ALTERNATIVE APPROACHES IN ESG INVESTING: FOUR ESSAYS ON INVESTMENT PERFORMANCE & RISK

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Alternative Approaches in ESG Investing:
Four Essays on Investment Performance & Risk

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at the
University of St Andrews

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Abstract

ESG (Environmental, social, and governance) investing is an investment philosophy to inform holistic and sound decision-making of investors for the purposes of both, nourishing a stable economy with acceptable rates of return while at the same time addressing stakeholders' non-financial concerns to preserve an inhabitable planet. Some scholars in finance argue that institutions subject to norms, i.e. responsible investors pay a financial cost from engaging in ESG activities. Moreover, they see ESG investing as distracting, inappropriate, risky and legally challenging. In response, several studies have emerged to show that ESG investing is a growing interest with investors, helps to mitigate financial risks, and does not need to represent a financial cost. Despite convincing evidence in a growing body of academic literature, many questions are still open to debate. Therefore, the principal objective of this thesis is to explore three dimensions of ESG investing, namely corporate environmental responsibility, renewable energy, and ESG disclosure quality. The research questions address issues relating to pension funds' investment decisions and legal obstacles resulting from utilising ESG information, financial return and risk implications of investing in renewable energy, substitutability of renewable energy for fossil fuel investments, and the effects of ESG disclosure quality on the expected cost of capital. To answer these questions, the thesis employs several standard and alternative empirical methods from the asset pricing and risk literatures. The thesis concludes the following. First, the integration of environmental responsibility into pension fund investment decision-making processes does not impede the financial and risk performance of pension funds. This means that pension funds should be allowed to consider such information in their investment decision making processes as the information does not reduce the overall financial return of the tested portfolios and does not violate trust law, i.e. the Employee Retirement Income Security Act (ERISA). Pension fund trustees have been prohibited to consider any non-financial criteria such as environmental, social, or governance criteria in their investment processes under trust law such as ERISA, when they could harm the finanical performance of the portfolio. To be more specific, a pension fund trustee breaches his fiduciary duties (the duty of loyalty and the duty of prudence), if he sacrifices the financial well-being of the pension fund for pursuing any other social goal (Langbein and Posner, 1980). In particular, the duty of loyalty is "...forbidding the trustee to invest for any object other than the highest return consistent with the preferred level of portfolio risk" (Langbein and Posner, 1980:98). Second, the thesis finds no evidence for sustained renewable energy equity premia. Furthermore, investments in

renewable energy equity are considerably riskier than in fossil fuel energy equity, meaning that renewable energy firms are undergoing a period of high uncertainties related to their business model, low carbon prices, and lacking public and private infrastructure investment (Bohl et al., 2013; Kumar et al., 2012; Sadorsky, 2012b). Finally, my thesis shows that companies with high ESG disclosure quality experience lower expected cost of equity and cost of debt financing, everything else equal.

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1 Introduction

1.1 Background and Motivation

Over the last decade, modern SRI (Socially Responsible Investing)[1] and ESG-themed (Environmental, Social and Governance) investing has seen remarkable growth rates. Since 2008, ESG investing has experienced more than a doubling of its global professionally managed assets from 5 to over 13 trillion US dollars (Eurosif, 2008; GSIA, 2013). A significant driving force behind this development has been the rapid growth of the Principles for Responsible Investment (PRI) and similar initiatives in promoting ESG investing across global financial markets (Della Croce et al., 2011; Eurosif, 2012).[2] The United Nations supported initiative has been promoting the consideration and integration of ESG concerns into investment decision-making processes of institutional investors from its launch in 2006, and successfully so. Recent figures on PRI signatories reveal that 1,250 asset owners, asset managers, and professional service providers, with combined assets under management of 45 trillion US dollars, have followed the lead to invest in accordance with the PRI's principles (PRI, 2014).

This development does not only illustrate the rapid growth of the PRI, but more importantly, shows the increasing awareness and willingness of institutional investors to engage in ESG investing (Derwall et al., 2011; Gifford, 2010; Sievänen et al., 2013).[3] The predominant group of PRI signatories are long-term institutional investors including pension or retirement funds, endowment funds, unit trusts, and insurance companies (PRI, 2011). In recent years, this group of investors have grown so immensely large in size that they jointly own the majority of all global financial assets, which easily justifies the term 'universal owner', as many scholars have suggested (Hawley and Williams, 2007; Thamotheram and Wildsmith, 2007; Urwin, 2011). Due to their considerable size, the financial performance of these universal owners is widely contingent on the financial performance of entire financial markets instead of the returns on individual stocks. Therefore, universal owners should have a natural interest to consider ESG concerns and renewable energy in their investment decision-making processes, that affects entire economies as opposed to ESG concerns that

[1] See the following for comprehensive literature reviews on modern SRI investing (Renneboog et al., 2008), SRI mutual fund performance (Chegut et al., 2011) and development of the term SRI (Eccles and Viviers, 2011).
[2] Not to mention the regulatory support across the globe that has helped SRI and ESG investing to grow (see e.g. Renneboog et al., 2008a; Renneboog et al., 2011).
[3] Given that much of the evidence pertaining to the financial performance of SRI and ESG investing has been positive (Beurden and Gössling, 2008; Derwall et al., 2005; Edmans, 2011; Gompers et al., 2003; Guenster et al., 2011; Kempf and Osthoff, 2007; Orlitzky et al., 2003; Statman, 2006).

individual corporations cannot externalise (Amalric, 2006; Hawley and Williams, 2007; Hawley and Williams, 2000; Mattison et al., 2011; Thamotheram and Wildsmith, 2007).

Despite institutional investors' interest and willingness to consider ESG information in their investment decision-making processes, the interpretation of fiduciary duties, to which investors are ultimately subscribed to, could present an obstacle to pursue such goals. In many common law jurisdictions, investors are under the impression that fiduciary duties restrict them from considering ESG and other non-financial information when making strategic investment decisions because it is understood that a fiduciary's main duty is only to achieve competitive returns and otherwise maximise financial returns (PRI, 2013; Richardson, 2006). Such narrow interpretations are common in the US context, where pension trustees are regulated by the Employee Retirement Income Security Act of 1974 (ERISA), under which fiduciaries are not encouraged to make investment decisions based on any factors other than financial ones (Interpretive Bulletin 2509.08-1). In the UK, fiduciaries were under similar impressions due to a widely misinterpreted case, Cowan v. Scargill, whereby fiduciaries were led to believe that their sole responsibility was to maximise financial returns (Cowan v. Scargill, 1 Ch. 270, 1985; Freshfields Bruckhaus Deringer, 2005). To shed light on the conditions under which ESG information is permissible, a report by Freshfields Bruckhaus Deringer gained prominence for its analysis of these conditions (Freshfields Bruckhaus Deringer, 2005; Gitman et al., 2009). While the Freshfields report has provided a lot of conceptual clarity it probably left the most crucial practical uncertainty unanswered: What are the financial and risk implications of ESG criteria consideration on a pension fund equity portfolio that complies with the legal duty of prudent action for proper purpose?

Chapter 4 of my thesis aims to address this remaining uncertainty. Using the Freshfields report as a starting point, the chapter empirically investigates this research question by developing a test of the prudent (conservative) integration of any ESG criterion in hypothetical equity pension fund investment processes. More specifically, the empirical analysis compares the return and risk characteristics of synthetic equity portfolios of pension funds with different degrees of corporate environmental responsibility. The chapter concludes that the integration of environmental responsibility is not an obstacle to the financial performance and risk and that pension funds are not legally prohibited from utilising such criteria.

Closely related to the debate on whether institutional investors are permitted to integrate ESG information in their investment policies (asset allocation decisions, portfolio construction, and stock-picking activities), is the steadily increasing demand and interest for renewable energy (World Economic Forum, 2011). To date, financial markets offer well over 100 renewable energy themed mutual funds (Muñoz et al., 2013; US SIF, 2013), clean tech indexes (Ortas and Moneva, 2013), and more recently a rapidly growing number of green bonds (Bolger, 2014; International Finance Corporation, 2014).

This revived surge in attention is especially driven by both, increasing fears of new regulations that could potentially internalise external costs and vocal fossil fuel divestment campaigns (similar to powerful campaigns during the Apartheid regime) that encourage institutional investors to turn their back on fossil fuel energy stocks and instead pursue investments in renewable energy (Bloomberg New Energy Finance, 2014; Thomas et al., 2007; Vittorio, 2014). As a consequence of recent environmental disasters including BP's oil spill in the Gulf of Mexico and Fukushima Daiichi Nuclear incident, the accountability of corporations and the role of governments to tackle corporate environmental misbehaviour is being challenged by the public (Bauer and Hann, 2010; Chazan and Crooks, 2013; Figge and Hahn, 2005). All over the world, debates are taking place about various policy instruments to protect the environment (Chava, 2011; Hirschl, 2009; Shin et al., 2014; Michalena and Hills, 2012). While Europe is at the forefront of pricing carbon through the European Union Emissions Trading Scheme (EU ETS), the US is discussing a carbon tax, cap-and-trade system, and even considering the implementation of new environmental legislations to favour the development of renewable energies (Chava, 2011; Mo et al., 2012). For example, some regulatory changes concerning renewable energy laws have already taken place over the last two decades in countries such as Canada and Germany. Ontario's Green Energy Act of 2009 is strongly promoting the development of renewable energy generation in North America (Songsore and Buzzelli, 2014). Likewise, the German Renewable Energy Act of 2000 encourages the wide-scale development of renewable energy technologies via feed-in-tariffs (Bohl et al., 2013).

Hence, it is vital for large institutional investors not only to understand that their portfolios have direct implications on societies and the natural environment, but more importantly, that these investors who seek protection against environmental risks develop an interest in monitoring externalities (Bauer and Hann, 2010; Mattison R. et al., 2011; Thomas et al., 2007). Strikingly, many of today's institutional investor portfolios are heavily exposed to those sectors of the economy that produce the highest negative environmental externalities, i.e. oil and gas sector (Bloomberg New Energy Finance, 2014; International Monetary Fund, 2011). Given the rising discontent of society with respect to these externalities, calls for fossil fuel divestment campaigns have become louder and could pose serious threats to the assets of fossil fuel energy producers to become obsolete and turn into "stranded assets" (Ansar et al., 2013). Due to the heavy exposure to fossil fuel energy stocks, for many institutional investors the potential impact of stranded assets could pose a real challenge (Bloomberg New Energy Finance, 2014).

As a result of these pressures, large-scale asset transfers from fossil fuel energy to renewable energy are possible. Current forecasts addressing the issue of stranded assets predict a potential transfer in the scale of over five trillion US dollars from fossil fuel stocks to renewable energy (Bloomberg New Energy Finance, 2014). Although, this represents a unique opportunity for renewable energy investments, many uncertainties faced by institutional investors need to be addressed. 1) Is there a difference between the financial performance of international renewable equity stock indexes and conventional stock indexes? 2) Does the financial performance of international renewable energy stock indexes differ over the first two EU ETS time periods? 3) Does the financial performance of renewable energy stock indexes depend on the investment region? 4) Does the risk of international renewable energy equity indexes relate to that of fossil fuel ones? 5) How does this relation differ geographically? 6) Do returns of renewable energy companies trail those of fossil fuel energy companies?

Chapters 5 and 6 of my thesis aim to address these research questions. Both chapters empirically investigate these research questions by testing the historical profitability and risk of global renewable energy equity indexes. Throughout my thesis, the term "risk" will refer to the deviation of an expected outcome (Ross et al., 2008). I measure the deviation of an expected outcome as systematic and idiosyncratic volatilities of returns, using investment risk proxies such as standard deviations, semi-standard deviations, lower partial moments, beta, absolute and relative tracking error volatilities, and downside tracking errors.

More specifically, Chapter 5 of my thesis compares the static and dynamic financial performance of renewable energy indexes with conventional equity market ones, while Chapter 6 compares absolute and relative tracking error volatilities between renewable and fossil-fuel energy equity indexes. Chapter 5 concludes that institutional investors could reap financial benefits from investing in renewable energy equity indexes as long as they pay close attention to renewable energy style characteristics and increase their understanding of specific sub-segments of renewable energy. Chapter 6 concludes that investors require substantial risk-premia from renewable energy due to higher return volatilities as opposed to fossil fuel energy. As my findings indicate, renewable energy indexes are riskier than fossil fuel energy indexes and riskier investments should compensate the investor with higher returns, in line with Modern Portfolio Theory. Considering both conclusions, renewable energy investments may substitute for fossil fuel energy investments once institutional investors account for the diversity within the renewable energy sector and expend additional resources on monitoring renewable energy risks.

Closely related to the debates on whether institutional investors shall be allowed to integrate corporate environmental sustainability information into their investment decision-making processes and the steadily increasing demand and interest for renewable energy, is the rapidly increasing supply of corporate disclosures of environmental, social, and governance (ESG) activities. In light of an increasing number of corporate scandals that have adversely impacted society and the economy, companies are under constant scrutiny by the public and investors alike. A recent PRI report (2014) suggests that large institutional investors such as pension and investment funds have called for more transparency by corporate managers with respect to their ESG activities. The report emphasises the growing demand "...for timely, comparable and material disclosure of corporate sustainability information to inform their investment decisions." (PRI, 2014). While investor's demand for increasing corporate ESG disclosures seems particularly appealing to companies who seek financing from equity and debt investors, the motivation for increased corporate disclosures on ESG activities could be driven by companies trying to re-build trust and re-gain their reputation following corporate scandals, as poorly managed ESG risks have shown to impact a company's reputation and sales (See e.g. Brammer and Pavelin, 2006; Lii and Lee, 2012).

Institutional investors' strategic investment decision-making processes are guided by assessments of a company's cost of capital, which represents "...the expected return on a firm's stock." (Lambert et al., 2007:386). While most of the existing literature has focused on the effects of specific ESG criteria on either the cost of equity or debt, it has left the following uncertainty unaddressed: What is the effect of ESG disclosure quality on a company's expected cost of capital?

Thus, Chapter 7 of my thesis aims to address this uncertainty. My chapter investigates this research question by empirically testing the effects of ESG disclosure quality on the expected cost of equity and debt capital. My chapter concludes that companies with high ESG disclosure quality have lower expected cost of equity and cost of debt capital, everything else equal.[4] My empirical analysis is robust to several alternative methods, based on Graham and Harvey's (2015) survey of the expected market premium and inferred from asset pricing models consistent with general market equilibrium models and the Efficient Market Theory, to compute the expected cost of equity and a novel proxy for the cost of debt.

1.2 Does pension funds' fiduciary duty prohibit the integration of environmental responsibility criteria in investment processes? A prudent investment test

Chapter 4 of my thesis aims to investigate return and risk implications of the prudent integration of any ESG criterion in hypothetical equity pension fund investment processes. More specifically, this chapter aims to empirically extend the analysis of the Freshfields report on the debate, over whether equity pension funds are legally prevented to integrate one specific type of ESG information, namely environmental sustainability criteria, into their investment processes and policies (Freshfields Bruckhaus Deringer, 2005; Rounds, 2005).

The main contribution of this chapter is to examine empirically the financial return and risk implications in the context of prudent (conservative) integration of environmental sustainability criteria into equity pension fund investment processes. In addressing this crucial issue, my chapter adds clarity to the debate, over whether integrating ESG criteria sacrifices the returns of pension funds' equity portfolios and thereby violates trust law and the fiduciary liability of trustees under, for example, the Employee Retirement Income Security Act (ERISA). Under ERISA, pension fund trustees have been disallowed to consider environmental, social, and governance (ESG) criteria when such considerations damage the financial well-being of the beneficiary (Langbein and Posner, 1980, O'Brien-Hylton, 1992). Langbein and Posner (1980) explain that a fiduciary's duty of loyalty is forbidding the trustee to pursue any social motives other than the highest return given the preferred level of portfolio risk.[5] However, pension funds are legally required to consider an ESG criterion, if there is a consensus amongst beneficiaries in favour of this criterion or the criterion is believed to be financially beneficial (Freshfields, 2005). As long as an ESG criterion does no financial harm, it may also be voluntarily considered.

[4] To overcome potential issues related to reverse causality and simultaneity between ESG disclosure quality and the cost of capital, I lag my ESG disclosure quality variable and all of my control variables by one year (See e.g. Harjoto and Jo, 2014; Oikonomou et al., 2014). In Chapter 7.3.5. 'Regression Models', I provide detailed explanations on my regression specifications.

[5] Thus, pension funds could even invest in hedge funds as long as the beneficiary's preferred level of portfolio risk is met and no financial harm caused.

This chapter aims to fill a gap in the literature by bridging two related literature streams. One stream is predominantly concerned about the relationship between ESG criteria and financial performance without considering the pension fund perspective (Kempf and Osthoff, 2007; Scholtens, 2008; Scholtens and Zhou, 2008), the other stream is mainly interested in pension funds' fiduciary duties with respect to ESG criteria without any empirical analysis of the financial and risk implications of ESG integration (Martin, 2009; Richardson, 2009; Sandberg, 2011).

