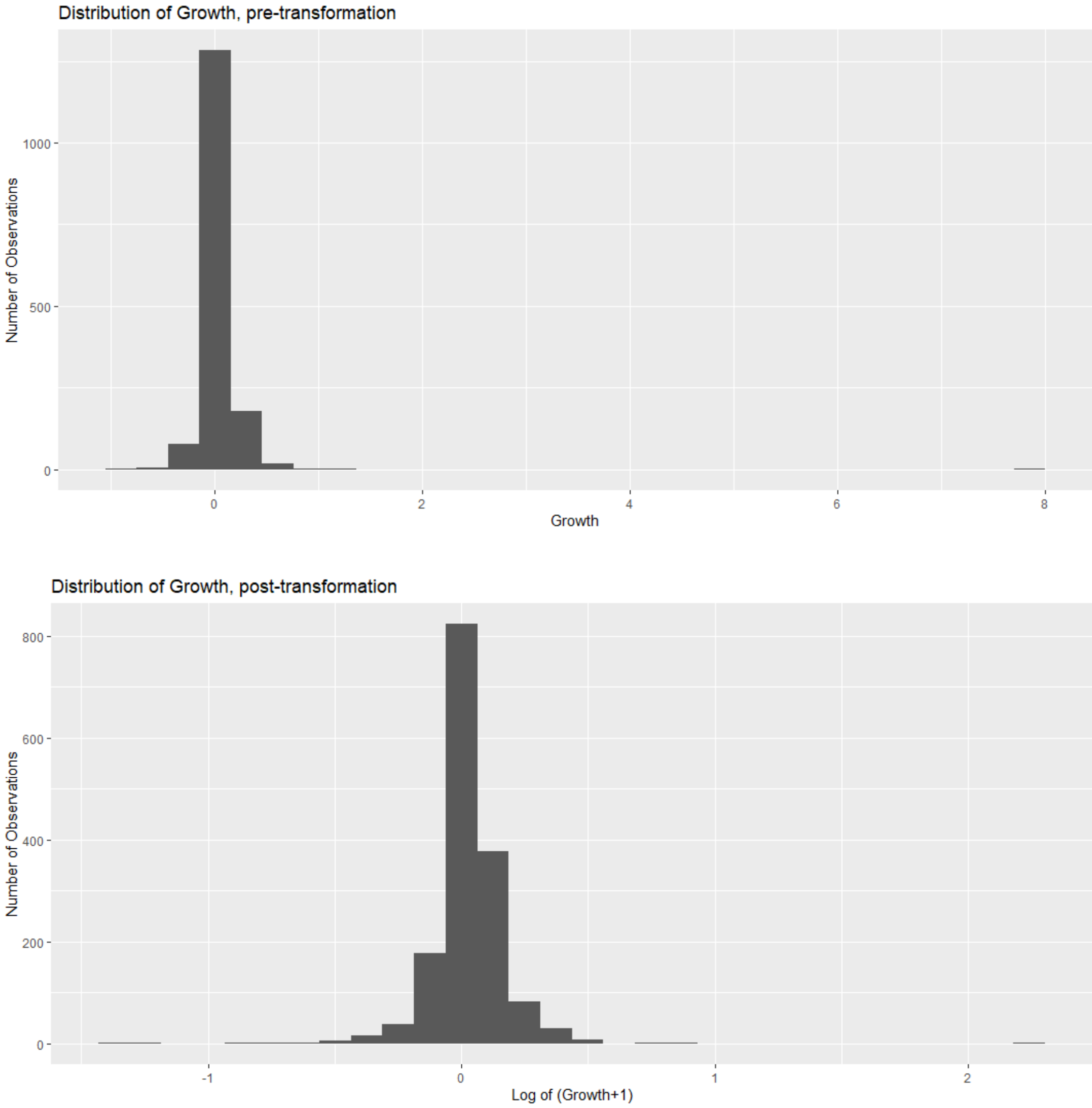


Figure 13: Variable Distribution - Growth



A.2 Additional Information

Figure 14: Heterogenity of CEP variable across Countries, Industries and Years

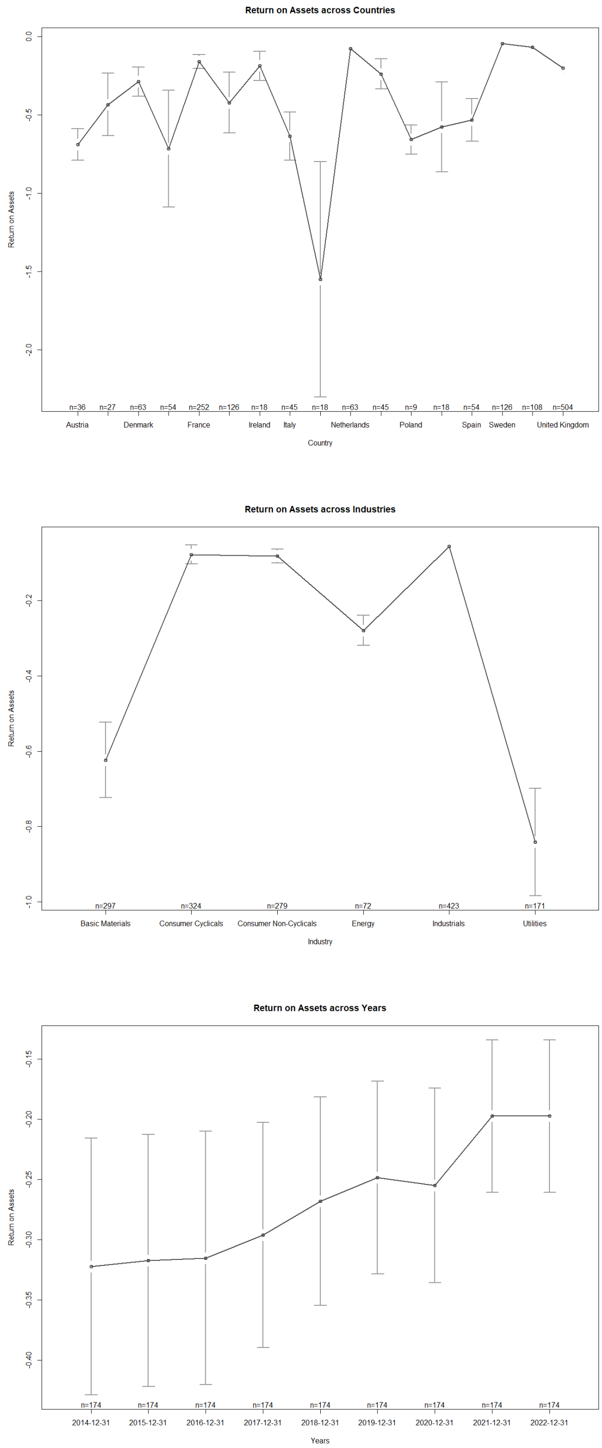


Table 13: Descriptive Statistics CEP Ranks 1-4 - Low Carbon Performance

Statistic	ROA	Abnormal ROA	Tobins Q	CEP	Abnormal Assets	Abnormal Profit	Abnormal Margin	Abnormal Asset-Turnover
N	513	513	513	513	513	513	513	513
Mean	0.081	−0.006	1.055	−0.630	8,320,126	631,771	0.014	−0.144
St. Dev.	0.050	0.045	0.913	0.902	51,844,944	3,977,753	0.183	0.278
Min	0.0002	−0.097	0.100	−5.604	−77,965,773	−8,893,413	−0.405	−0.938
Max	0.298	0.195	7.113	−0.018	281,133,756	22,558,581	0.598	0.612

Table 14: Descriptive Statistics CEP Ranks 5-7 - High Carbon Performance

Statistic	ROA	Abnormal ROA	Tobins Q	CEP	Abnormal Assets	Abnormal Profit	Abnormal Margin	Abnormal Asset-Turnover
N	1,053	1,053	1,053	1,053	1,053	1,053	1,053	1,053
Mean	0.097	0.004	1.548	−0.092	−4,606,540	−319,302	−0.004	0.062
St. Dev.	0.053	0.050	1.220	0.174	51,999,746	2,666,193	0.193	0.623
Min	0.003	−0.100	0.155	−1.198	−98,726,725	−10,233,953	−0.406	−0.904
Max	0.349	0.233	8.216	−0.001	470,685,504	15,001,358	0.559	3.216

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B Summary

B.1 Introduction

Climate change is one of the most challenging issues for humanity. Due to its importance, politicians, non-governmental organizations, and supranational bodies have made addressing climate change a top priority. In 2015, 196 parties signed the legally binding Paris Agreement and committed to limiting the global average temperature increase to a maximum of 2°C compared to pre-industrial levels (United-Nations, 2015).

To achieve the goals of the Paris Agreement, the role of companies in contributing to the reduction of greenhouse gas emissions has gained public attention. Previous research shows that 71% of GHG emissions since 1988 can be attributed to just 100 companies. Even though those companies are all operating in the energy sector, this highlights the importance of companies with respect to reaching the anticipated climate goals. (Carbon-Disclosure-Project, 2017). As a result, corporate environmental performance has become a point of interest not only among investors but also in academic research. Researchers have examined the relationship between corporate carbon policies and financial performance. Some argue that reducing carbon performance harms shareholder value (Walley and Whitehead, 1994) while others claim that efficient carbon policies can enhance resource efficiency and, therefore, financial performance (Porter, 1991; Porter and van der Linde, 1995).

The academic literature on carbon policies has expanded, with studies exploring, for instance, the impact of carbon policies on financial performance, labor productivity, and the cost of capital (Ambec and Lanoie, 2008; Horváthová, 2012; Busch and Hoffmann, 2011; Orlitzky et al., 2003; Margolis and Walsh, 2003; Aragón-Correa and Sharma, 2003). However, there is a lack of comprehensive studies that test the conceptual frameworks empirically. Existing empirical tests led to mixed results, providing limited explanations for the observed relationships between corporate environmental performance and financial performance; thus, the understanding of the mechanisms that underlie the effect that carbon policies have on financial performance remains ambiguous.

This thesis aims to contribute to existing research by systematically analyzing the mechanisms underlying the influence of corporate environmental performance on financial performance with a holistic approach. By identifying the driving mechanisms, the study improves the understanding of the subject and improves the information for managerial decision-making. Therefore, the Stoxx Europe 600 index with a time period from 2013 to 2022 is used. Based on existing theoretical concepts, hypotheses on how corporate environmental performance affects financial performance are synthesized. A fixed-effects linear regression model is used to analyze the initial relationship. Moreover, subsamples based on carbon performance are evaluated to draw conclusions about the mechanisms of the impact of carbon policies on financial performance. Additionally, a Granger causality model with multiple time lags is used to explore potential causal relationships between environmental performance and financial performance. By shedding light on this topic, this thesis provides valuable insights for academic research and managerial decision-making in the context of addressing climate change.

B.2 Literature and Hypotheses

B.2.1 Literature Review

Corporate environmental performance (CEP) and its impact on corporate financial performance (CFP) have been extensively studied. One of the major theories, established by Porter and van der Linde (1995) suggests that well-designed environmental regulations can enhance a company's competitiveness, leading to improved financial returns. They argue that such regulations can drive innovation in processes and products, resulting in increased efficiency or value creation. This theory identifies two mechanisms: "process offsets," where companies innovate to use resources more efficiently, and "product offsets," where companies improve for instance product design to minimize waste and resource consumption. Ultimately, these innovations can enhance a company's competitive position, and, therefore, positively influence its financial performance.

Walley and Whitehead (1994) however, argue that environmental initiatives are associated with high costs, primarily burdening firms instead of benefiting their financial performance. Palmer et al. (1995) emphasizes the need for careful cost-benefit analyses to prevent negative effects on CFP. In response to these perspectives, Ambec and Lanoie (2008) propose a conceptual framework that expands the framework of Porter and van der Linde (1995).

Another theoretical perspective is based on the literature on carbon disclosure. This perspective suggests that the impact of carbon policies on CFP is driven by stakeholder interaction rather than operational efficiency. Three main theories support this viewpoint. The legitimacy theory, based on Dowling and Pfeffer (1975); Freeman (1984), and Ambec and Lanoie (2008), explores how companies align their decisions with prevailing stakeholder values to enhance their societal acceptance. Thus, companies strive to improve their carbon performance by reducing emissions. The signaling theory, connected to voluntary disclosure, suggests that companies signal their superior performance by disclosing carbon-related information to the market and stakeholders, resulting in short-term financial benefits. Lastly, the agency theory argues that disclosing carbon-related information reduces information asymmetry and associated agency costs (Zhang and Liu, 2020).

In summary, there are two primary branches of theory regarding the impact of CEP on CFP. The first, based on Porter and van der Linde (1995), emphasizes the link between superior environmental performance, increased efficiency, and enhanced financial performance. The second branch, based on Ambec and Lanoie (2008); Downar et al. (2021) and Jensen (2001) highlights the importance of stakeholder interaction and the potential positive impact of CEP on CFP through improved relationships.

Despite a multitude of conceptual studies, empirical findings on the impact of CEP on CFP remain inconclusive. Busch et al. (2022b) and Velte et al. (2020) provide overviews of empirical results, with the majority of studies indicating a positive correlation between CEP and CFP, while a smaller proportion shows a negative correlation or no significant relationship. Studies by Trinks et al. (2020); Horváthová (2010) and Konar and Cohen (2001) find positive impacts of carbon efficiency on certain financial metrics, while others like Delmas et al. (2015) find mixed results, with short-term benefits and long-term value decreases for high-carbon-emitting industries. Bus, on the other hand, show a negative impact on both return on assets and market valuation, suggesting a lack of financial incentives for companies to improve their carbon performance.