The empirical analysis shows that the integration of environmental sustainability criteria into pension fund equity investment policies is not an obstacle to the financial return and risk performance and that equity pension funds complying with the fiduciary duty of trustees under ERISA are not prevented from informing their investment decisions with such criteria.

Chapter 4 is subject to several limitations. First, the findings are only directly relevant to the equity allocation of pension funds. However, pension funds' asset allocations also consist to a large degree of fixed income, cash and other alternative asset classes, whose implications this chapter does not analyse. Second, the findings are only directly applicable to corporate environmental sustainability criteria supplied by EIRIS. Other ESG dimensions related to social and governance issues from other ESG data providers such as KLD or MSCI will need to be analysed in the future.

1.3 Static and dynamic multi-factor performance and investment style of international renewable energy stock indexes

In the pursuit of simultaneously minimising investment risk and increasing financial return through the diversification of assets, sustainable equity investors seek alternative options to achieve this goal. Over the last decade, several alternative energy related equity investments have emerged such as Renewable Energy Equity Indexes. These thematic equity indexes aim to serve as a benchmark for the financial performance of listed renewable energy companies (Bohl et al., 2013; Henriques and Sadorsky, 2008; Ortas and Moneva, 2013).

Thus, the principal objective of Chapters 5 and 6 of my thesis is to investigate risk premia of renewable energy equity indexes before the launch and during the first two phases of the European Trading Scheme (EU ETS), using static and dynamic performance evaluation methods. In addressing this research objective, the my chapter helps institutional investors to better understand the financial prospects and characteristics of renewable energy investments.

This chapter has the following contributions to the extant literature. First, the static and dynamic financial analysis is based on a multi-factor framework and thereby extends the methods of existing studies that investigate risk premia of renewable energy indexes using dynamic market models (Ortas and Moneva, 2013). Second, in applying this method to a global sample of renewable energy indexes, this chapter extends Bohl et al. (2013) sample, who purely focus on German renewable energy equity indexes. Third, it complements the literature by analysing the financial performance of renewable energy indexes over several phases of the EU ETS.

The main finding shows that risk premia in global renewable energy equity markets are not persistent and short-lived. During the first trading phase of the EU ETS, a significant outperformance of renewables is driven by small cap stocks, momentum trading, and positive investor sentiment. In contrast, the second phase of the EU ETS is marked by a performance reversal and renewable energy indexes become extremely risky and uncertain investments, likely driven by the financial crisis and over-expectations by irrational investors.

The empirical results are subject to several limitations. First, my findings indicate that the financial performance of renewable energy indexes is not driven by geographical differences but sector differences. Thus, further research should look into the diverse sub-sectors of renewable energy and use sector rather than geographical benchmarks. Second, this chapter does not distinguish between pure-play[6] and more liberal renewable energy equity indexes. While pure-play renewable energy indexes employ very strict sector screens to sort out any non-renewable energy companies, liberal renewable energy indexes could allow to include energy producers from the nuclear, gas, or bio-fuels sectors. A focus on these sector screens and a distinction between pure-play and non pure-play indexes could be fruitful.

1.4 The Risks of Investing in Renewable and Conventional Energy Stock Markets

Chapter 6 aims to investigate the risks of investing in international renewable energy equity markets. Investigating the risk relationship between renewable and conventional energy stocks is essential to the understanding in two ways. First, whether renewable energy investments can substitute for conventional fossil-fuelled energy stocks in the future; second,

[6] Pure-play renewable energy equity indexes only benchmark energy companies that generate 100% of their energy from renewable sources such as wind, solar or hydro energy. Other renewable energy indexes are more liberal and also list energy companies generating energy through nuclear, gas, or bio-fuels.

to help institutional investors to better manage the risks of investing in these alternative energy equity indexes.

The principal contribution of this chapter is to investigate the risk behaviour of a sample of global renewable energy equity markets providing a direct comparison between the returns of traditional, fossil-fuelled energy equity indexes and renewable energy equity indexes. Furthermore, this chapter develops an alternative measure of relative risk, namely the downside tracking error that aims to capture the asymmetric risk behaviour of alternative asset classes. In addressing these objectives, this chapter aims to shed light on the debate, whether renewable energy equity indexes are more volatile than traditional energy indexes and therefore should be substituted in the future (Sadorsky, 2012a, b). This chapter aims to fill a gap in the literature by relating two literature streams. One stream is largely focussed on the relationship between oil prices and the impact on stock prices without considering renewable energies (Driesprong et al., 2008; Mohamed, 2012; Scholtens and Yurtsever, 2012). The other stream investigates renewable energies and the effect of oil prices but ignores the risks of conventional fossil-fuel stocks (Kumar et al., 2012; Sadorsky, 2012b).

The empirical analysis shows that investing in renewable energy equity is considerably riskier than in traditional energy equity markets, using several absolute, relative, and downside risk measures to explain these findings. This chapter argues that renewable energy investing is faced with high uncertainties regarding renewable energy firms' current business model, low or non-existent carbon prices, and a lack of private and public investments in renewable energy infrastructure (Bohl et al., 2013; Kumar et al., 2012; Sadorsky, 2012b).

This chapter has the following limitations. First, the risk findings apply to investing in renewable energy equity markets only. More recently, the renewable energy sector has seen a growing demand for green bonds and fixed income products, which could reduce risk and increase institutional investment in the sector (Bolger, 2014; International Finance Corporation, 2014). Second, the results apply to renewable energy equity indexes in developed countries, while emerging renewable equity markets could illustrate a different risk behaviour.

1.5 The Effects of Environmental, Social, and Governance (ESG) Disclosure Quality on the Cost of Capital

In Chapter 7 of my thesis, I aim to empirically investigate the effects of Environmental, Social, and Governance (ESG) disclosure quality on the expected cost of equity and debt capital, using a large sample of US S&P 500 companies. Based on Heinkel et al.'s (2001) and Merton's (1987) theoretical framework, consistent with the Efficient Market Theory (which I discuss in Chapter 2 'Theory: The Efficient Market Theory'), I hypothesise that companies with high ESG disclosure quality have lower expected cost of equity and debt, everything else being equal. The theoretical mechanisms through which ESG disclosure quality could affect the expected cost of equity and debt are the depth's of a companies investor base, reductions in companies' beta or systematic risk, and future litigation and reputational risks (Lambert et al., 2007; Merton, 1987). The three mechanisms are discussed in more detail in Chapter 7.2.1. 'ESG Disclosure and the cost of capital', as well as why ESG disclosure quality could be "priced" by the market (See Chapter 7.2.1.4. 'ESG Disclosure and Diversification').

The main contribution of my chapter is the investigation of the relevance of companies' ESG disclosure quality for equity and debt investors. My chapter contributes to the existing literature by extending the research on voluntary ESG disclosure information (See e.g. Dhaliwal et al., 2011; Plumlee et al., 2010) as well as the effects of ESG on the expected cost of equity and debt, more generally (See e.g. Bauer and Hann, 2010; Chava, 2011; El Ghoul et al., 2011; Oikonomou et al., 2014). My chapter contributes by using a novel indicator to measure the extent (or *quality*) of companies' ESG disclosure, alternative approaches to compute the expected cost of equity and debt capital, and by investigating the effects of ESG disclosure quality on the cost of debt, which, to the best of my knowledge, has not been studied before.

My empirical results suggest that ESG disclosure quality is negatively associated with all of my expected cost of equity and cost of debt variables, while also controlling for company-and bond-specific characteristics. This means that companies with high ESG disclosure quality have lower expected cost of equity and debt capitals, all else equal. My results of the relationship between ESG disclosure quality and the expected cost of equity and debt imply that the market prices a company's ESG disclosure quality along with other factors and that the market appears to be inefficient with respect to this information set.

Chapter 7 has the following limitations. First, my analysis is based on a sample of US S&P 500 companies and does not evaluate other countries. Thus, my results are only directly applicable to large companies in the US. My sample is consistent with realted studies in a US context (See e.g. Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Oikonomou et al., 2014; Plumlee et al., 2010; Sharfman and Fernando, 2008). Given different cultural and regulatory frameworks in other countries, an investigation beyond the US could yield different results. Second, my results are based on expected cost of equity estimates inferred from asset pricing models and one cost of debt proxy. This means that my results are directly only relevant to equity and debt investors who compute the expected cost of equity and debt in a similar fashion. However, it seems unlikely that computing implied cost of equities (as in Dhaliwal et al., 2011; El Ghoul et al., 2011) would change my results considerably, as prior findings also suggest that companies with high ESG have lower implied cost of equities.

1.6 Thesis Structure

My thesis is structured in the following manner. Chapter 2 describes my theoretical background which is based on the Efficient Market Theory. Chapter 3 outlines my methodological position and research methodology. Chapter 4 is my first empirical chapter and it investigates whether integrating ESG criteria damages the returns of hypothetical pension funds' equity portfolios and thereby violates trust law and the fiduciary liabilities of trustees. Chapter 5 is my second empirical chapter and it studies whether ESG information sets in form of a renewable energy equity investment trading strategy generate persistent renewable energy equity premia relative to conventional equity benchmarks. Chapter 6 is my third empirical chapter and it investigates idiosyncratic risks of international renewable energy equity indexes relative to fossil-fuel equity indexes. Chapter 7 is my fourth empirical chapter which studies whether my third proxy for ESG, namely ESG disclosure quality affects a company's expected cost of equity and debt capital. Chapter 8 concludes with the implications of my results for the Efficient Market Theory, contributions to the extant literature, future research avenues, practitioner and policy relevance as well as limitations.

2 Theory: The Efficient Market Theory

2.1 Brief History of Efficient Market Theory

The origins of the Efficient Market Theory can be traced back to Louis Bachelier's thesis, *The Theory of Speculation*, where he theorises information diffusion in the context of financial markets (Read, 2013). Bachelier, a mathematician by formation who was strongly influenced by probability theory, is most prominently credited with independently inventing and influencing Brownian Motion, Random Walk Theory, and the first sophisticated formula to price derivatives and options (Read, 2013).

Before the explicit formulation of the Efficient Market Theory and Efficient Market Hypothesis by Fama in the 70s, researchers developed an interest in the Random Walk Theory invented by Bachelier and later independently re-invented by Osborne in 1959 (Fama, 1965). The Random Walk Theory is based on two assumptions: price independence and price distribution (Fama, 1965). Meaning that successive price changes should not be predictable and that prices should follow a certain distribution. Fama (1965) empirically tested both assumptions of the Random Walk Theory and concluded that successive price changes are indeed independent and return distributions follow a Paretian distribution (Fama, 1965). He showed that these conditions are "...consistent with the existence of an "efficient" market for securities" and "...given the available information, actual prices at every point in time represent very good estimates of intrinsic values" (Fama, 1965:90). Fama suspected that competition among sophisticated chart readers and analysts was contributing to price independence and market efficiency. Thus, boldly claiming that chart-reading techniques had no value to investors.

While Fama (1965) laid the foundations of the Efficient Market Theory in his 1965 paper, he explicitly formulated and empirically tested the theory in 1970 (Fama, 1970). His groundbreaking paper provided a comprehensive review of existing theoretical and empirical evidence on the efficient markets model classifying three forms of market efficiency: (i) weak form market efficiency (ii) semi-strong form market efficiency, and (iii) strong form market efficiency (Fama, 1970). Weak form market efficiency tests incorporate information sets only related to the price or return history of a security. Semi-strong market efficiency tests incorporate information sets related to all publicly available information, and strong-form market efficiency tests incorporate information sets related to public and private (or inside) information of a security.

Much research has been devoted to testing the three forms of market efficiency with diverse findings. During the 1950's up to the 1980's, weak and semi-strong form market efficiency tended to hold well and were widely accepted (Jensen, 1978). For example, in a lengthy review of weak form market efficiency tests in the 70s (also Random Walk Theory), Fama (1970:414) concluded that the "results are strongly in support". Similarly, semi-strong form tests of market efficiency, where the speed of stock price adjustments to the release of new information is of interest, were largely accepted as well (Dimson and Mussavian, 1998; Fama et al., 1969; Jensen, 1978). However, strong form market efficiency was not fully accepted as it represented more of a conceptual addition to the previous two forms of market efficiency rather than a realistic condition (Dimson and Mussavian, 1998; Jensen, 1978).

Although the Efficient Market Theory has been extensively tested by proponents and critics, the evidence remains inconsistent and scholars continue in trying to empirically verify or refute it (Fama, 1991). The fact that market efficiency can only be tested in conjunction with a model of market equilibrium (e.g. capital asset pricing model) increases the complexity of this task, as all tests for market efficiency will be joint tests of market behaviour and models of asset pricing (Dimson and Mussavian, 1998). I will discuss this important issue in more detail in Chapter 2.7. 'Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium'.

The empirical literature on market efficiency is so voluminous, that several reviews exist (Dimson and Mussavian, 1998; Kothari, 2001) and more recently (See e.g. Subrahmanyam, 2010; Fama and French, 2015; Jacobs, 2015) to comprehensively discuss the state of the Efficient Market Theory at different points in time.

2.2 Definition of Market Efficiency

Several definitions of market efficiency exist to date. According to the founding father of the Efficient Market Theory, efficient capital markets are "efficient in processing information" (Fama, 1976:133). This means that stock prices observed in capital markets are based on "correct" assessments of all information available at a given moment in time (Fama, 1970, 1976). Thus, in an efficient capital market stock prices entirely incorporate all available information (Fama, 1970) which leads to the conclusion that given informational efficiency, "actual prices at every point in time represent very good estimates of intrinsic values" (Fama, 1965:90).

As the difference between the price and the intrinsic value of a stock is the expected reward for investing in that stock, according to Fama's definition of an efficient market, that difference should be close to zero (Kothari, 2001). Meaning that there is no abnormal reward to be made and that the intrinsic value of a stock is reflected in its price. Thus, the Efficient

Market Theory posits that active investors[7] will not be able to consistently outperform the market (Bodie et al., 2008). Based on this reasoning, proponents of the Efficient Market Theory argue that passive investment strategies, such as Exchange Traded Funds (ETFs)[8] will be always superior relative to actively management mutual funds (Fama, 1970; Jensen, 1968). Under the Efficient Market Theory, active management is seen as a wasted effort and merely understood to increase transaction costs which will reduce the performance of active funds net of fees (Jensen, 1968).

After his original definition of the Efficient Market Theory in the 70s, Fama amended his initial definition of market efficiency, to keep up with newly published evidence challenging the Efficient Market Theory, over the following years (Fama, 1991). In his dissertation, Fama (1965:90) defined an efficient market as one where "...given the available information, actual prices at every point in time represent very good estimates of intrinsic values." In a later paper, Fama (1995:56) revised his definition by stating that "...the actual price of a security will be a good estimate of its intrinsic value." It is not surprising that Fama revised his definition, given the published empirical evidence against even the weakest form of market efficiency, as new work found that stock returns can be predicted, for example, based on past returns or dividends (Fama, 1991).

A more general and economically relevant definition of Efficient Markets is provided by Michael Jensen, which Fama later acknowledged as "...an economically more sensible version of the efficiency hypothesis.", reads as follows (Fama, 1991:1575; Jensen, 1978):

"A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t." (Jensen, 1978:96)

This definition of efficient markets is more flexible as it implies that capital markets can be more or less efficient over time. Jensen's understanding of an efficient market is also more in line with Grossman and Stiglitz (1980) thought of non-constant market equilibrium. The authors note that a market for information will not be always in equilibrium if arbitrage is costly. Only those arbitrageurs who spend resources to gather information receive a compensation (Grossman and Stiglitz, 1980). In their model, information flows from the

[7] Active investors are those investors who try to outperform their chosen general market index such as the S&P 500 or MSCI All World. Generally, any fund manager who invests money of a third party, will be bound to some benchmark index specified in their investment policy.
[8] These are passive mutual funds that aim to replicate equity indexes.

"informed" to the "uninformed", whereby informed individuals bid up the price of a security when the return is going to be high and bid down the price when the return is going to be low (Grossman and Stiglitz, 1980).

In relation to the Efficient Market Theory, Grossman and Stiglitz (1980) reject Fama's definition of an efficient market, because if it were true, then informed traders could not make a return on using their information. There is mounting empirical and practical evidence to support the claim that informed traders do consistently beat passive investment strategies, such as broad equity market benchmarks (Berkshire Hathaway, 2014; Blake et al., 2013). Also, several real-world investors such as Warren Buffett, Walter Schloss, Charles Munger and many other prominent investors have managed to continuously outperform passive equity indexes such as the S&P500, over many years (Berkshire Hathaway, 2014; Buffett, 1984).

2.3 Theoretical assumptions for perfect Efficient Markets

Before addressing the theoretical assumptions for Efficient Markets in more detail and how they relate to ESG or Responsible Investment in this thesis, I briefly discuss the major assumptions for perfect markets to draw a distinction between perfect and efficient markets.

Perfect Market Theory has had a substantial impact on Finance research during the 50s and 60s, when it was applied to research questions related to stock price behaviour, corporate finance and capital asset pricing (Jensen et al., 1989). A perfect (competitive) market is generally characterised by the conditions of price takers, free entry and exit of companies, homogenous products, and perfect information (Mankiw, 2012).[9] This means that the price of a product (or e.g. a security) is determined by supply and demand of competing economic agents and the market as a whole rather than certain individual economic agents (Mankiw, 2012). While perfect markets are an unachievable ideal in real markets, they provide a theoretical benchmark to which real markets can be assessed against (Jensen et al., 1989). Thus, broadly speaking, it could be said that Fama's (1970) Efficient Market Theory was developed within the framework of Perfect Market Theory in the context of stock price behaviour. A well-known theory of stock price behaviour is the random walk theory, on which the Efficient Market Theory is ultimately based on (See Chapter 2.1. 'Brief History of Efficient Market Theory). The motivation of the Efficient Market Theory is therefore not to

[9] As the market consists of many buyers and sellers whose buying and selling activities have an insignificant impact on the market and the price of a product, they take the price as given and are therefore called 'price takers' (Mankiw, 2012). Companies do not have any barriers of entering or exiting a desired market and also sell the same product (Mankiw, 2012). Finally, perfect information implies that buyers and sellers have full transparency of the conditions of the market as well as that the information is freely and costlessly available (Mankiw, 2012).

establish whether markets are perfect, as this is an ideal state, but to establish whether markets are efficient in processing information and thereby accurately determine stock prices (accurate estimates of value) (Fama, 1976). To conclude, perfect markets imply efficient markets, however, capital markets can be efficient without being perfect (Welch, 2011).

According to Fama (1970:387), in a market where the current price of a security "fully reflects" all available information, the following three conditions or assumptions are sufficient for markets to be efficient. [10] Violations of any of the following three assumptions could be seen as a potential source for market inefficiency:

i) No transaction costs in trading securities
ii) Asset markets are frictionless, and all information is costlessly and simultaneously available to all investors.
iii) Investors are price-takers and have equivalent (homogenous) expectations on the implications of current information for the current price and distributions of future prices of securities.

These assumptions are extreme and non-existent in real-world capital markets (Fama, 1970). However, in the following paragraph, I will aim to discuss the implications of each of the core assumptions of the Efficient Market Theory and compare how they differ from conventional relative to socially responsible investor portfolios, to see if any has a greater potential for market inefficiency.

i) Transaction costs of buying and selling securities do not differ between conventional and responsible investor portfolios because the responsible investor draws from the same, although more restricted stock universe, relative to the conventional investor. However, transaction fees for investment in mutual funds, such as management fees and load fees (front-end and back-end fees)[11], are perceived to differ to some extent (see e.g. Renneboog et al., 2008). One would expect socially responsible mutual funds to be more expensive due to their costs of engaging with and actively monitoring companies on socially responsible issues (Gil-Bazo et al., 2010). However, after comparing the fee differential

[10] Models of market equilibrium, such as the Capital Asset Pricing Model (CAPM), to test for market efficiency rest on the beforementioned and three additional assumptions (Copeland et al., 2005; Shih et al., 2014):
iv) Investors are risk-averse and rational, aiming to maximise the expected utility of their wealth.
v) The quantities of assets are fixed, and all assets are marketable and perfectly divisible.
vi) There exists a risk-free asset at which investors may borrow or lend unlimited amounts.

[11] Load fees pay for trading costs and marketing expenses; management fees tend to pay for managerial compensation (Renneboog et al., 2008a)

between socially responsible and conventional mutual funds, Gil-Bazo et al. (2010) come to conclude that fund fees are not statistically significantly between the two groups.[12]

ii) In the context of social responsibility and ESG information, the assumption that all information is costlessly and simultaneously available to all investors, does not apply. Not all companies voluntarily disclose and report on their sustainable performance. In order to fill this information gap for investors, third party ESG data providers have specialised in collecting and standardising this information. Sources for ESG information vary from one data provider to another, but predominantly rely on written questionnaires and interviews with company managers, in addition to public information (Aslaksen and Synnestvedt, 2003; EIRIS, 2011d). To compensate for collecting and standardising ESG information, data providers such as EIRiS charge fees for their data and research services. Thus, in contrast to the assumption of costlessly and simultaneously available information to all investors, in the context of ESG information, not all investors will have access to this information at the same time. The fact that ESG information is costly and not simultaneously available to all investors has implications for the Efficient Market Theory. As a result, it could be argued that given the cost and access to ESG information, the semi-strong form of the Efficient Market Theory does not hold with respect to this kind of information. Further, this condition could be seen as a potential source for stock market inefficiency, according to Fama's definition of an efficient market (Fama, 1970).

iii) The third assumption for efficient markets posits that investors have homogenous expectations on the current information for the current price and distributions of future prices of securities (Copeland, 2005; Fama, 1970). This assumption is likely the largest source for market inefficiency and a great challenge to the Efficient Market Theory. According to Fama (1970), stock markets could be inefficient with respect to this third assumption, if there are investors who will consistently make superior assessments of current publicly available information relative to the information already incorporated in market prices (and assessed by the market[13]). While Fama (1970:388) originally argued that disagreement among investors does not imply markets to be inefficient, Fama and French (2007:672) updated the original statement by concluding that "...without complete agreement, testable predictions about how expected returns relate to risk are also lost." According to Fama and French (2007), disagreement between investors can be explained by two groups of investors, the informed

[12] Average fund expenses for socially responsible mutual funds relative to conventional mutual funds are 134.45 and 135.58, respectively. Average total load fees for socially responsible mutual funds amount to 181.55 relative to 213.34 for conventional mutual funds (See Gil-Bazo et al., 2010).

[13] The market represents all investors such as informed and uniformed investors (Fama and French, 2007).

and the misinformed. While the group of informed investors will know the distribution of future prices of securities, the misinformed will misperceive it (Fama and French, 2007). Thus, disagreement between informed and misinformed investors will lead to informed investors to overweight (underweight) assets that are underweighted (overweighted) by misinformed investors due to their "erroneous" beliefs[14] about the distribution of future prices of securities (Fama and French, 2007).

One the one hand, if socially responsible investors falsely estimate the future prices of securities by integrating ESG information into their analysis, the large share of informed investors would not be able to erase fully the price effect of socially responsible investors (Fama and French, 2007). The price effect would last until socially responsible investors or the misinformed learn that they are misinformed (Fama and French, 2007). As long as socially responsible investors do not correct their erroneous beliefs, markets would be theoretically less efficient (Fama and French, 2007). However, this is only possible if socially responsible investors or investors with erroneous beliefs represent a large share of invested assets (Fama and French, 2007). In today's stock markets, socially responsible assets represent about 30 percent of the total global invested assets, which means that social responsibility or ESG information would not make the stock markets entirely inefficient (GSIA, 2014). Also, predictions about expected returns and risk will have meaning "...without complete agreement..." (Fama and French, 2007:672).

On the other hand, if socially responsible investors rightly estimate the future prices of securities by considering ESG information in their analysis, and ESG criteria matters, then stock markets would be inefficient. Several studies have shown that investors do not use value-relevant or "priced" ESG information in their decision-making processes (See e.g. Campbell and Slack, 2011; Clarkson et al., 2013; Hamilton et al., 1993)

To sum up, two out of the three main assumptions underlying the Efficient Market Theory could be potential sources for stock market inefficiency. First, ESG information is costly and not simultaneously available to all investors. Second, investors do not have homogenous expectations on the current information for the current price and distributions of future prices of securities, as some investors have shown to be able to consistently assess publicly available information better than others (Copeland, 2005; Fama, 1970). The following chapter discusses the pricing of ESG information in stock markets.

[14] "Erroneous" beliefs are defined as investment tastes of investors that lead to a departure of rational prices, such as socially responsible investing, loyalty, home bias, favourite sports team and so on (Fama and French, 2007).

2.4 Empirical Tests of Market Efficiency

Since Fama's formulation of weak, semi-strong, and strong-form market efficiency in the 70s, hundreds of papers have empirically tested market efficiency and as Fama (1991:1575) notes himself, "The literature is now so large that a full review is impossible...". In this spirit, the subsequent chapter will briefly review the most relevant articles that have appeared on each of the three forms of market efficiency. Further, I will aim to highlight the position of my thesis with respect to existing empirical tests of market efficiency.

2.4.1 Weak Form Tests

Weak form tests of market efficiency were performed to test the price or return independence assumption of the Random Walk Model (or Random Walk Theory) (Fama, 1965). In other words, markets are said to be weak form efficient when technical traders cannot use information incorporated in historical prices to predict future prices. Meaning that prices or returns should be independent of each other. In order to test this assumption, Fama (1965) computed serial correlation coefficients, runs tests[15], and Alexander's filter techniques on daily, four-day, nine-day, and sixteen-day stock market price changes, to conclude that there is no evidence of dependence, and that the independence assumption of the Random Walk Model can be confirmed. In the light of subsequent research (see e.g. Lo and MacKinlay, 1988), Fama (1991:1580) corrected his initial conclusion that returns could not be predicted. He argues that "...recent research is able to show confidently that daily and weekly returns are predictable from past returns." Not only did scholars find that past returns help predict future returns, other variables such as inflation, interest rates, dividend yields, earnings/price ratios, helped predict stock returns (Bodie, 1976).

2.4.2 Semi-Strong Form Tests, i.e. Event Studies

The goal of short-term semi-strong form market efficiency tests is to examine whether stock markets[16] use available information correctly in setting stock prices (Fama, 1976), and the speed at which stock prices adjust to the release of new information (Fama, 1970). The dominant empirical tool to test for short-term semi-strong market efficiency is the event study methodology, using the CAPM or the market model (See e.g. Equation 4) (Dimson and Mussavian, 1998). Essentially, event studies examine the short-term price behaviour of securities around specific events such as changes in legislation, earnings announcements, or

[15] Fama (1965:74) defines a runs test "as a sequence of price changes having the same sign".
[16] Aggregate decisions of individual investors (Fama, 1976)

stock splits (Binder, 1998). Fama et al. (1969) was the first study to perform an event study. To empirically test how quickly prices adjust to new information, Fama et al. (1969) investigated the effect of stock splits on securities' stock prices.[17] The authors concluded that the stock market "almost immediately" incorporates stock split information after the announcement date (Fama et al., 1969:20). In relation to stock market efficiency, their findings implied that stock markets are indeed efficient given the rapid adjustment of stock prices to that particular event. Subsequent event studies have used various events to investigate how stock prices react to the arrival of new information in the form of mergers and acquisitions (Halpern, 1983), seasoned equity offerings (Akhigbe and Whyte, 2015), sovereign debt rating announcements (Michaelides et al., 2015), corporate social responsibility (Krüger, 2015), environmental regulation (Ramiah et al., 2013), and environmental programmes (Fisher-Vanden & Thorburn, 2011) have been studied extensively.

In the context of socially responsible investing, many event studies have been performed to investigate the stock price behaviour of firms to the arrival of new information in relation to environmental, social, and governance information and its implications for market efficiency (Frooman, 1997). Frooman's meta study of 27 published works on this topic revealed that shareholder wealth decreases if firms act in an irresponsible or illegal manner (Frooman, 1997). In particular, he observed significantly negative abnormal returns for firms with many controversial and illegal incidents (or events) such as criminal misconduct, fraud, pollution, product recalls, fines for safety violations, and price fixing. These findings are in line with recently published works (Krüger, 2015). Similarly, Hamilton (1995) finds that firms with higher pollution events such as air emissions or toxic spills experience significantly negative abnormal returns after the announcement. Klassen and McLaughlin (1996) even observe significantly positive abnormal returns for firms with strong environmental management initiatives.

With respect to the implications for stock market efficiency, the predominant view held among scholars using the event study methodology in this field is that usually new events related to environmental, social, and governance issues tend to be relatively quickly incorporated into the stock prices of firms (See e.g. Capelle-Blancard and Laguna, 2010; Endrikat, 2015; Jacobs et al., 2010; Little et al., 1995). As such, stock markets tend to be efficient relative to new publicly available information in the short-term. The emphasis on the

[17] More technically, the residual from the estimated market model shows whether stock splits have any effect on the return of a firm, after controlling for an economy wide factor (Binder, 1998).

short-term is important, as the event study methodology is not capable of assessing whether the market is efficient over longer periods of time, and whether market efficiency persists or not. In the following chapter I will review studies testing market efficiency over longer time periods.

2.4.3 Strong-form Tests

The strong-form of the Efficient Market Theory implies that all available information (public and private information) is entirely reflected in stock prices (Fama, 1970). As the theory distinguishes between public and private information, it is important to explain what is meant by private information. The literature distinguishes between two types of private information, a) inside information held by corporate insiders, and b) private information held by professional investment managers, which could be in form of private assessments based on public information (e.g. an analyst's assessment report) (Fama, 1970, 1991). Thus, the goal of strong-form market efficiency tests is to investigate the long-term profitability of mutual fund managers and investment trading strategies with specialist information (Dimson and Mussavian; Fama, 1970). These tests are concerned with the ability of investors or trading strategies to consistently outperform the market, which should not be possible if the market is truly efficient (Fama, 1970). Jensen (1968) was probably one of the first and most comprehensive tests of this kind of strong form market efficiency tests, at the time. He analysed the investment performance[18] of 115 mutual funds over the period from 1945 to 1964, using an "absolute" measure of investment performance, i.e. the multiperiod Capital Asset Pricing Model (CAPM) based on Lintner (1965) and Sharpe's (1964) single-period model (See e.g. Equation 4), and found very little evidence that mutual funds outperformed the market significantly, even before deducting mutual fund fees of a fund manager (Jensen, 1968). Based on his evidence, he concluded that markets are efficient and investors are better off with a passive buy-and-hold strategy (Jensen, 1968).

However, since the 70s "There is evidence that some security analysts (e.g., Value Line) have information not reflected in stock prices", Fama concluded in his second extensive review on the strong-form market efficiency (Fama, 1991:1603). He argues that some scholars (see e.g. Copeland and Mayers, 1982; Stickel, 1985) have found evidence that Value Line and other security analysts produce private information and when that information is revealed to the market it leads to stock price adjustments. These adjustments occur because producing private information is costly and investors are compensated for incurring these

[18] Which is defined as the "predictive ability" of a portfolio manager (Jensen, 1968).

costs (Fama, 1991). This implies that the stock market is less efficient because there will be some private information that is not entirely reflect in stock prices (Fama, 1991).

In the context of socially responsible and ESG investing, and similar to Jensen's work on mutual funds, several studies have investigated the financial performance of socially responsible mutual funds relative to conventional funds over the long term (Barnett and Salomon, 2006; Bauer et al., 2005; Geczy, et al., 2005; Hamilton et al., 1993; Kreander et al., 2005; Renneboog et al., 2008a). The main conclusion of these studies tends to be that socially responsible funds neither significantly outperform nor underperform relative to conventional funds[19]. In terms of the implications for market efficiency, this research would indicate that markets seem to be efficient in the long term.

However, in addition to studies on mutual funds, much research has assessed whether certain investment trading strategies based on ESG information generate abnormal returns over the long term (See e.g. Edmans, 2011; Gompers et al., 2003; Kempf and Osthoff, 2007), which would imply that markets are not efficient with respect to certain environmental, social, and governance information. As these studies find that investment trading strategies based on high social responsibility, good corporate governance, and positive employee relations generate significant abnormal returns, one could question whether markets are truly efficient in the long run with respect to certain information sub-sets.

In my thesis, the efficiency of capital markets is understood along the lines of Jensen's somewhat more economically relevant definition of an efficient market (See Chapter 2.2. 'Definition of the Efficient Market Theory'. This means that stock markets are efficient based on a certain information set as long as it is impossible to make economic profits based on that information set (Jensen, 1978). I will address the implications of each of my empirical findings for the efficiency of capital markets based on Jensen's definition. Having reviewed several studies that test Fama's weak, semi-strong, and strong-form tests of market efficiency, my thesis is most similar to the kind of market efficiency tests conducted by Jensen (1968), that aim to investigate the long-term profitability of investment trading strategies (portfolio trading strategies), equity indexes, and companies, rather than market efficiency tests in the strictest sense such as studies on insider trading[20] (See e.g. Tavakoli et al., 2012). In this spirit, the studies closest to mine are those of Edmans (2011), Gompers et al. (2003), Kempf and Osthoff (2007), and Schröder (2007).