The link between conceptual frameworks and empirical findings remains ambiguous. Busch et al. (2022a) attributes the negative impact of CEP on CFP to a lack of investor pressure and incentives for companies to enhance their environmental performance. Horváthová (2010) suggests that the time required to amortize the costs of CEP initiatives might explain the long-term impact on CFP. However, there is currently no empirical study systematically combining conceptual frameworks with empirical findings to investigate the driving mechanisms behind this relationship in a holistic manner.

B.2.2 Hypotheses Development

Four hypotheses are investigated to bridge the gap between conceptual and empirical studies. Building on theories based on the ideas of Porter and van der Linde (1995) and Dowling and Pfeffer (1975) and Ambec and Lanoie (2008), a positive impact of corporate environmental performance (CEP) on corporate financial performance (CFP) is expected, as supported by previous empirical studies (Trinks et al., 2020; Horváthová, 2010). Following the framework of Porter and van der Linde (1995) it can be expected that companies with a better carbon performance use their resources more efficiently and therefore yield a higher ROA.

H1a: Companies with better corporate environmental performance yield a higher ROA

Based on stakeholder-oriented theories, the relationship between corporate environmental performance (CEP) and corporate financial performance (CFP) is primarily manifested in external relationships, particularly in signaling performance to shareholders. Previous studies have indicated that shareholders value the environmental performance of companies, leading to a higher market valuation and Tobin's Q for firms with better environmental performance. These findings align with studies Delmas et al. (2015) and Konar and Cohen (2001), supporting the expectation of a positive impact of CEP on market valuation.

H1b: Companies with higher corporate environmental performance yield a higher Tobins Q

The primary measure of CFP in the empirical field examining the relationship between CEP and CFP is ROA. ROA is an accounting-based ratio and provides a reliable measure of financial performance compared to more opaque measures like market valuation or stock market performance. Therefore, ROA is used as a starting point to analyze the driving mechanisms behind the relationship. The resource-based theory, as proposed by Porter and van der Linde (1995), is primarily associated with the asset base of a company. According to this theory, companies that improve their CEP through innovation and increased efficiency require fewer assets for their operations, leading to higher returns on assets compared to their peers. In summary, the resource-based theory suggests that companies with superior CEP will demonstrate higher efficiency and require fewer assets for their operations, resulting in higher returns on assets.

H2: Firms with superior CEP require fewer assets to yield similar or higher financial returns than their peers

According to stakeholder-based theories, the impact of corporate environmental performance on corporate financial performance is driven by the perception of key stakeholders rather than solely by operational efficiency. Various stakeholder groups, including shareholders, employees, and customers, play a crucial role in shaping the relationship between CEP and CFP. In terms of shareholders and capital providers, studies by Bui et al. (2020) and Gerged et al. (2021) indicate that firms with lower carbon intensity are rewarded with lower costs of capital, while those with higher carbon intensity are penalized with higher costs of capital. Additionally, Kleimeier and Viehs (2016) find that companies with higher carbon emissions experience increased costs of debt. These findings suggest that improved perception among capital providers can lead to lower financing costs and improved availability of capital. Concerning employees, research by Woo et al. (2014) and Delmas and Pekovic (2013) show that pursuing environmental actions and incorporating environmental standards can enhance labor productivity. This indicates that improved perception among employees can result in either lower labor costs or increased product output, ultimately impacting the firm's financial performance positively. When considering the stakeholder group of customers, Servaes and Tamayo (2013) reveal that companies with high customer awareness and better corporate social responsibility (CSR) performance tend to generate higher returns on their assets by being able to charge higher prices for their products. This suggests that higher revenues, driven by improved customer perception, can directly affect a company's financial performance. According to these stakeholder-based theories, the increase in operating profit that results from improved relations with corporate stakeholders is what primarily drives the impact of CEP on CFP. The improved perception by capital providers, employees, and customers ultimately translates into either reduced costs or increased revenues, impacting the firm's overall financial performance positively.

H3: Firms with superior CEP yield higher operating profits than their peers

To improve the understanding of those results, it is investigated whether there is any evidence for a causal relationship between CEP and CFP. Based on Nelling and Webb (2009) a Granger causality approach is used to investigate the potential causality of the relationship.