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[19] While some studies tend to find a significant outperformance of socially responsible mutual funds relative to conventional mutual funds (See e.g. Mallin et al., 1995).

[20] For example, Tavakoli et al. (2012) conclude that insider trading activity has predictive power in excess of publicly available information which challenges the strong-form market efficiency.

2.5 Efficient Market Theory and ESG information

2.5.1 Pricing of ESG information

The theoretical debate about socially responsible investing (which is the incorporation of environmental, social, and governance criteria into investment processes) in the context of traditional Finance theories such as the Efficient Market Theory have led to the development of alternative hypotheses (see Bauer et al., 2005; Hamilton et al., 1993). In the context of informationally efficient markets and Efficient Market Theory, the question whether ESG information is a "priced" risk factor matters to a great extent. To answer the question whether ESG is "priced" in stock markets, scholars tend to refer to the theoretical debate on demand differences (or tastes) for different types of stocks (Fama and French, 2007; Galema et al., 2008; Hamilton et al., 1993). For example, excess demand for socially responsible stocks and a shortage in demand for conventional stocks will overprice socially responsible stocks (Galema et al., 2008). This explanation is in line with Heinkel et al.'s (2001) capital market equilibrium model, which is also consistent with efficient capital markets, and shows that when socially responsible investors do not have a preference for irresponsible companies due to their differences in tastes for certain assets (See e.g. Fama and French, 2007), then fewer investors are available to hold the shares of irresponsible companies, which will reduce diversification (risk-sharing) and increase a companies' cost of capital (Heinkel et al., 2001).

To empirically test whether social responsibility is priced in the traditional finance context, Hamilton et al. (1993:63) suggest the following three hypotheses:

> *Hypothesis 1:* (Risk-adjusted) expected returns of socially responsible portfolios are equal to (risk-adjusted) expected returns of conventional portfolios.
>
> *Hypothesis 2:* (Risk-adjusted) expected returns of socially responsible portfolios are lower than the expected returns of conventional portfolios.
>
> *Hypothesis 3:* (Risk-adjusted) expected returns of socially responsible portfolios are higher than the expected returns of conventional portfolios.

According to Hamilton et al. (1993), social responsibility or ESG information will not be priced if expected returns are equal. This is because "...responsible investors who sell stocks find enough conventional investors ready to buy that the prices of the stocks do not drop." Hamilton et al. (1993:63). The second hypothesis (underperformance hypothesis) is consistent with a view where social responsibility or ESG information is priced by the market. As Heinkel et al. (2001) explain, when fewer conventional investors are available to hold the shares of a responsible company, this wil reduce diversification (risk-sharing), lower the stock price, and increase the company's cost of capital. The third hypothesis (overperformance hypothesis) is also consistent with a view where social responsibility or ESG information is priced, however, mispriced. Hamilton et al. (1993:64) argue that this is possible when a significantly large share of investors "consistently underestimate the probability that negative information will be released about companies that are not socially responsible" (Bauer et al., 2005). To give one example, conventional investors who consistently underestimate the likelihood of chemical firms having issues with uncontrolled chemical spills, will see a drop in the stock prices of these chemical firms following the spill. While reduced stock prices will lower the returns of conventional portfolios holding chemical stocks, portfolios of socially responsible investors will be unaffected (See e.g. Hamilton, 1995)[21]. In such a situation, stock markets do not price social responsibility correctly (Bauer et al., 2005; Hamilton et al., 1993; Moskowitz, 1972).

After Hamilton et al.'s first study on this topic, many empirical studies have followed in testing the performance differential of socially responsible and conventional portfolios and the implications for social responsibility as a "priced" risk factor.

In support of the underperformance hypothesis of socially responsible portfolios, Renneboog et al. (2008a) document that socially responsible investment funds domiciled in Europe, North America, and Asia-Pacific significantly underperform their conventional market benchmarks by -2.2 to -6.5 percent per annum. Thus, in line with the underperformance hypothesis, the authors conclude that ESG screens tend to negatively impact on the returns of socially responsible investment funds. Any additional screen reduces the financial performance by 1 percent per annum, all else equal (Renneboog et al., 2008a). The implications of their findings support the theoretical notion that social responsibility is priced by the market, but that socially responsible investment funds are overpriced (Galema et al., 2008; Hamilton et al., 2003).

Much of the empirical evidence is in support of the equal-performance hypothesis, whereby neither socially responsible portfolios nor conventional stock portfolios over-or underperform relative to each other. In other words, most studies find no significant difference between the risk-adjusted returns of socially responsible portfolios relative to conventional portfolios (Barnett and Salomon, 2006; Bauer et al., 2005; Geczy, et al., 2005; Kreander et al., 2005). These findings are consistent with a view that social responsibility is

[21] Hamilton (1995) found that investors experienced negative abnormal returns holding publicly traded stocks, following the disclosure of negative news on environmental pollution as proxied by the EPA's Toxic Release Inventory (TRI).

not priced by the stock market (Hamilton et al., 1993). On a sample of US socially responsible mutual funds, Geczy et al. (2005) conclude that socially responsible screens impose a cost of merely 1 to 2 basis points per month. Similarly, Bauer et al. (2005) find no evidence of German, UK and US socially responsible mutual funds to perform significantly different relative to conventional funds, over the sample period from 1990 to 2001. Barnett and Salomon (2006) find a U-shaped relationship between the amount of socially responsible screens and the financial performance of socially responsible investment funds. More specifically, they argue that initially socially responsible investors pay a price for employing socially responsible screens, however, as the screening intensity reaches a maximum, the risk-adjusted returns are improved again (Barnett and Salomon, 2006). Finally, using a matched-pair technique on a sample of 60 socially responsible and conventional funds, Kreander et al. (2005) find no significant difference in the risk-adjusted returns between the two types of funds.

According to Hamilton et al.'s (1993) third hypothesis, if socially responsible portfolios have higher returns relative to conventional portfolios, stock markets will incorrectly price social responsibility. Such mispricing has been reported in several empirical and meta studies[22] investigating socially responsible investment portfolios and several dimensions of social responsibility and ESG information (Beurden and Gössling, 2008; Kempf and Osthoff, 2007; Mallin et al., 1995; Margolis and Walsh, 2003; Orlitzky et al., 2003). Based on a matched sample of UK ethical mutual funds relative to non-ethical mutual funds, Mallin et al. (1995) find ethical funds to outperform both, their non-ethical counterparts and conventional equity market benchmarks. A related study (see e.g. Kempf and Osthoff, 2007) investigates the implications of two competing investment trading strategies of buying stocks with high social responsibility and selling stocks with low social responsibility. The authors report that such a long/short trading strategy is capable of generating abnormal returns of 8.7 percent per annum (Kempf and Osthoff, 2007). Some evidence of socially responsible criteria not being fully valued by the stock markets has also been reported (Edmans, 2011). The study finds an abnormal performance of an investment trading strategy, based on a portfolio of firms with strong employee satisfaction, that outperforms conventional portfolios by 3.5 percent per annum (Edmans, 2011). One reason for the outperformance, the author suggests, is related to mispricing, whereby high employee

[22] Several meta studies (see e.g. Beurden and Gössling, 2008; Margolis and Walsh, 2003; Orlitzky et al., 2003) document a slightly positive performance difference in favour of socially responsible portfolios relative to conventional ones.

satisfaction causes higher firm value which the stock market fails to recognise immediately (Edmans, 2011). The mispricing, i.e. the abnormal performance of socially responsible criteria found in Edman's study persists for several years until it is corrected by the stock market.[23] This finding is at odds with the Efficient Market Theory, as social responsibility or any ESG variable that is beneficial to the value of a firm should be quickly incorporated and not lead to any prolonged excess returns over time (Edmans, 2011).

In summary, whether social responsibility or ESG information is "priced" by the stock market has been intensely debated in the empirical literature and to a much lesser extent in the theoretical literature (Three formal theoretical approaches have been proposed by Dam and Scholtens, 2015; Heinkel et al, 2001; Mackey et al., 2007)[24]. To empirically analyse whether ESG information is "priced" by the market, Hamilton et al. (1993) suggest three alternative hypotheses (equal performance, underperformance, or overperformance) based on the risk-adjusted returns of socially responsible portfolios relative to conventional portfolios. The under- or overperformance hypotheses are consistent with a world where socially responsible criteria is "priced" by the markets. The underperformance hypothesis indicates excess demand for socially responsible firms and leads to overpricing of these firms (Galema et al.,2008; Hamilton et al., 1993). In contrast, the overperformance hypothesis indicates that investors "consistently underestimate the probability that negative information will be released about companies that are not socially responsible" (Hamilton et al., 1993:64). In a world where the equal performance hypothesis holds, social responsibility is not priced by the market. A lot of empirical evidence has been devoted to testing Hamilton et al.'s three hypotheses, with mixed results.

2.6 Systematic risk, Idiosyncratic risk, and Diversification

The Theory of Efficient Markets assumes investors to be "...rational, profit-maximizers actively competing, with each trying to predict future market values of individual securities..." (Fama, 1995:4). These rational investors are essentially interested in earning the highest returns possible given a chosen level of risk (Fama, 1970). One possibility, as Fama notes is "to posit that equilibrium prices (or expected returns) on securities are generated as in

[23] Edmans (2011) shows that abnormal returns declined and completely disappeared after 5 years.
[24] Building on the theoretical frameworks of Heinkel et al. (2001) and Mackey et al. (2007), Dam and Scholtens (2015) argue that from an external (investor) perspective, social responsibility is associated with a higher market value relative to book value, as the assets of socially responsible companies are priced higher than the assets of irresponsible companies due to less demand for irresponsible companies. As mentioned previously, this argumentation links up to the theoretical debate on demand differences (See e.g. Fama and French, 2007; Galema et al., 2008; Hamilton et al., 1993).

the 'two parameter' Sharpe [40] Lintner [24,25] world" (Fama, 1970:384). The "two parameter world" Fama refers to in his paper, is also known as the Capital Asset Pricing Model (CAPM) (Lintner, 1965; Sharpe, 1964).

In the CAPM model, risk is represented by the "beta coefficient", which is also referred to as "systematic risk" (Ross et al., 2008:418). Beta can be computed by the sum of the sample covariance between the excess returns on a portfolio (x) and the excess returns on a market index (y)[25] (Black et al., 1972; Brooks, 2008). The CAPM model can be formally expressed by the following equation:

$$E(R_i) = R_f + [E(R_M) - R_f] * \beta_i \qquad (1)$$

where, R_f is the return on some risk-free rate. $E(R_M) - R_f$, represents the risk-adjusted return on a market index. β_i, refers to systematic risk.

In other words, beta measures the exposure of portfolio (x) to the movements of market index (y) (Bodie et al., 2008). Thus, in an efficient market, rational investors will be compensated with a higher expected return if they take on more risks or higher beta portfolios/stocks (Fama, 1970).

Systematic risks refer to those risks that affect all firms in a portfolio or stock market that cannot be simply eliminated by diversification (Bodie et al., 2008). For example, Statman (1987) argues that at least 30 stocks are required for a well diversified portfolio. Other commentators suggest to hold over 30 stocks domestically and internationally (Solnik, 1995). The risk that remains after diversification is systematic (Bodie et al., 2008). Examples of systematic risks generally relate to macro-economic variables such as interest rates, inflation, industrial production, oil prices, regulations, economic recessions, and war (Chen et al., 1986; Gilson and Kraakman, 2014; Hamilton, 1983). While systematic risks have been predominantly associated with economic factors in the past, more recently, systematic risks have also been associated with environmental, social and governance risks. Environmental risks such as climate change risks increase the likelihood of earthquakes and other weather anomalies that could affect entire stock markets (see e.g. Liesen, 2012; Pinkse and Kolk, 2009). Systematic risks related to governance issues could be political risks (Bekaert et al., 2014; Click, 2005). For example, these risks could include governments seizing private assets and imposing unexpected taxes or royalties on company profits across entire stock markets

[25] Or more formally expressed in the following equation (Brooks, 2008): $\beta = \frac{\Sigma(X_t - \bar{X})(Y_t - \bar{Y})}{\Sigma(X_t - \bar{X})^2}$ (2)

(Bekaert et al., 2014; Brewer, 1983). Other examples of political risks are driven by social upheaval and could include terrorism and civil war (Click, 2005).

Several scholars (see e.g. Aupperle and Van Pham, 1989; Oikonomou et al., 2012) have found evidence that environmental, social, and governance risks increase systematic risk. In particular, Oikonomou et al., (2012) show that a firm's community concerns[26] are positively related to measures of systematic risk (proxied by beta, as computed in Equation 2), based on a large sample of US firms.

Legislation is one of the channels through which external systematic risks related to environmental, social, and governance issues become internalised. Legislation is a systematic risk because once a law is in place it will affect all companies in a portfolio or stock market. ESG related legislation would be no exception. For example, Renneboog et al., (2008b) and Richardson (2008) provide excellent summaries of national legislatory initiatives in the context of socially responsible investing in different countries. The authors expect the number of ESG related legislation to increase in the future[27].

In contrast to systematic risks, risks that can be diversified away are referred to as unsystematic, diversifiable, or idiosyncratic risks (Bodie et al., 2008). These risks are usually firm, or industry-specific. According to the Efficient Markets Theory and Modern Portfolio Theory, rational investors receive higher compensation for taking higher systematic risks (Markowitz, 1952). As idiosyncratic risks can be eliminated through diversification in an efficient market, systematic risks tend to be the risks *rational* investors care about (Markowitz, 1952).

However, idiosyncratic risks matter as well, especially in the context of socially responsible investors, who include environmental, social, and governance (ESG) risks in their asset allocation decisions.[28] According to the Efficient Market Theory, socially responsible investors are not seen as fully rational investors, but as investors with "...an extreme form of tastes for assets of consumption goods...", rather than *rational* investors who purely focus on maximising risk-adjusted returns (Fama and French, 2007:675). Thus, the socially responsible investor's utility is not only constrained to maximising risk-adjusted returns, but environmental, social, and governance considerations matter to a great extent, whereby

[26] These are defined as "Investment controversies, negative economic impacts, tax disputes, and other concerns" (Oikonomou et al., 2012:493).
[27] Some examples of ESG-related regulatory initiatives can be found in the UK's amendment to the Pensions Act (1995), German Renewable Energy Act, or the Sarbanes-Oxley Act Section 404.
[28] In contrast to proponents of the Efficient Market Theory and the rational agent model, Behavioural Finance scholars argue that idiosyncratic risks matter more to Arbitrageurs relative to systematic risks as they tend to be highly specialised and less diversified investors (Shleifer and Vishny, 1997).

socially responsible investors are willing to accept lower returns if their portfolio's social aims are met (Renneboog, 2008a). Bollen (2007) calls the socially responsible investor's utility a "multi-attribute" utility function that also incorporates personal and social beliefs.

2.6.1 Diversification and ESG information

Critics of socially responsible investing tend to argue that socially responsible portfolios will always underperform relative to conventional portfolios due to diversification[29] penalties (Hoepner, 2010; Kurtz, 2005; Rudd, 1981). They argue that under Modern Portfolio Theory, ESG screens (or any screen for that matter) reduce the investible universe and leave the investor with a suboptimal portfolio (Markowitz, 1952; Sharpe, 1964). A suboptimal portfolio within the mean-variance efficiency frontier that is tilted towards a less favourable risk-return tradeoff relative to conventional portfolios (Renneboog et al., 2008a).

While this seems plausible from a theoretical perspective, empirical evidence has shown that a reduced stock universe does not necessarily lead to less diversified portfolios and lower risk-adjusted returns.[30] For example, Bello (2005) investigates the effect of diversification on investment performance between socially responsible funds relative to conventional funds and finds no difference between these funds. Other studies report that even passive socially responsible investment portfolios, such as socially responsible equity indexes, generate competitive risk-adjusted returns relative to conventional equity indexes (Kurtz, 2005; Schröder, 2007). Thus, the return reducing effects of ESG screens on the diversification of portfolios are not certain (Bello, 2005).

More recent studies (see e.g. Hoepner, 2010) even challenge the widely held belief that ESG screens negatively affect portfolio diversification on the following two grounds. First, ignoring ESG screens could be financially detrimental. This results from the fact that diversification recommends investors to spread their assets across sectors and asset classes, regardless of whether certain assets are involved in controversies that could potentially harm their future financial value (e.g. BP's oil spill or Fukushima Daiichi's nuclear disaster)[31]. Second, several studies have highlighted the idiosyncratic risk mitigating effect of employing ESG screens (see e.g. Bauer et al., 2009; Boutin-Dufresne and Savaria, 2004; Lee and Faff,

[29] Portfolio diversification is a function of a) number of stocks, b) correlation between stocks, and c) standard deviation of stocks (Markowitz, 1952).
[30] Kacperczyk et al. (2005) show that skilled mutual fund managers could deviate from well-diversified portfolios to more concentrated holdings in industries when they believe to have informational advantages. On a sample of US mutual funds, the authors find that more concentrated funds perform better than well-diversified funds (Kacperczyk et al., 2005).
[31] Both of which have led to substantial fines for BP and Daiichi. For example, BP's oil spill will cost the company about 90 billion US Dollars in environmental liabilities (Chazan and Crooks, 2013).

2009; Mishra and Modi, 2013). Although advocates of Modern Portfolio Theory would argue that diversification alone eliminates idiosyncratic risks, as mentioned previously, portfolio diversification is a function of a) number of stocks, b) correlation between stocks, and c) standard deviation of stocks (Markowitz, 1952), whereby c) includes both, systematic and idiosyncratic risks (Hoepner, 2010). If the literature on the idiosyncratic risk reducing effect through ESG screens is correct, then a risk reduction will also affect the total risk, i.e. standard deviation and therefore the diversification of portfolios.

Not only from the perspective of socially responsible investors, conventional Finance scholars have started to question the power of diversification also (see e.g. Pukthuanthong and Roll, 2015). Empirical findings show that the annualised volatilities of portfolios are often about half as large as the volatilities of the same portfolios' constituents (Pukthuanthong and Roll, 2015). Even very well-diversified portfolios can be extremely volatile (Pukthuanthong and Roll, 2015). The authors show that on a portfolio basis, the S&P 500 had an average annualised volatility of 16.3 percent, while the individual constituents of the S&P 500 in aggregate amounted to an average annualised volatility of 36.1 percent, over the same time period.

2.7 Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium

Any empirical test of the Efficient Market Theory is subject to the so called "Joint Hypothesis Problem", which is regarded a serious issue in market efficiency tests (Fama, 1970, 1976). According to Fama (1991) the "Joint Hypothesis Problem" increases the complexity of testing for market efficiency. In fact, any test for market efficiency will always be a joint test of market behaviour and models of asset pricing (Dimson and Mussavian, 1998). Thus, if a study concludes that stock markets are inefficient, it could well be that the asset pricing model used in the study to test for market efficiency is a bad model of expected returns, for example, due to misspecifications relating to omitted variables or insufficient explanatory power (Dimson and Mussavian, 1998).

If anomalies (or stock market inefficiencies) persist over time and remain after testing different specifications of asset pricing models, then one could have found a real market inefficiency. However, this is not guaranteed. As the distinction between real market inefficiency and bad model of market equilibrium is very "ambiguous" (Fama, 1991:1576).

As a result, the Efficient Market Theory is not an empirically testable proposition because one can never be entirely certain whether the observed anomaly is attributable to market inefficiency or driven by a poor model of market equilibrium (Alajbeg et al., 2012). Or as Fama puts it, "The joint-hypothesis problem is more serious. Thus, market efficiency per se is not testable." (Fama, 1991:1575).

2.8 Critics of the Efficient Market Theory

In the following chapter, I will address the main critics of the Efficient Market Theory. The first camp of critics is generally supportive of the notion of efficient capital markets, however, criticise the models of market equilibrium used to test for efficient capital markets, as they continue to find stock market anomalies (or potential profit opportunities). The second camp of critics is more fundamental and questions one of the cornerstones of market efficiency: the rational agent model (Barberis and Thaler, 2002). Both camps provide alternative perspectives on the shortcomings of the Efficient Market Theory.

2.8.1 Stock Market Anomalies[32]

As mentioned in Chapter 2.2 "Definition of the Efficient Market Theory", according to the Efficient Market Theory, no investment strategy should yield abnormal risk-adjusted returns. Yet, the academic finance community has identified and documented over 100 investment strategies, i.e. stock market anomalies, that outperform passive investment strategies such as passive equity indexes, in the past (Subrahmanyam, 2010; Jacobs, 2015). The appearance of anomalies or potential profit opportunities is not consistent with the Efficient Market Theory (Schwert, 2003). Among the many stock market anomalies, the first to be documented was the value anomaly (Basu, 1977, 1983). Basu (1977) showed that firms with low Price/Earnings ratios financially outperformed firms with high Price/Earnings ratios by over 7% per annum. Based on these findings, Basu (1977) concluded that firms trading at different Price/Earnings ratios have been incorrectly priced by the market and therefore offer "abnormal" returns. The value anomaly uncovered by Basu (1977) was followed by another well documented anomaly: the size anomaly or the "small-firm effect" (Banz 1981; Reinganum 1981). From 1931 to 1975, Banz (1981) found that the 50 smallest stocks on the New York Stock Exchange outperformed the 50 largest stocks by about 1% per month. Banz' (1981) finding of a size anomaly was confirmed in different stock exchanges all over the world (See e.g. Dimson and Marsh, 1989). Since the discovery of the "small-firm effect" in the literature, the anomaly seems to have disappeared (Schwert, 2003). The disappearance of an anomaly would strengthen the argument that an actual market inefficiency existed, but had

[32] These are also referred to as "Cross-sectional tests of return predictability" (Kothari, 2001:110)

been corrected after its publication. In addition to the value and size anomalies reported in the literature, other well elaborated stock market anomalies are related to calendar and seasonal effects such as January, Weekend, Month of the year, Week of the month, Day of the week, and Hour of the day effects (Ariel, 1987; French, 1980; Harris, 1986; Keim 1983; Reinganum 1983; Rozeff and Kinney, 1976). Studies of calendar and seasonal effects tend to find empirical evidence for abnormal (positive or negative) returns during these periods. However, explanations for why calendar and seasonal effects exists are inconsistent (Dimson and Mussavian, 1998).

Another well known anomaly is the momentum effect (DeBondt and Thaler, 1985; Jegadeesh and Titman, 1993). While Jegadeesh and Titman (1993) find that investment strategies based on buying past winners and selling past losers in the short-term generate abnormal returns of about 12 percent over the sample period from 1965 to 1989, on average, DeBondt and Thaler (1985) show that investment trading strategies buying past losers and selling past winners in the long-term outperforms. It is therefore not surprising that investment opportunities based on momentum investing have been found to appear and disappear depending on the time period tested (Schwert, 2002).

Finally, some anomalies such as the Initial Public Offerings (IPO) effect are still debated fiercely (Ritter, 1991). The IPO anomaly indicates that an investment strategy investing in IPO's over the sample period from 1975 to 1984 substantially underperformed their benchmarks in the long-term (Ritter, 1991). It seems that over-optimistic investors tend to systematically over-estimate the value of freshly listed growth companies which results in stock price reversals and financial underperformance over the long-term (Ritter, 1991).

While the existence of stock market anomalies would generally indicate capital market inefficiency, this cannot be concluded with certainty for mainly two reasons. First, scholars who have discovered anomalies in stock markets in the past have most likely contributed to the efficiency of capital markets by explicitly highlighting successful trading strategies to investors in the real world. The disappearance, reversal, or re-appearance of past anomalies strengthens this point (Schwert, 2003). Second, due to the joint hypothesis issue, the existence of an anomaly does not necessarily deem capital markets inefficient, as the inefficiency could also lie with the tested model of market equilibrium, i.e. asset pricing model (Schwert, 2003)[33].

[33] I discuss the Joint Hypothesis Problem in more detail in Section 2.7. "Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium".

With the joint hypothesis issue in mind, several authors have claimed that stock market anomalies are driven by methodological biases and are not the result of actual market inefficiencies. Based on the size and value anomalies reported in the literature (see e.g. Banz, 1981; Basu, 1977, 1983; Reinganum 1981), and the apparent failure of the CAPM to explain the cross-section of average stock-returns, Fama and French (1992, 1993) have suggested to include two risk factors that proxy for the observed size and value anomaly, to extend the CAPM to a three-factor model (Fama, 2007). Similarly, as Fama and French's three-factor model did not account for the momentum anomaly, which was comprehensively documented in Jegadeesh and Titman's (1993) study, Carhart (1997) proposed a four-factor model that incorporates a momentum variable and extends Fama and French's three-factor model.

The bottom line is that observed stock market anomalies are always exposed to the Joint Hypothesis Problem. Whether one has found an actual stock market anomaly, or whether the anomaly appears to be driven partly or fully by a faulty equilibrium market model is very ambiguous. Thus, one will hardly conclude with certainty whether observed anomalies make the market inefficient.

2.8.2 Behavioural Finance Critique

While the base assumption of the anomalies literature is that of market efficiency in the spirit of Fama, the Behavioural Finance critique is more fundamental and questions one of the cornerstones of market efficiency: the rational agent model (Barberis and Thaler, 2002). The behavioural critique argues that financial markets are not expected to be efficient, and that "...systematic and significant deviations from efficiency are expected to persist for long periods of time." (Shleifer, 2000:1). The two main critiques of Behavioural Finance proponents on the Efficient Market Theory are limits to Arbitrage and psychological biases that make investors less rational than the rational agent model assumes (Barberis and Thaler, 2002; Bodie et al., 2008; Shleifer and Vishny, 1997). According to the Efficient Market Theory, rational arbitrageurs quickly eliminate all mispricing of security prices (at zero cost), which in turn discourages active investors to search for mispriced securities (making it impossible to profit from mispricing). The Arbitrage argument is criticised by proponents of Behavioural Finance because mispricing in stock markets could persist due to risky and costly Arbitrage strategies, which could lead to considerable mispricing for some time (Barberis and Thaler, 2002; Shleifer, 2000). Arbitrage strategies have been found to be exposed to the following two risks: Fundamental and Noise trader risk (Barberis and Thaler, 2002; De Long et al., 1990; Shleifer and Vishny, 1997). Fundamental risk is the risk of falling stock prices that rational arbitrageurs eliminate by simultaneously investing in one security and shorting an identical substitute security (Barberis and Thaler, 2002). This investment strategy is problematic because perfect substitute securities only rarely exist (Shleifer, 2000). Another limit to arbitrage, Noise trader risk, is related to the idea that mispricing opportunities turn into mispricing threats for rational arbitrageurs, due to a worsening of their Arbitrage position (Barberis and Thaler, 2002). De Long et al. (1990) argue that noise traders, these are traders with erroneous beliefs who trade on noise rather than information, make it difficult for rational arbitrageurs to exploit mispricing. The unpredictability of noise traders' future opinions about stocks could lead to a persistent divergence of the stock's fundamental value (Barberis and Thaler, 2002). Behavioural Finance scholars also oppose the idea of costless Arbitrage strategies. They argue that transaction costs such as commissions and other fund related fees can increase the cost of Arbitrage and thereby reduce the attractiveness of such opportunities (see e.g. Shleifer and Vishny, 1997).

In addition to the limits of Arbitrage, proponents of Behavioural Finance criticise the rational agent model because they have found evidence that agents are prone to certain cognitive biases when forming beliefs. For example, the works of psychologists (see Kahneman and Tversky, 1974; Weinstein, 1980) have shown that people tend to be subjected to the following psychological biases when making decisions and forming beliefs under uncertainty: Anchoring, Availability Biases, Conservatism, Overconfidence, Representativeness, Optimism, and Wishful Thinking.[34] To give one example, Weinstein (1980) has found that people tend to be overoptimistic when estimating probabilities about future events. Other psychological biases such as Anchoring show that when people estimate probabilities and are given an arbitrary starting value, their estimate will be strongly influenced by this starting value and not deviate too much from the "anchor" (Kahneman and Tversky, 1974).

To sum up, the Behavioural Finance critique addresses the cornerstone of the Efficient Market Theory: the rational agent model. Proponents of Behavioural Finance argue that limits to arbitrage and cognitive biases tend to question the rationality of agents. More specifically, they argue that mispricing of security prices can persist because arbitrage strategies could be costly and risky, as opposed to the traditionally held view among Efficient

[34] For more insights on Behavioural Finance and cognitive biases, the reader is referred to an extensive literature survey by Barberis and Thaler (2002).

Market Theorists that such strategies are costless and risk-free. Furthermore, agents are subject to cognitive biases that can lead to substantial deviations from rationality.

2.9 Conclusion

To conclude, my chapter aimed to discuss the theoretical roots of my thesis within the context of the Efficient Market Hypothesis. In so doing, I outlined the brief history, definitions, theoretical assumptions, and previous empirical tests of Market Efficiency and the Efficient Market Hypothesis. The second part of my chapter was concerned with the relevance of ESG information in light of the Efficient Market Hypothesis. To be more specific, my chapter seeked to contrast systematic and idiosyncratic risks as well as outline the role of diversification (under Modern Portfolio Theory) with respect to ESG information. Further, my chapter highlighted the complexity of interpreting empirical tests or findings of Market Efficiency via the Joint Hypothesis Problem (bad model vs. real market inefficiency). Overall, the chapter was a starting point to locate my thesis and my underlying methodological approach within the Efficient Market Theory as well as to guide me in outlining my empirical results and their implications for Market Efficiency.

3 Methodological Positions and Research Methodology

3.1 Introduction

The principal goal of this chapter is to explore the core philosophical assumptions (ontology, epistemology, human nature, and methodology) and well established research paradigms about the nature of social science and society, to elaborate on the assumptions related to each paradigm, and to then be able to position my thesis within the context of a research paradigm. Further, this chapter aims to discuss the research paradigm most commonly followed in Finance research and my thesis as well as to delineate potential limitations of my chosen research paradigm with respect to the approaches and methods that characterise it. The second part of this chapter will focus and expand on the choice of my research methodology and highlight the nature of my empirical methods applied in this thesis.

The methodological positioning of my thesis is guided by Burrell and Morgan's (1979) influential work on social theory. Burrell and Morgan's framework categorises existing sociological and organisational theories into specific research paradigms based on the underlying philosophical assumptions embedded in a theory (Louis, 1983). The framework has had an immense impact as it helped researchers better understand and classify theories and other researchers' approaches and methods. Thus, to locate my research within one of Burrell and Morgan's (1979) research paradigms, requires the identification of my approach to social science on a spectrum of the subjective-objective nature of science. Burrell & Morgan (1979) outline four core assumptions concerning ontology, epistemology, human nature, and methodology to delineate the subjective or objective nature of science.

Ontology describes assumptions made regarding the phenomena under study. On one extreme, the phenomenon is objective and external to the researcher, while on the other extreme, the phenomenon is subjective and the product of the researcher's mind (Bettner et al., 1994; Burrell and Morgan, 1979; Lagoarde-Segot, 2015).

Epistemology describes assumptions made concerning the nature of knowledge. It helps to define how a researcher perceives knowledge creation, whereby the researcher distinguishes between knowledge that exists external to the researcher and can be acquired, and knowledge that comes to existence through personal experiences (Burrell and Morgan, 1979; Lagoarde-Segot, 2015).

Human nature is concerned with the interaction of human beings with each other and their external environment (Bettner et al., 1994; Burrell and Morgan, 1979; Lagoarde-Segot, 2015).

Methodology is concerned with the approaches to research and how one can create meaning of the phenomena under study and the social world in which it is situated (Burrell and Morgan, 1979). While the nomothetic approach is characterised by testing hypotheses about phenomena that are distant to the researcher using quantitative methods to analyse data, the ideographic approach is analysing phenomena closer to the researcher using in-depth ethnographic techniques to obtain knowledge about specific phenomena (Burrell and Morgan, 1979; Hurt and Callahan, 2013).

In addition to identifying where I stand on the subjective or objective dimension of the nature of science, it is equally important to discuss assumptions about the nature of society (Burrell and Morgan, 1979). Burrell and Morgan (1979) suggest to discuss assumptions about the nature of society along the regulation-radical change dimension. The regulation dimension is concerned with "the need for regulation in human affairs", and assumes unity of society in the status quo (Burrell and Morgan, 1979:17; Lagoarde-Segot, 2015). In contrast, the radical change dimension is concerned about the emancipation of people within existing structures that hinder their potential for development, and assumes disagreement of society, intending to break the status quo and developing alternatives (Burrell and Morgan, 1979:17; Lagoarde-Segot, 2015).

3.2 The Burrell and Morgan Matrix

Figure 1 depicts Burrell and Morgan's (1979) Four Paradigm Model of Social Theory in a 2 by 2 matrix, distinguishing between four mutually exclusive research paradigms: Radical humanist, Radical structuralist, Interpretive, and Functionalist (Burrell and Morgan, 1979).

Figure 1: Four Paradigm Model of Social Theory (Burrell and Morgan, 1979)

THE SOCIOLOGY OF RADICAL CHANGE

SUBJECTIVE	'Radical humanist'	Radical structuralist'	OBJECTIVE
	'Interpretive'	'Functionalist'	

THE SOCIOLOGY OF REGULATION

3.2.1 Interpretive

The Interpretive paradigm views the social world as socially-constructed by individuals (Ardalan, 2003). Therefore, it believes that the social world is influenced by human values and objective analysis will be unable to uncover the truth (Hurt and Callahan, 2013). This research paradigm is characterised by seeking to understand and provide meaning to the social world (Burrell and Morgan, 1979). Researchers are subjective and initially analyse phenomena by observation techniques to later access, deepen and confirm their observations to generate meaningful understanding of the phenomenon (Ardalan, 2003; Burrell and Morgan, 1979).