H4a: The carbon performance in the past serves as a predictor for abnormal returns on assets

H4b: The carbon performance in the past serves as a predictor for higher efficiency and therefore lower levels of assets compared to industry peers

H4c: The carbon performance in the past serves as a predictor for higher operating profits compared to industry peers

B.3 Data and Methdology

B.3.1 Data

This study utilizes a European dataset, which is less commonly explored in the existing literature, where studies have predominantly focused on multinational settings or the USA. The sample consists of the Stoxx Europe 600, and provides a comprehensive overview of European firms with high market capitalizations. To mitigate biases from exceptional events or crises like the COVID-19 pandemic, panel data spanning from 2013 to 2022 is used, resulting in a ten-year observation period. To ensure the analysis focuses on industries with significant carbon emissions, industries such as finance, real estate, technology, and healthcare are excluded, following previous studies (Horváthová, 2010). This allows for an examination of sectors where carbon emissions play a substantial role. Data on financial performance, carbon performance, and control variables are obtained from the Refinitiv dataset.

B.3.2 Variables

To execute the investigation, a multitude of variables and measures are required. The dependent variables are displayed in the "Variables and Measures", Panel A; the independent variables are in Panel B; and the control variables are displayed in the table "Control Variables".

To address endogeneity, the study employs a lagged approach by lagging both the majority of control variables and the main independent variable by one year. This helps to account for potential confounding variables and the delayed impact of carbon performance on financial performance (Horváthová, 2010; Busch et al., 2022a; Delmas et al., 2015).

B.3.3 Methodology

This thesis aims to explore how CEP influences CFP and utilizes a quantitative methodology to investigate the hypotheses.

Variables and Measures

Panel A: Financial Performance - Dependent Variables		
Variable	Computation	Literature
Return on Assets	$\frac{OperatingProfits}{TotalAssets}$	Velte et al. (2020)
Tobins Q	$\frac{MarketCapitalization}{BookValue}$	Delmas et al. (2015)
Asset Turnover	$\frac{TotalSales}{(TotalAssets_{StartPeriod}+TotalAssets_{EndPeriod})/2}$	
Abn. Return on Assets	$ROA_t - \frac{1}{n}\sum_{i=0}^{n-1} ROA_{ind.,t}$	
Abn. Total Assets	$TotalAssets_t - \frac{1}{n}\sum_{i=0}^{n-1} TotalAssets_{ind.,t}$	
Abn. Current Assets	$Curr.Assets_t - \frac{1}{n}\sum_{i=0}^{n-1} Curr.Assets_{ind.,t}$	
Abn. Fixed Assets	$Fix.Assets_t - \frac{1}{n}\sum_{i=0}^{n-1} Fix.Assets_{ind.,t}$	
Abn. Profit	$Profit_t - \frac{1}{n}\sum_{i=0}^{n-1} CurrentAssets_{ind..,t}$	
Abn. Asset Turnover	$Turnover_t - \frac{1}{n}\sum_{i=0}^{n-1} Turnover_{ind..,t}$	

Panel B: Environmental Performance - Independent Variables			
Variable	Computation	Expected Impact	Literature
Carbon Intensity (CI)	$\frac{CO2EmissionsScope2}{TotalSales}$	-	Velte et al. (2020)
Abnormal Carbon Intensity	$CI_t - \frac{1}{n}\sum_{i=0}^{n-1} CI_{ind.,t}$	-	
Environmental Performance	$-\frac{CO2EmissionsScope2}{TotalSales}$	+	Busch et al. (2022a)

Note: Expected impact on financial performance. Literature states examples. Additional sources are mentioned in the text.

Control Variables

Variable	Computation	Expected Impact	Literature
Size	$ln(TotalAssets + 1)$	+	Delmas et al. (2015)
Leverage	$\frac{TotalDebt}{TotalCapital}$	-	Busch et al. (2022a)
R&D Intensity	$\frac{R\&DExpenditures}{TotalSales}$	+	Lee et al. (2015)
Prive to Book Value (PBV)	$\frac{MarketValue_{Share}}{BookValue_{Share}}$	+	Trinks et al. (2020)
Beta	$\frac{Covariance_{Rm,Re}}{Variance}$	-	Siddique et al. (2021)
Capital Intensity	$\frac{CapitalExpenditures}{TotalAssets}$	-	Delmas et al. (2015)
Liquidity	$\frac{OperatingCashFlow}{TotalSales}$	+	Busch et al. (2022a)
Growth	$(\frac{TotalSales_t}{TotalSales_{t-1}} - 1)$	+	Busch et al. (2022a)

Note: Expected impact on financial performance. Literature states examples. Additional sources are mentioned in the text.