3.2.2 Radical humanist

The Radical humanist research paradigm, similar to the Interpretive paradigm is a subjectivist approach which views the social world as socially-constructed (Hassard, 1991). In this research paradigm individuals are seen as "...the prisoners of the (social) world they create", and are therefore in a constant battle to challenge and critique ideological superstructures and domination by empowering and emancipating individuals to change the status quo (Burrell and Morgan, 1979; Hassard, 1991:278). Researchers are subjective and in addition to describing certain phenomena, they aim to instil change by critique and alternative action plans on challenging the status quo (Hurt and Callahan, 2013).

3.2.3 Radical structuralist

The Radical structuralist research paradigm views the social world as existing and factual (Hassard, 1991). Thus, it seeks to uncover domination struggles within existing social structures, to inform and convince individuals stuck in those structures to revise and change the structures (Hurt and Callahan, 2013). In order to uncover power struggles, the Radical structuralist highlights flaws in structural relationships in society (Hurt and Callahan, 2013). Researchers are objectivists, meaning that quantitative research is valid in this paradigm (Bettner et al., 1994).

3.2.4 Functionalist

This research paradigm assumes that society concretely exists and rules dictate a certain order (Ardalan, 2003). The functionalist paradigm is characterised by seeking rational explanations to social affairs, highly pragmatic, and described as a problem-oriented approach which seeks "to provide practical solutions to practical problems" (Burrell and Morgan, 1979:26; Hurt and

Callahan, 2013). Researchers are objectivists and analyse phenomena by excluding themselves from the object under study and analyse it by empirical and technical means, similar to how natural scientists operate (Burrell and Morgan, 1979).

In the following chapter, I will aim to position my thesis within the context of the Functionalist research paradigm with a focus on Finance research.

3.3 Functionalist Paradigm in Finance Research

"Academic finance probably constitutes one of the best examples of the *functionalist paradigm* within the social sciences" (Lagoarde-Segot, 2015:6). Many authors have come to conclude that the functionalist research paradigm is the framework for finance research (Ardalan, 2003, 2005, 2010; Bettner et al., 1994; Lagoarde-Segot, 2015). The functionalist reserach paradigm has been applied in various contexts in finance research such as money and capital market theories (Ardalan, 2003; Bettner et al., 1994; Lagoarde-Segot, 2015).

In order to position how the functionalist paradigm applies to finance research and my thesis, I aim for a brief analysis of the four underlying core assumptions with respect to ontology, epistemology, human nature, and methodology that characterise the nature of science and society of the functionalist paradigm in the context of finance.

With respect to Ontology, finance research finds its roots in the objectivist ontology. Capital markets (e.g. stock market) are treated similar to the natural world, assuming stable and tangible structures (Lagoarde-Segot, 2015). Finance researchers perceive capital markets as objective and external to themselves (Lagoarde-Segot, 2015). Further, financial institutions and financial behaviour, which are both parts of the capital market, also exist separately in the social world (Lagoarde-Segot, 2015).

In terms of Epistemology, finance research is driven by a positivist Epistemology. The object under study (such as the capital market) is seen as an external entity that is governed by certain regulations which the researcher can uncover by using cause and effect mechanisms such as statistical causality (Bettner et al., 1994; Lagoarde-Segot, 2015).

Assumptions about Human nature in finance research generally describe human beings as profit seeking and rational agents (Lagoarde-Segot, 2015). Individual rational investors thus contribute to the efficient allocation of capital and price determination in the market. External shocks such as macro-economic influences (e.g. unemployment estimates) cause the investors to rapidly re-allocate capital and to determine new price levels of assets (Lagoarde-Segot, 2015).

Finally, the methodology of finance research commonly uses quantitative methodologies to measure and explain certain financial activity. It assumes that any and all financial activity is quantifiable, and therefore can be used as input for statistical analysis (Bettner et al., 1994).

3.4 Functionalist Paradigm in my Thesis

The functionalist research paradigm is the perspective of this thesis. While I acknowledge the existence of other worldviews and potential alternative truths, I accept the limitations that arise from the functionalist research paradigm.

Finance theories such as the Efficient Market Theory, Modern Portfolio Theory, or Capital Asset Pricing Theory are generally assessed from the functionalist research paradigm (Ardalan, 2003). It is assumed that finance theories can be objectively evaluated by reference to empirical evidence, and based on that evidence accepted or rejected (Ardalan, 2003). To give one example, and in the case of the Efficient Market Theory, Fama (1970:384) notes, that a statement describing efficient markets, in that "efficient market prices fully reflect available information" is too broad and general for any empirical test and therefore should be more specifically formulated. To make Efficient Market Theory empirically testable, Fama suggested three sub-groups of market efficiency: weak, semi-strong, and strong-form efficient markets (Fama, 1970). In order to support or refute the Efficient Market Theory, numerous empirical studies have since been performed (Dimson and Mussavian, 1998; Fama, 1970; Kothari, 2001).

To give one example, from the functionalist perspective, assumptions about the human nature of the Efficient Market Theory are based on some form of basic general equilibrium model (e.g. fair game expected return model see Fama, 1970). Individuals who participate in stock investing are assumed to be rational human beings with the utility to maximise profits. Within the functionalist paradigm, one stock price is treated as any other stock price and is only influenced by new information on system-wide economic developments such as inflation, interest rates, unemployment figures and company specific information such as earnings, contracts, cost reductions. These information flows are external to the rational agent who is buying and selling stocks. Meaning that the agent is merely playing a passive role and the forces of setting the stock price are determined by the external environment (Ardalan, 2003).

3.5 Limitations of the Functionalist Research Paradigm

The major limitation to explicitly or implicitly view the world from one specific research paradigm could be the distortion of the "truth" (Hurt and Callahan, 2013:37). What seems to be the finding about a phenomenon under study from one perspective, might not reflect the same finding from another perspective. Using a fairy tale to describe Burrell and Morgan's four research paradigms, Hurt and Callahan (2013) illustrate that unless a researcher adopts all four world views, he will most likely never uncover the truth. The "home paradigm" in finance research is most closely related to the functionalist research paradigm as outlined previously.

For example, the functionalist paradigm in finance research requires financial activities to be quantifiable. Bettner et al. (1994) illustrate that finance researchers treat the concept of debt similar to how a natural scientist treats protons. The capital structures of corporations are treated equally, debt in one company is indistinguishable from debt in another company (Bettner et al., 1994). However, in some cases financial activity might not be perfectly quantifiable as with debt. Also, it could be that more than one proxy describe the same phenomena under study, or even worse, none of the chosen proxies describe what we think they describe. To give one example, a company's goodwill is hard to proxy for as it represents corporate reputation in excess of the book value of a company that could be perceived subjectively from one potential acquirer to another. Thus, having to deal with imperfect proxies could be seen as a major limitation to the functionalist paradigm in finance research.

Another possibly more important limitation of the functionalist paradigm in finance research is related to the assumption about human nature, i.e. rational human beings with their only utility to maximise profits. This assumption is a cornerstone of the Efficient Market Theory (Fama, 1970). In the context of socially responsible investors this assumption can be somewhat relaxed. Socially responsible investors' utility is not only targeted at financial outcomes, but social outcomes of their investments matter as well (Hamilton et al., 1993). As Fama (2007:675) notes, socially responsible investors are not seen as rational investors in the traditional finance view of the world, however, as investors with "...an extreme form of tastes...". Meaning that because of their tastes for certain assets, i.e. socially responsible or ethical assets, they are willing to sacrifice financial returns, which rational investors would not do.

Similarly, proponents of Behavioural Finance seem to question the assumptions of investor rationality on the basis of limits to arbitrage[35] and psychological biases which have been documented in the literature (Barberis and Thaler, 2002; Bodie et al., 2008). To the first point, they argue that mispricing in stock markets could persist due to very risky and costly arbitrage strategies (Barberis and Thaler, 2002). Thus, the limits to arbitrage can allow substantial mispricing and prices to be "wrong" for a very long time (Barberis and Thaler, 2002; Shleifer, 2000). The work of psychologists shows that actual people make choices and form expectations very different to a rational person. The work of Kahneman and Tversky (1974) has shown that people are prone to cognitive biases, such as Representativeness, Availability, and Adjustment and Anchoring, which all have effects on how they judge the probability of future outcomes. Other examples of psychological biases include Overconfidence, Optimism and Wishful Thinking (Barberis and Thaler, 2002; Shleifer, 2000). Chapter 2.8.2. 'Behavioural Finance Critique', discusses the Behavioural Finance critique of the Efficient Market Theory in somewhat more detail.

In conclusion, Burrell and Morgan's (1979) influential Four Paradigm Model of Social Theory has guided me in defining the methodological position of my thesis, which can be best described by the functionalist research paradigm. Traditional empirical and theoretical Finance research such as the Efficient Market Theory, predominantly rely on the functionalist world view, because it is rooted in an objectivist Ontology, positivist Epistemology, rational Human Nature, and quantitative Methodologies. I have also shown major limitations to the core assumptions of the functionalist research paradigm in Finance. In particular, how the assumptions about the rationality of human beings have been challenged by socially responsible and behavioural finance scholars.

3.6 Research Methodology

Having discussed my methodological position in the previous chapter, this chapter will concentrate and expand on the choice of my research methodology and the nature of my empirical methods used in this thesis.

As mentioned in the previous chapter, methodology is concerned with the approaches to research and how one can make meaning of the phenomena under study and the social world (Burrell and Morgan, 1979). Thus, based on the underlying assumptions of the four

[35] Arbitrage is an investment strategy that provides "riskless profits at no cost" (Barberis and Thaler, 2002). For example, if a company is listed on two different stock exchanges qouted at different prices, then an Arbitrageur could buy the cheaper stock in one exchange and immediately sell the expensive stock in the second exchange, making a profit on the price differential between the two exchanges (Bodie et al., 2008).

research paradigms analysed in the previous chapter, each research paradigm is characterised by certain approaches to methodology. For example, the "nomothetic" approach is concerned with hypothesis testing and quantitative methods to analyse data, while the "ideographic" approach uses ethnographic techniques (Burrell and Morgan, 1979; Hurt and Callahan, 2013). Scholars have come to characterise different approaches to methodology as qualitative, quantitative, or a combination of both, qualitative and quantitative research (see e.g. Bryman 2004; Harwell, 2011). In my thesis, the functionalist perspective predominantly relies on a research methodology that is of a quantitative nature and is therefore more in line with the "nomothetic" approach described by Burrell and Morgan (1979). The quantitative research methodology is particularly prominent for studies in the field of finance, but also within the field of socially responsible investing, which can be understood as the intergration of environmental, social, and governance (ESG) concerns into investment decision making, as it aims to empirically test hypotheses that correspond to research questions on the relationship between ESG concerns and the financial performance of companies (See e.g. Frooman, 1997; Orlitzky et al., 2003; Horváthová, 2010).

Quantitative researchers obtain findings by quantifying information, analysing data, testing hypotheses, and presenting implications of their findings in relation to the theoretical background (Bryman, 2004). This means that quantitative research is typically undertaken in a deductive manner, whereby hypotheses are deducted from theory, secondary data collected, and then empirically tested using statistical models (Bryman, 2004). However, not all quantiative research includes the explicit formulation of a hypothesis, rather "theory acts loosely as a set of concerns in relation to which the social researcher collects data" (Bryman, 2004:63).

The distinct advantages and main concerns to quantitative researchers are those of "Causality", "Generalization", "Measurement", and "Replication" (Bryman, 2004; Harwell, 2011). Quantitative research is interested in objectively explaining why certain relationships exist and go beyond describing them (Bryman, 2004). The aim is to quantify concepts and to test the casual relationships or make predictions based on the quantified concepts, which are generally referred to as dependent and independent variables (Brooks, 2008). Once a quantitative researcher has established that his empirical findings have not occured by chance, generalisations beyond the analysed sample to a wider population are very likely and perceived as an advantage over other forms of research methodologies (Given, 2008). Related to the concept of generalisation, another advantage of quantitative research is replicability (Bryman, 2004). The concept of replicability is essential to quantitative research and refers to the ability of a researcher to replicate an existing study carried out by another researcher (Bryman, 2004). Thus, if a study lacks replicability, then it has only very little value for quantiative research (Given, 2008)[36].

However, a main disadvantage of quantitative research is the notion of a lack of subjectivity (Bryman, 2004). In the pursuit of objectivity, quantitatitve researchers distance themselves from the object under study, assuming a separation between the social world and the objects within it (Bryman, 2004). This hinders the quantitative researcher in gaining in-depth access and information of the objects under study (Bryman, 2004). In contrast, qualitative research does not make this distinction which allows it to engage with the object more closely and appreciate how the object understands and interprets its social world (Given, 2008).

In the following chapter, based on the beforementioned advantages and concerns to quantitative research, I will discuss the concepts of reliability and validity in the context of quantitative research, in somewhat more detail.

3.6.1 Reliability and Validity

In quantitative research, the two concepts of reliability and validity of an empirical analysis are seen as fairly crucial (Davis and Bremner, 2008). Reliability is concerned with the consistency of empirical relationships between concepts or variables (Davis and Bremner, 2008). Most commonly, the consistency of relationships or outcomes can only be established through replication (Bryman, 2004; Davis and Bremner, 2008). Meaning that, observed realtionships or outcomes should not change substantially from one researcher to another, and neither over time. To give one example, quantitative researchers that observe a significantly positive relationship between ESG concerns and the financial performance of a firm should conclude the same findings independent of each other. Another aspect of judging the reliability of an empirical analysis is to investigate its stability (Bryman, 2004). More specifically, tests of temporal stability enable the quantitative researcher to conclude that the observed relationships between concepts or variables are consistent through time (Davis and Bremner, 2008). A simple test for temporal stability of an observed relationship is to analyse different sub-sample time periods based on a full sample time period. Ideally, the variation of the outcome should be low (Davis and Bremner, 2008). In other words, relationships are

[36] This also explains the need for transparency regarding research methodologies and particularly research methods. A lack of transparency could increase the probability that researchers adpot an alternative interpretation or research process that leads to conflicting research findings.

considered stable only when the findings from the full sample time period do not differ substantially relative to its various sub-sample time periods.

In quantitative research, validity refers to internal and external validity, as well as the measurement problem of an empirical analysis, a concept, or a variable (Bryman, 2004; Given, 2008; Harwell, 2011). While internal validity is concerned with how well an empirical analysis has been performed by a researcher, external validity is concerned with the generalisability of empirical findings (Bryman, 2004). The measurement problem refers to the idea that a variable can only be a valid proxy for certain phenomena, when it explains what it claims to explain (Given, 2008; Harwell, 2011). Internal validity therefore refers to the inside of a study and is concerned with whether a study and empirical analysis was performed correcly with an emphasis on "...the procedures and operations used to conduct a research study..." (Leighton, 2010:620). To give one example, a study that investigates the relationship between ESG concerns and the financial performance of a company will achieve high internal validity if it concludes that no other variable such as the size of a company and other confounding effects, except ESG concerns caused the financial performance. External validity is concerned with the outside of a study and whether findings can be generalised to other contexts beyond the sample studied (Bryman, 2004; Leighton, 2010). The advantage of generalising findings of one study to a wider population is "...that the findings can be of benefit to many and not just a few." (Leighton, 2010:467). Thus, the concept of external validity adds to the replicability concern discussed above, highlighting the desire for consistent empirical findings between quantitative researchers, but also between different samples. For example, studies with high external validity (or generalisable research findings) will find the same relationship between ESG concerns and the financial performance in the US as well as in the UK and other countries. Finally, measurement validity is concerned with the appropriateness of a proxy for a certain concept or phenomena under study (Bryman, 2004). For example, some financial activity is better quantifiably than others. The variables used to measure certain financial concepts are not always perfect and ideal. To give one example, stock prices or stock returns are meant to describe the market-based financial performance of a company. There are however many different variables that could describe the financial performance of a company such as book-value-based financial performance variables.[37] Thus, studies with high measurement validity use appropriate proxies for the concept they would like to investigate and are clear on what and how they measure these

[37] For example, profitability, income, return on equity (ROE).

concepts. In the following chapter, I will outline my approach to the data collection and discuss the features of secondary data.

3.6.2 Data Collection and Sources

This chapter provides a very brief discussion about my data, the data types, and the main data sources and providers that I have used in my thesis. For more specific information on my selected sample size, geographical coverage and sample period, in any of my empirical chapters, the reader is referred to (Chapter 4.3.2. 'Investment universe, portfolio construction and ESG integration; Chapter 5.4. 'Data Section'; Chapter 6.3. 'Data Description'; Chapter 7.3.1. 'Sample Selection').

Generally, quantitative researchers make use of secondary data that has been collected by third parties. Bryman (2008) notes that using secondary data has the advantages of high quality, standardisation, and substantial geograhical coverage. Usually, data sets that have been collected by third parties such as Bloomberg or Thomson Reuters Datastream tend to be of high quality, as they are consistently monitored and collected through rigorous procedures. Thus, my thesis relies predominantly on four data sources including Bloomberg, EIRIS, StyleResearch, and Thomson Reuters Datastream.

My financial data can be characterised as historical time-series and "continuous" data (Brooks, 2008). Essentially, continuous data types such as stock returns can take any value and are only limited by the desired precision of the researcher (Brooks, 2008). The main financial data types in my thesis are data such as total stock returns, interest rates, market capitalisation, total assets, intangible assets and liabilities. To compute returns from total return data[38] for stock portfolios, indexes, or individual companies, in any of my empirical chapters, I generally use the following formula for continuously compounded returns as follows (See e.g. Brooks, 2008):

$$r_{i,t} = \ln\left(\frac{P_{i,t} + D_{i,t}}{P_{i,t-1}}\right) \qquad (3)$$

$r_{i,t}$ denotes continuously compounded returns for asset i at time t. $P_{i,t} + D_{i,t}$ is the stock price plus any dividend paid to investors for asset i at time t. $P_{i,t-1}$ denotes the stock price of asset i from the previous observation.

[38] Total return data includes capital gains (or the appreciation of the stock price) and any dividend payments that have been made to investors (Brooks, 2008). I use total return data instead of stock price data because it considers dividend payments. Not accounting for divident payments could lead to an underestimation of total returns (Brooks, 2008).

My non-financial data can be characterised as ordinal data, which means that it can be ordered or ranked (Brooks, 2008). EIRIS analyses and surveys companies to obtain information on a wide range of topics concerning their Environmental, Social, and Governance (ESG) performance. In total, EIRIS collects over 700 fine-grained sub-criteria relating to the three "E", "S", and "G" dimensions. While EIRIS collects and updates any of the over 700 sub-criteria throughout the year, the data is made available at the end of each year, beginning in 2004. For a detailed explanation on how I use ESG criteria to create portfolios, the reader is referred to Chapter 4.3.2. 'Investment universe, portfolio construction and ESG integration'.

3.6.3 Research Methods

This chapter provides a somewhat broader understanding of the kind of quantitative research methods selected in my thesis, however, for more detailed explanations of the actual research methods applied in any of my empirical chapters, the reader is referred to Chapter 4.3.5. 'Financial performance assessment', Chapter 4.3.6. 'Risk management opportunities', Chapter 5.3. 'Empirical Analysis', Chapter 6.4. 'Methods', Chapter 7.3.5. 'Regression Models'.

To test for different forms of stock market efficiency, finance scholars have developed a range of specific research methods (See Chapter 2.4. 'Empirical Tests of Market Efficiency'). Empirical tests for long-term stock market efficiency are generally based on investigations of the financial performance of portfolios of stocks, mutual funds, or equity indexes, because the financial performance tends to have implications for stock market efficiency. Thus, in my thesis, I use research methods based on correlation and regression analysis to evaluate the long-term financial performance and its implications for stock market efficiency of portfolios and equity indexes with a preference for environmental, social, and governance (ESG) concerns. Correlation and regression analysis is one of the most common research methods for quantitative researchers (Brooks, 2008).

3.6.3.1 Correlation Analysis

Correlation analysis can be defined as the "degree of linear association", aiming to measure the extent to which one variable is associated with another variable (Brooks, 2008:28). This means, correlation is a useful research method to establish the relation between two variables. However, correlation does not imply causality and therefore the researcher is not able to investigate how and to what extent one variable causes the other (Brooks, 2008).

3.6.3.2 Regression Analysis

To investigate causal relationships between variables, I will use regression analysis. In contrast to correlation analysis, regression analysis does not treat variables in a symmetrical way, rather it allows the researcher to define dependent and independent variables, which can then be used to test for causal relationships (Brooks, 2008). Another advantage of regression analysis is the potential inclusion of more than one independent variable, i.e. multiple regression analysis, that cause the dependent variable (Brooks, 2008). In other words, regression analysis "is an attempt to explain movements in a variable by reference to movements in one or more other variables" (Brooks, 2008:27).

As previously mentioned, the quantitative research methodology in general, and regression analysis in particular, is very popular among studies in the field of finance and more specifically, socially responsible investing (See e.g. Frooman, 1997; Orlitzky et al., 2003; Horváthová, 2010). The studies closest to my thesis tend to employ a range of specific regression analysis methods to analyse the financial performance of investment trading strategies of mutual funds, investment portfolios, or equity indexes and its implications for market efficiency. Such investment performance evaluation methods are commonly known as Asset Pricing Models, which I have discussed in Chapter 2.4. 'Empirical Tests of Market Efficiency' (Fama, 1970; Huberman and Kandel, 1987; Jensen, 1968).

The earliest and one of the most widely applied investment performance evaluation methods is referred to as "Jensen's alpha" (Jensen, 1968), which is based on the static one-period Capital Asset Pricing Model (CAPM)[39] of Sharpe (1964) and Lintner (1965). Jensen's alpha evaluates the returns generated by a mutual fund, investment portfolio, or equity index relative to the risk-adjusted returns of a market benchmark portfolio (Kreander et al., 2005). Jensen's measure can be formally stated as follows:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + \varepsilon_{i,t} \qquad (4)$$

Where, $r_{i,t}$ denotes the continuously compounded returns for asset i at time t. $r_{f,t}$ refers to the risk-free rate, generally proxied by a national T-bill. $r_{m,t}$ denotes continously compounded returns for a selected market benchmark. α_i is the intercept of the regression and is refered to as "Jensen's alpha", an indicator of the financial performance of an asset. β_i represents the regression's estimated beta coefficient and indicates an asset's exposure to the selected market benchmark. $\varepsilon_{i,t}$ is the error term. Several scholars in the socially responsible investment field

[39] See Equation 1.

have applied Jensen's alpha to investigate the financial performance of socially responsible mutual funds (including ethical funds) relative to conventional mutual funds (See e.g. Gregory et al., 1997; Luther and Matatko, 1994; Kreander et al., 2005; Mallin et al., 1995).

However, the critique of the stock market anomalies literature on the Efficient Market Theory has revealed shortcomings in using Jensen's alpha as the single investment performance evaluation method (See Chapter 2.8.1. 'Stock Market Anomalies'). The criticism is driven by scholars who find empirical evidence of persistent profitable investment trading strategies (also known as stock market anomalies) relative to passive investment strategies, which should not exist in the world of the Efficient Market Theory. The Efficient Market Theory posits that no profitable investment trading strategy shall persist over the long term. However, several scholars have reported empirical evidence of such persistent profitable investment strategies (See e.g. Subrahmanyam, 2010; Jacobs, 2015). As already noted earlier in Chapter 2.8.1. 'Stock Market Anomalies', the first and most prominent stock market anomalies are the size and value anomalies (Banz 1981; Basu, 1977, 1983; Reinganum 1981). To address the shortcomings of the CAPM and Jensen's Alpha and to account for the value and size anomalies, extensions to the method have been proposed by Fama and French (1992, 1993). In order to incorporate the two anomalies, Fama and French (1993) propose the following three factor model:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + s_i (r_{smb,t}) + h_i (r_{hml,t}) + \varepsilon_{i,t} \qquad (5)$$

Where, $r_{smb,t}$ denotes the returns on the difference between a portfolio of companies with small market capitalisations relative to a portfolio of companies with large market capitalisations. $r_{hml,t}$ denotes the returns on the difference between a portfolio of companies with high book to market ratios relative to a portfolio of companies with low book to market ratios. s_i and h_i represent the coefficients of exposure to both difference portfolios based on size and value, respectively. Many scholars in the field of socially responsible investing have used Fama and French's extended and similarly adjusted methods to assess the financial performance of mutual funds (See e.g. Gregory et al., 1997; Kreander et al., 2005).

While Fama and French's extended method is able to account for the value and size anomalies reported in the literature, their model has been criticised of not being able to account for another well-known stock market anomaly, the momentum effect (Jegadeesh and Titman, 1997). As described in my previous chapter, the momentum anomaly was found to be a successful investment strategy to persistently generate abnormal returns. To address the shortcoming of Fama and French's extended version to account for the momentum anomaly, Carhart (1997) proposed to extend the existing model once more with a proxy for the momentum effect as follows:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + s_i (r_{smb,t}) + h_i (r_{hml,t}) + m_i (r_{mom,t}) + \varepsilon_{i,t} \qquad (6)$$

Where, $r_{hml,t}$ denotes the returns on the difference between a portfolio of companies with high stock returns over the previous year relative to a portfolio of companies with low stock returns over the previous year. m_i is the coefficient of exposure to the momentum variable. Carhart's extended version of the multi-factor model has been applied widely to investigate the financial performance of conventional and socially responsible mutual funds and investment portfolios. The studies closest to my thesis (Edmans, 2011; Gompers et al., 2003; Kempf and Osthoff, 2007; Schröder, 2007; Renneboog et al., 2008a) have applied the same or variations of my selected research methods.

In summary, my research methods chapter was meant to give the reader a somewhat better understanding of the kind of quantitative research methods applied in my thesis. To assess the long-term financial performance of portfolio returns and equity indexes with a preference for environmental, social, and governance (ESG) concerns, and its implications for stock market efficiency, I use research methods based on correlation and regression analysis. For more details on my specific research methods, sample sizes, and sample periods, the reader is referred to the respective empirical chapters (Chapters 4, 5, 6, and 7).

3.6.3.3 Limitations of selected Research Methods

A limitation commonly voiced about correlation and regression analysis is that of changing and time-varying empirical relationships between variables (Bryman, 2004; Davis and Bremner, 2008). This limitation clearly addresses the reliability concern of quantitative research methods, as outlined in Chapter 3.6.1 "Reliability and Validity". To address this limitation and to ensure consistent and stable empirical relationships between variables, regression analyses should be replicable from one researcher to another and stable to different sub-samples. Thus, in my thesis, I aim to transparently document and disclose my selected data sources and data transformations, portfolio constructions, applied research methods, and other important aspects to allow other researchers to easily replicate my chapters. Furthermore, to overcome the stability issue of empirical relationships between variables in any of my empirical chapters, I apply several sub-sample regression analyses, and modern forms of dynamic regression analyses (see e.g. the application of the Kalman Filter in Chapter 5.3.2. "Dynamic Performance Analysis").

3.7 Conclusion

In conclusion, this chapter aims to outline my methodological positions as well as the choice of my research methodology and the nature of my empirical methods used in this thesis. In establishing my methodological positions, I was guided by Burrell and Morgan's (1979) influential framework on social theory. Based on my core philosophical assumptions regarding ontology, epistemology, human nature, and methodology, I come to conclude that the Funcionalist research paradigm is the perspective of my thesis, which also represents the "home" paradigm of Finance research. Traditional empirical and theoretical Finance research such as the Efficient Market Theory, predominantly rely on the functionalist world view, because it is rooted in an objectivist Ontology, positivist Epistemology, rational Human Nature, and quantitative Methodologies. I have also shown major limitations to the core assumptions of the functionalist research paradigm in Finance. In particular, how the assumptions about the rationality of human beings have been challenged by socially responsible and behavioural finance scholars.

The second section of this chapter concentrates on the choice of my research methodology. I can conclude that my research methodology is related to the nomothetic approach described by Burrell and Morgan (1979), which is closely related to a quantitative approach to methodology. Further, I do not only highlight the importance of Reliability and Validity in quantitative research, but also discuss the issues of Causality, Generalization, Measurement, and Replication (Bryman, 2004; Harwell, 2011). Finally, I discuss the primary research methods used in my thesis such as correlation and regression analysis, and their potential limitations with respect to Reliability and Validity in quantitative research.

4 Does pension funds' fiduciary duty prohibit the integration of environmental responsibility criteria in investment processes? A prudent investment test

Does pension funds' fiduciary duty prohibit the integration of environmental responsibility criteria in investment processes? A prudent investment test[40]

Abstract

Pension funds have recently developed an increasing interest in environmental, social or governance (ESG) criteria, but critics claim that the integration of any of these non-financial criteria into pension fund investment processes conflicts with fiduciary duties. On this matter, the 2005 Freshfields report concluded that pension funds' fiduciary duties (e.g. prudent action for proper purpose) only permit the consideration of an ESG criterion, if this process has no detrimental financial effects. Thus, this chapter aims to investigate the financial and risk implications of integrating any ESG criterion into an investment process from the perspective of equity pension funds, whose unique financial and legal characteristics require a specialised research design (e.g. a prudent, very large scale investment process). To study this effect, I develop a test of the prudent integration of ESG criteria in hypothetical equity pension fund investment processes. I analyse over 1,500 firms from 26 developed countries over the sample period starting in January 2004 and ending in May 2010, using aggregated and disaggregated corporate environmental responsibility ratings supplied by EIRIS. My results are twofold. First, I find no indications that the integration of aggregated or disaggregated corporate environmental responsibility ratings into equity pension fund investment processes has any detrimental financial effect. Second, findings from my risk analysis even support integrating corporate environmental criteria into equity pension fund investment processes, as it helps to lower downside volatilities. Robustness tests for temporal consistency and sector bias confirm these findings. Hence, I conclude that pension funds' fiduciary duties do not appear to prohibit the integration of environmental responsibility criteria into their investment processes. Future research might want to investigate the effect of integrating other ESG criteria into a realistic prudent pension fund investment process.

[40] Material from Chapter 1 forms the basis of an essay that is currently revised to be re-submitted to Environment and Planning A with two co-authors Andreas Hoepner (supervisor) and Sebastian Siegl.

4.1 Introduction

Pension funds have recently shown an increasing interest in considering environmental, social or governance (ESG) criteria in their investment processes (Cox et al., 2004; Cumming and Johan, 2007; Haigh and Shapiro, 2013; Petersen and Vredenburg, 2009; Sievänen et al., 2013). Proponents argue that this practice has many advantages not only for pension funds but also for those economies, on whose financial wellbeing pension funds depend and whose citizens depend on pension funds. Their main argument is simple. Pension funds with their enormous investor strength have the ability to ensure not only economic stability but also stable environmental, social and corporate governance conditions in those global economies, to which their internationally diversified portfolios are exposed.[41] As a consequence, this stability allows these economies to flourish, which leads to healthy financial returns for pension funds (Clark and Hebb, 2005; Hawley and Williams, 2007; Sethi, 2005). Critiques, however, fear inappropriate political influence in pension fund decision-making and exposure to financial risks. Especially, they argue that the integration of ESG criteria into pension fund investment processes *"subvert[s] .. a fiduciary's common law duty of undivided loyalty"(Rounds, 2005:76).*

The conditions under which ESG consideration is permissible appeared hidden in a complex web of legislation until 2005, when a report by Freshfields Bruckhaus Deringer gained prominence for its analysis of these conditions. The report concludes that pension funds are legally required to consider an ESG criterion, if there is a clear consensus amongst beneficiaries in favour of this criterion or the criterion is believed to be financially beneficial. Pension funds may also voluntarily consider an ESG criterion in case it does no financial harm, but otherwise pension funds are legally prohibited from integrating any ESG criteria in their investment process (Freshfields Bruckhaus Deringer, 2005; Langbein and Posner, 1980). This conclusion has become widely accepted (Gitman et al., 2009).[42]

While the analysis and conclusions of the Freshfields report have provided a lot of conceptual clarity, the report did not represent a practical breakthrough as it left many practical uncertainties untouched (Collie and Myers, 2008; Freshfields Bruckhaus Deringer,

[41] Given that pension funds represent one of the largest institutional investor portfolios with assets worth 29.8 Trillion USD, they seem to have a natural interest in the sustainable long-term performance of companies they invest in, as well as, the sustainable development of an economy as a whole (Hawley and Williams, 2007; OECD, 2014). As pension funds invest in the entire market, their portfolios will be exposed to positive and negative externalities created by individual companies, which gives them a genuine interest in managing a sustainable long-term development of an economy (Hawley and Williams, 2007). These attributes make pension funds the ideal candidate for empirical tests of the integration of ESG criteria.

[42] Especially in common law countries such as the UK and US (Gitman, et al., 2009).

2005; OECD, 2007; Richardson, 2006; Richardson, 2011; Sandberg, 2011; Taylor and Donald, 2007; Woods and Urwin, 2010). Further, Sandberg argues that the Freshfields report does not call for much optimism, as it does not explain what type of ESG considerations can be made (Sandberg, 2011). Above all, the majority of institutional investors continue to ignore ESG considerations (Sandberg, 2011; UNEP FI 2009; Woods and Urwin, 2010).