Hypothesis 1a:

$$ROA_{i,(t)} = \alpha_0 + \alpha_1 CEP_{i,t-1} + \alpha_2 Size_{i,t-1} + \alpha_3 Leverage_{i,t-1} + \alpha_4 R\&D_{i,t-1} + \alpha_5 PBV_{i,t} + \alpha_6 Beta_{i,t} + \alpha_7 CAPIN_{i,t-1} + \alpha_8 Liquidity_{i,t-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \epsilon_i \quad (6)$$

Hypothesis 1b:

$$TobinsQ_{i,(t)} = \alpha_0 + \alpha_1 CEP_{i,t-1} + \alpha_2 Size_{i,t-1} + \alpha_3 Leverage_{i,t-1} + \alpha_4 R\&D_{i,t-1} + \alpha_5 PBV_{i,t} + \alpha_6 Beta_{i,t} + \alpha_7 CAPIN_{i,t-1} + \alpha_8 Liquidity_{i,t-1} + \gamma_{i,y} + \delta_{i,c} + \rho_{i,s} + \pi_i \quad (7)$$

with ϵ, π being the error term. γ_y, δ_c and ρ_i reflect the year, country and industry effects.

To ensure the validity of the analysis, the model has been selected, based on statistical tests. Also in line with previous studies, such as Busch et al. (2022a), Nelling and Webb (2009), and Delmas et al. (2015) a fixed-effects ordinary least squares model is used. To ensure the validity of the models and limit potential heteroscedasticity concerns, robust error terms are calculated for the model. Moreover, the necessary transformations of the variables are executed.

To test Hypotheses 2 and 3, an alternative approach is adopted. Abnormal performance is computed to benchmark company measures against industry averages. The sample is divided into subsamples based on average abnormal carbon performance over the past ten years, resulting in CEP Ranks. Companies are then categorized into distinct portfolios based on their CEP Rank. To compare the financial performance and drivers among the different carbon portfolios, abnormal performance measures are utilized.

CEP Ranks

CEP Rank	Performance	Number of companies
Rank 1	1st Percentile	3
Rank 2	10th Percentile	22
Rank 3	25th Percentile	17
Rank 4	Median	15
Rank 5	75th Percentile	54
Rank 6	90th Percentile	36
Rank 7	99th Percentile	27

To explore the causality between CEP and CFP, a Granger causality approach following the methodology of Nelling and Webb (2009) is applied by estimating both, regression models and a formal Granger causality test. Further, the relationship between CEP and operating income, respectively total assets is tested, using the same methodology.

B.4 Results

Generally, the descriptive statistics are in line with previous studies. Minor deviations compared to samples from other studies can be observed for the ROA and Tobin's Q. These deviations can be attributed to the effects of COVID-19 and the financial crisis. Control variables, such as size, leverage, R&D intensity, and liquidity, are within the expected range, although they may differ from other studies due to sample variations. CEP shows a negative correlation with size, in line with expectations. Additionally, CEP is positively correlated with R&D expenditures. Both ROA and Tobin's Q are positively correlated with CEP, providing initial support for the hypothesis that better CEP is correlated with superior financial performance. Overall, the descriptive data and correlation results align with previous research, and comparisons to prior studies are made to validate the findings and establish a foundation for further investigations.

The table for Regression 1 presents the results for Hypotheses 1a and 1b. The R^2 value of the model with ROA as the dependent variable is 0.217, surpassing the R^2 of previous investigations. The increase can be attributed to the inclusion of R&D expenditures, based on the findings of Lee et al. (2015) and McWilliams and Siegel (2000). Carbon intensity has a highly significant positive effect on ROA. A 10% increase in corporate environmental performance leads to a 0.13 percentage point increase in ROA. This supports previous research indicating a positive relationship between CEP and ROA. Size has a negative effect on ROA, contrary to initial expectations, which may be due to variations in sample composition. Leverage and beta also have a significant negative effect on ROA, suggesting that increased firm risk affects financial performance negatively. R&D expenditures and liquidity have a positive effect on ROA, indicating that investing in research and expansion and having access to funds lead to improved financial performance.

When Tobin's Q is used as the dependent variable, CEP has no noticeable impact, consistent with previous findings. The control variables show similar effects as observed for ROA, with R&D expenditures, past growth, and liquidity positively affecting market valuation, while size and risk factors have a negative impact. The investigation of subsamples based on emission levels in the industry reveals that these findings hold for high-emission industries. For low-emission industries, the impact of carbon intensity becomes insignificant.

In conclusion, the analysis reveals a significant positive impact of CEP on ROA, indicating that companies with better carbon performance exhibit higher returns on assets. This finding holds for the total sample and high-emission industries but becomes insignificant when considering only low-emission industries. However, no impact of CEP on Tobin Q is observed. These findings align with previous studies, supporting the notion that CEP influences financial performance positively, especially in high-emission industries (Trinks et al., 2020; Horváthová, 2010; Patten, 1992).

The mechanisms driving the impact on ROA are investigated by comparing financial variables across different CEP Ranks. The p-values of the one-sided Wilcoxon test are summarized in the table. Panel A, shows that firms in the top 1% of CEP rankings have significantly higher abnormal returns on assets compared to all other CEP Ranks. Firms in CEP Rank 1 perform significantly worse compared to firms in other CEP Ranks. Additionally, companies in CEP Ranks 5 and 6 have significantly higher financial performance than companies with lower carbon performance than the median of their peers. However, this effect diminishes for lower CEP Ranks, where no significant difference in financial performance is observed. These findings highlight the robustness of previous investigations and indicate that firms with better carbon performance also perform better financially than their industry peers. Panel B presents the pattern for abnormal total assets. Firms in CEP Rank 7 operate with significantly fewer assets compared to firms in lower CEP Ranks. Generally, companies in all CEP Ranks have fewer abnormal assets than those in CEP Rank 1. Similar to Panel A, a clear pattern emerges in Panel B, which shows that firms with better carbon performance can operate with fewer assets while achieving higher returns on assets compared to their peers. On the other hand, companies with lower carbon performance require more assets while not outperforming their industry peers. Panel C examines the difference in abnormal operating profits. According to external theories and Hypothesis 3, companies with higher CEP Ranks are expected to yield higher abnormal profits than their peers. However, Panel C reveals a contradicting finding. The one-sided Wilcoxon test does not show significantly abnormal average profits for companies with better environmental performance. When inverting the test, it is observable that companies with lower CEP Ranks, and therefore higher emissions than their peers, yield significantly higher abnormal profits than firms with better CEP.

Regression 1: CEP on CFP

	Dependent variable:	
	ROA	Tobins Q
	panel linear	*panel linear*
	(1)	(2)
CEP (inverted sign)	-0.036***	0.060
	(0.009)	(0.009)
Size	-0.034***	-0.296***
	(0.006)	(0.006)
Leverage	-0.090***	-0.518***
	(0.030)	(0.030)
R&D Intensity	-0.136***	-0.966**
	(0.052)	(0.052)
PBV	0.001***	0.024***
	(0.0008)	(0.0008)
Beta	-0.010***	-0.115***
	(0.005)	(0.005)
Capital Intensity	-0.004	0.055
	(0.003)	(0.003)
Liquidity	0.272***	2.080***
	(0.005)	(0.005)
Growth	0.020***	0.146***
	(0.004)	(0.004)
Year Fixed Effects	Yes	Yes
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	1,566	1,566
R^2	0.217	0.179
Adjusted R^2	0.108	0.066
F Statistic (df = 9; 1375)	42.252***	33.398***

Note: Numbers in parentheses are heteroscedasticity-robust standard errors. ROA = Return on Assets,CEP = Corporate Environmental Performance, sign has been inverted due to square-root transformation, PBV = Price to Book Value

*p<0.1; **p<0.05; ***p<0.01

In conclusion, the analysis shows that companies with better carbon performance typically have higher financial performance as seen in their abnormal return on assets. These findings hold across different CEP Ranks. Additionally, firms with better carbon performance can operate with fewer assets while achieving superior financial performance compared to their industry peers. However, there is no evidence of a significant difference in abnormal operating profits based on CEP Ranks.

Investigating the difference between abnormal assets in-depth, it becomes evident that the result is driven, by both current and fixed assets. Both types of assets show a similar pattern, indicating that firms with better carbon performance are able to operate more efficiently in terms of current and fixed assets. To address potential endogeneity concerns, the results are calculated on a 10-year average. This ensures that the pattern is not only driven by short-term factors but also remains consistent over a longer time horizon.

Regarding the assessments of causality, the regression model with the two included time lags does not show sufficient evidence for a causal relationship between CEP and CFP. When expanding the time frame to five years, the formal Granger causality tests indicate that CEP does not serve as a significant predictor for the abnormal return on assets or abnormal operating profits. However, there is a significant relationship between previous CEP values over a five-year period and future abnormal fixed assets, suggesting that past CEP levels have explanatory power for abnormal (fixed) assets in later periods. Inverse Granger tests do not show significant results, indicating that previous abnormal assets do not predict future CEP. This suggests that the effects are most likely not driven by reverse causality. In conclusion, changes in CEP have a small but significant long-term impact on abnormal fixed assets. This finding supports the notion of a causal relationship between CEP and CFP and therefore strengthens the resource-based theory, established by Porter (1991) and Porter and van der Linde (1995).

B.5 Discussion

The findings suggest that the main driver of behind the positive impact of CEP on CFP is not improved stakeholder relationships but rather increased resource efficiency. While stakeholder-oriented theories play a minor role in explaining the impact of CEP on financial performance, resource-based theories explain the observed financial merits of improved CEP. Therefore, CEP serves as an indicator of how efficiently and resource-efficiently companies operate.

For practitioners, these findings can be encouraging. Improving CEP may not directly lead to higher market valuations or increased ROA. However, companies that prioritize their carbon performance are likely to operate more efficiently overall. Reducing carbon intensity should be seen as an opportunity to review internal processes and enhance resource efficiency. Investments in carbon reduction can lead to process improvements and increased overall efficiency, although the direct financial returns may not be significant in the short term.

The study has limitations and suggests directions for further research. The impact of external theories on CFP, particularly the effects of different stakeholder groups, can be explored in more

Significance Levels for one-sided Wilcoxon Test between CEP Ranks

Panel A: Abnorm. ROA is significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.001***					
Rank 5	.003***	.779				
Rank 4	<.001***	.368	.208			
Rank 3	<.001***	.032***	.009***	.092		
Rank 2	<.001***	.029***	.006***	.190	.755	
Rank 1	<.001***	<.001***	<.001***	<.001***	.005***	<.001***

Panel B: Abnorm. Total Assets are significantly lower for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.995					
Rank 5	<.001***	<.001***				
Rank 4	<.001***	<.001***	.000***			
Rank 3	<.001***	<.001***	.032**	.967		
Rank 2	.140	.015	.966	1.000	1.000	
Rank 1	<.001***	<.001***	<.001***	.004***	.003***	<.001***

Panel C: Abnorm. Assets Turnover is significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	<.001***					
Rank 5	.190	.994				
Rank 4	<.001***	.061	<.001***			
Rank 3	<.001***	.064	<.001***	.737		
Rank 2	.316	.994	.200	1.000	1.000	
Rank 1	.013**	.606	.121	.844	.783	.068

Panel D: Abnorm. Profits are significantly higher for higher CEP Ranks

	Rank 7	Rank 6	Rank 5	Rank 4	Rank 3	Rank 2
Rank 7						
Rank 6	.074*					
Rank 5	1.000	1.000				
Rank 4	1.000	1.000	1.000			
Rank 3	1.000	1.000	.899	.017		
Rank 2	.355	.790	.001***	<.001***	.001***	
Rank 1	1.000	1.000	.986	.392	.918	.999

Wilcoxon test investigates the stated hypotheses. *p<0.1; **p<0.05; ***p<0.01

detail. Using multiple measures for each stakeholder group would provide a deeper understanding of their specific impacts on financial performance. Additionally, the study's approach can be extended by employing a difference-in-difference analysis to compare companies that improve their CEP over time with those that maintain a constant CEP level. This approach would provide insights into the causality of the relationship. Empirical limitations include the potential for omitted variable bias in the models and discrepancies in the data on carbon emissions reported by different sources. Data quality, particularly the self-reporting bias in carbon emissions data, could be a concern.

In summary, the findings contribute to the resource-based view of CEP and provide insights into the relationship between CEP and CFP. The results suggest that improved CEP indicates increased resource efficiency rather than improved stakeholder relationships. For practitioners, focusing on CEP can lead to operational efficiencies, although the direct financial returns may be limited. Further research should explore the impact of external theories on CFP and investigate causality and the time horizon in which the effects materialize.

B.6 Conclusion

This study examines the relationship between corporate environmental performance and corporate financial performance. The findings reveal a significant positive relationship between CEP and return on assets (ROA) in the Stoxx Europe 600 sample from 2013 to 2022. When considering industries with high carbon emissions, the positive effect of CEP on ROA persists, while it becomes insignificant for industries with low carbon emissions. However, no significant relationship is observed between CEP and market valuation, measured by Tobin's Q.

The study also reveals that companies with above-average carbon performance compared to their industries not only outperform their peers in terms of ROA but also exhibit fewer abnormal assets. This suggests that more effective resource utilization is what drives their superior financial performance. Furthermore, companies with higher carbon performance tend to have lower operating profits, indicating increased costs associated with improving carbon performance. The application of a Granger causality models show evidence for a causal relationship between CEP and abnormal assets. No evidence for reverse causality is observable.

In conclusion, the study demonstrates that companies with superior carbon performance generally exhibit higher financial performance due to their efficient use of assets. However, carbon performance is not a definitive predictor of success. Instead, it serves as an indicator of superior asset management and efficiency. Companies with lower carbon performance should use this as an opportunity to assess their overall process efficiency and strive for improved carbon and financial performance in the long run.

Overall, these findings highlight the importance of efficient resource utilization and suggest that companies should focus on improving their carbon performance as an aspect of long-term success.