The possibly most important remaining uncertainty relates to the following research question:

> *What are the financial and risk implications of ESG criteria consideration on a pension fund equity portfolio that complies with the legal duty of prudent action for proper purpose?*

I analyse this question using the Freshfields report as a starting point and with a special emphasis on fiduciary duties such as the standard of prudence which is a fiduciary's legal duty to act in the best interest of pension scheme members (Davis and Hu, 2009), without a thorough analysis of other obstacles pension funds might encounter when considering ESG such as market short-termism or incentive structures (Friends Provident Foundation, 2011; Lydenberg, 2009; Poerio et al., 2011).

To the best of my knowledge, this research question is unexplored to date. My study closely relates to two streams of literature pursuing slightly different research objectives. One stream conducted many quantitative studies of the relationship between ESG criteria and investment performance but ignored the pension fund perspective with its unique research design requirements resulting from pension funds' financial characteristics and legal duties (e.g. Kempf and Osthoff, 2007; Lo and Sheu, 2007; Scholtens, 2008; Scholtens and Zhou, 2008). Another stream provided detailed explorations of pension funds' fiduciary duties with respect to ESG criteria but did not undertake any empirical analysis of the financial and risk implications of ESG integration (Martin, 2009; Richardson, 2009; Sandberg, 2011; Woods and Urwin, 2010). Hence, I consider this chapter to represent an attempt to bridge the gap between these two literature streams and investigate this research question.

To analyse my research question, I develop a test of the prudent integration of any ESG criterion in synthetic pension fund investment processes.[43] I ensure a prudent integration of ESG criteria by only using standard assets and investment transactions with a relatively

[43] ESG criteria is used to construct hypothetical pension fund equity portfolios based on different degrees of corporate environmental responsbility. They are needed for the construction of my portfolios and to contrast the financial performance and investment risk between hypothetical pension portfolios with different tastes for corporate environmental criteria. For example, to contrast hypothetical equity pension portfolios investing in companies who represent environmental leaders relative to environmental laggards.

low risk. The realistic nature of the pension fund investment processes derives from aspects such as their assets under management, their investment universe, or the sample period starting in January 2004 and ending in May 2010. I use corporate environmental responsibility ratings from EIRIS, which also supplies to several large pension funds and asset managers.[44] My test compares the return and risk characteristics of 25 hypothetical equity portfolios with five different degrees of responsibility in five different corporate environmental responsibility criteria (one aggregated measure and four disaggregated measures). My econometric analysis appears reliable, as it explains between 89% and 98% of return variation of all tested hypothetical equity pension portfolios.

My results provide no indications that the integration of aggregated or disaggregated corporate environmental responsibility criteria into investment processes has detrimental financial performance effects for equity pension fund portfolios. More interestingly, I find evidence that the inclusion of corporate environmental responsibility criteria considerably reduces the downside risk of pension funds' financial performance. Related studies investigating the relationship between corporate social responsibility and financial risk support my findings. These studies collectively conclude that social irresponsibility carries a cost, unlike social responsibility which provides "insurance-like" protection of firm value against negative events (Godfrey et al., 2009; Jo and Harjoto, 2012; Jo and Na, 2012; Oikonomou et al., 2012).

In line with the literature, my results suggest that fiduciary duties are not a constraint for the integration of corporate environmental responsibility standards into equity pension fund investment processes in any of the nine large jurisdictions studied by Freshfields and us (US, UK, Canada, Australia, Japan, Germany, France, Italy and Spain) (Freshfields Bruckhaus Deringer, 2005).

The chapter is structured as follows. Chapter 4.2. 'Background' discusses legal interpretations of the relationship between pension funds, fiduciary duty and ESG criteria. Chapter 4.3. develops the research design. In Chapter 4.4. 'Results', I report the findings of both, financial and risk implications of integrating corporate environmental criteria. Chapter 4.5. 'Robustness Tests' reports robustness test results. Chapter 4.6. concludes.

[44] While I design my prudent investment test to apply to any ESG criteria, I apply this test to one criteria, namely corporate environmental responsibility. The reason for this scope limitation is the recent public focus on issues of environmental damage. I select a set of corporate environmental responsibility criteria for my analysis in this chapter and hope to see future research investigating other ESG criteria.

4.2 Background

4.2.1 The debate on pension funds and ESG criteria

Historically, the use of non-financial criteria was solely a moral or religious statement and not an investment strategy (Bengtsson, 2008a, b; Richardson and Cragg, 2010; Sparkes and Cowton, 2004). Today's situation is quite different with the integration of environmental, social or governance (ESG) criteria in investment strategies increasingly attracting attention of a vast number of different institutions such as asset managers, pension funds, governmental or non-governmental organisations (Derwall et al., 2011; Emel, 2002; Gifford, 2010).

As a consequence of this surge in attention and perceived potential, a heated debate emerged on the question, if ESG criteria represent relevant and appropriate considerations in investment processes of pension funds. Proponents usually argue along three lines. First, they suggest that, at least in some cases, the consideration of ESG criteria, especially ESG risks, simply represents a pension fund investment strategy that delivers stable returns (Clark and Hebb, 2005; Kiernan, 2007; Sethi, 2005). Second, proponents argue that pension funds and other institutional investors such as insurance companies have grown so enormously large in size over recent decades that they now jointly own the majority of all financial assets worldwide and deserve to be titled *'universal owner'*. Due to their sheer size, the financial performance of those universally owning pension funds will largely dependent on the performance of financial markets as a whole instead of the returns to individual assets. Hence, universal owners have an incentive to integrate any ESG criteria which affects the world economy into their investment processes instead of just considering those ESG criteria that individual corporations cannot externalise (Amalric, 2006; Hawley and Williams, 2007; Hawley and Williams, 2000; Mattison et al., 2011; Thamotheram and Wildsmith, 2007). Third, some proponents consider it to be simply an implicit responsibility of pension funds to be concerned about the wellbeing of society and the natural environment and therefore integrate ESG factors in their investment approaches (Berry, 2011; Lydenberg, 2007; Richardson, 2009; Solomon, 2009).

Critiques of ESG criteria consideration by pension funds originate from a more extremely held view and are fewer in numbers than proponents, but as vocal as possible (Entine, 2005; Munnel and Sundén, 2005; Rounds, 2005). They also argue broadly along three lines, as they consider ESG integration (i) to represent an inappropriate political interference in pension funds' investment strategies, (ii) to be financially risky and (iii) to undermine the fiduciary duty of undivided loyalty (ibid.).

4.2.2 Common Law Legal interpretations of pension funds' fiduciary duty with respect to ESG criteria

As noted above, some critiques of ESG considerations claim that ESG is in conflict with pension fund trustees' legal obligations to invest in a prudent way.

Since many defined benefit pension schemes are facing deficits these days, the pension fund industry sees risk management as a top priority (Franzen, 2010; McKillop and Pogue, 2010). Consequently, the question of what impact ESG considerations might have on the financial risks and returns of a pension fund is of paramount importance. For example, CalPERS Global Principles of Accountable Corporate Governance states: "CalPERS believes that environmental, social, and governance issues can affect the performance of investment portfolios to varying degrees across companies, sectors, regions, and asset classes over time." (Mercer, 2011: ii; The California Public Employees' Retirement System (Calpers), 2010: 15)

While some regulatory changes concerning the fiduciary responsibility of pension funds in relation to ESG investment have taken place over the last decade in countries such as Australia, France, Germany or the UK, there is little evidence to suggest that the legal interpretation of the duties of (especially common law countries) pensions has dramatically changed (Dhaliwal et al., 2012; Freshfields Bruckhaus Deringer, 2005; Richardson, 2008, 2011; Richardson and Cragg, 2010; Sandberg, 2011; Sturm and Badde, 2001).[45]

According to the 'traditional interpretation' of pension funds' fiduciary duties, a pension fund should follow certain generally accepted principles such as utilising diversification to achieve competitive risk-adjusted returns in accordance with the risk parameters specified in the investment policy. All decisions are to be made in good faith for the economic benefit of the beneficiaries (Berry, 2011; Freshfields Bruckhaus Deringer, 2005; Richardson, 2006). Recent KPMG reports encapsulate the traditional view in a straightforward way, whereby the fiduciary duties of institutional investors implicitly emphasise maximising financial returns (KPMG, 2005, 2011).

Often, in a US context, The Employee Retirement Income Security Act of 1974 (ERISA) is mentioned since it was clarified in a 2008 US Department of Labor Bulletin, that ERISA prohibits investment decisions based on any factors other than economic (financial)

[45] Recent calls for a re-interpretation of fiduciary obligations such as the one by Berry (2011) for Fair Pensions are recognised. However, the degree of their success remains to be seen.

ones (Interpretive Bulletin 2509.08-1). If nothing else, sound risk and return management over a portfolio is the focal point of ERISA (Richardson, 2008).

However, in Board of Trustees v. City of Baltimore, 1989 none of Baltimore City's three employee pension plans were allowed to remain invested in companies doing business in or with South Africa. While Baltimore City's Ordinance No.765 was challenged by the Board of Trustees of each pension plan on constitutional grounds, it was upheld by the court (Board of Trustees of Employee Retirement System of the City of Baltimore v. City of Baltimore 317 Md., 1989; Freshfields Bruckhaus Deringer, 2005; Richardson, 2008; Smith, 1990). This was, however, not the first example of US case law dealing with the use of ESG criteria. In 1978 the Associated Students of the University of Oregon challenged the opinion that divesting corporations operating in South Africa would violate Oregon's prudent investment rule (Richardson, 2008).

Nowadays, more than a few large US pension funds subscribe to various methods of ESG investing such as CalPERS (California Public Employees' Retirement System), or TIAA-CREF (Teachers Insurance and Annuity Association - College Retirement Equities Fund) (Mercer, 2011; Richardson, 2008). The growing acceptance for responsible investment practices originates from a number of reports prompting increased investment values and decreased risks (Mercer, 2011).

Similarly, the UK view on pension fund's ESG consideration has moved beyond the traditional view held in the famed Cowan v. Scargill [46] where the purpose of a trust is seen as to act in the "best interests" of the beneficiaries, which has been translated into best financial interests (Cowan v. Scargill, 1 Ch. 270, 1985; Thornton and Fleming, 2011).

Freshfields Bruckhaus Deringer, for example, argues that Cowan v. Scargill is widely misinterpreted, whereby investment decision makers have come to believe that they are required to maximise financial goals in each individual investment. Additionally, Freshfields Brukhaus Deringer contend that the profit-maximisation approach commonly said to

[46] Cowan v. Scargill represents the earliest case, in UK case law, that has attracted a lot of attention in the finanical industry (Richardson, 2008). In this case, the National Coal Board started legal proceedings against the National Union of Mine Workers, both of which were appointed trustees who governed the Mineworkers' Pension Scheme (Freshfields, 2005; Richardson, 2008). The Union of Mine Workers disagreed on a proposal by the National Coal Board, to increase foreign investment and energy investments that could compete with coal (Richardson, 2008). Robert Megarry, the judge, concluded that trustees must act in the best interest of beneficiaries, where he argued that "the best interests of the beneficiaries normally mean their *financial* interests" (Cowan v. Scargill, 1 Ch. 270, 1985; Freshfields, 2005; Richardson, 2008:228). The case has been (mis)used by many commentators to aid the view that the sole responsibility of pension trustees is to maximise profits (Freshfields, 2005). While Megarry, the judge, later clarified that he did not support this view, commentators continued to misunderstand the case.

characterise Cowan v. Scargill is questionable[47], and that the duty is to implement an investment strategy which incorporates risk and return objectives suitable to the trust (Freshfields Bruckhaus Deringer, 2005). For example, my analysis in this chapter shows that even naive contemporaneous ESG investment strategies are capable of achieving this goal without breaching trustees' fiduciary duties.

Another famous UK court case on ESG investing is Harries v. Church Commissioners in which the court emphasised the trustees' obligation to abide by the purpose of the trust (Harries v Church Commissioners 1 WLR at 1247, 1992; Freshfields Bruckhaus Deringer, 2005). Further, the Charity commission, supervising charities under the 1993 UK charities act, has made it clear that charities shall only aim to invest for best possible financial results, as long as it advances the organisation’s charitable purpose (CharityCommission, 2011; Freshfields Bruckhaus Deringer, 2005; Richardson, 2008).

Martin v. Edinburgh (City) District Council, 1988 is another UK case. According to Richardson (2008) this case shows that a UK court interpreted the duty of loyalty as to seek a reasonable rate of return not as to maximise financial returns. However, Penner (2012) notes that the decision to divest companies with South African interests was found to be a breach of trust, due to the fact that the divestment was made without considering the best financial interests of the beneficiaries. Thornton and Fleming (2011: 52) brings the discussion together by stating "...the fundamental duty of pension fund trustees must be the proper fiscal management of the fund to provide reasonable returns to the benficiaries" (ibid.).

As long as the overriding objective (sound fiscal management) is adhered to, ESG considerations are acceptable (while some would argue in fact that ESG consideration would be a criteria for sound fiscal management). This standard is noticeable in the so called ‘tie-break’ principle by which a pension fund trustee has the power to select an investment over another based on environmental or social considerations when the investments are expected

[47] According to Article 172 of the Companies Act (2006), the duty of a company director is "to promote the success of the company". The success of the company is for the benefit of its members, i.e. shareholders. Similar to the Cowan vs. Scargill case, Article 172 of the Companies Act (2006) this could be seen as to maximise profits for the shareholders. The Companies Act (2006) is, however, more specific with regard to the fiduciary duties of company directors and ESG information. In line with the fiduciary duties of pension fund trustees, the Companies Act (2006) requires directors of companies to follow fiduciary duties. Meaning that, according to Article 174 of the Companies Act (2006), company directors have the "duty to excercise reasonable care, skill and diligence". The Companies Act (2006) is also more specific with regard to the duties of company directors in relation to ESG information, and under Article 417(5)(b)(i), states that in case a company is quoted, the business review must incorporate environmental matters "including the impact of the company's business on the environment". The problem with this article is that a) it does not tell the company director what kind of environmental information must be integrated and b) how it should be integrated.

to have the same financial benefits (Baker and Nofsinger, 2012; Freshfields Bruckhaus Deringer, 2005; PensionsRegulator, 2007).

Finally, on the topic of fiduciary duty in the UK, The Companies Act 2006 has obligated corporate directors to include community and environmental interests in their decision-making process. According to section 172, the long-term success of a company, called 'enlightened shareholder value' should be pursued (Richardson, 2008; Thornton and Fleming, 2011; UNEP FI, 2009).

The legal situation is even less elaborated on in other major economies such as Australia and Canada. Due to a lack of case law on the fiduciary duties of trustees and the scope for ESG investing in these countries, the UK with the richest case law tends to guide fiduciaries in the Australian and Canadian pension sector (Freshfields Bruckhaus Deringer, 2005; Richardson, 2008). Particularly, the widely misinterpreted Cowan v. Scargill case is heavily relied upon. One example of continuing misinterpretations of fiduciary duties in general, and Cowan v. Scargill in particular, can be found in Australia's largest industry pension fund, Australian Superannuation Fund. The pension fund's ESG investment beliefs state, "Our fiduciary duty to members is critical. Appropriate ESG investment activities will be explored, but will not be undertaken at the expense of its fiduciary duty." (Australian Super, 2013; Financial Services Institute of Australasia, 2012). The funds' investment philosophy implicitly mirrors the profit maximisation intent and highlights that ESG integration may be costly (or perceived as an expense). Another example that illustrates the profit maximisation intent is the so called “sole purpose test”, which constrains trustees' to ensure that funds are managed solely in the best monetary interests of the members (Freshfields Bruckhaus Deringer, 2005). In short, a portfolio should be characterised by sound risk and return objectives (Richardson, 2008). Nevertheless, critics argue that the sole purpose test of fiduciary duty, which constitutes the duty of loyalty, takes a narrow focus on solely maximising financial benefits to beneficiaries, thus, encouraging investments in highly unethical investment opportunities because of their potential rewards (Gray, 2012). Further, critics perceive the sole purpose test as a major barrier to ESG adoption (Freshfields Bruckhaus Deringer, 2005). However, according to Keith Johnson, in a commentary to Gray (2012: 18), this is a "popular misconception about fiduciary duty for at least two reasons." First, he argues that fiduciaries are required by law to ensure a sustainable balance between short- and long-term risks and returns. Second, fiduciary duties, including the sole purpose test are dynamic fiduciary laws (evolved and re-interpreted over time) with the purpose of guiding rather than prescribing trustees' investment decisions (Hawley et al., 2011). More recently, proponents of the sole purpose test conclude that it is not seen as a major barrier to ESG integration, however, calls for more guidance on how to integrate ESG issues, from institutions such as the Australian Prudential Regulation Authority (APRA), have been voiced (Carlisle, 2011).

Although, Canadian legislation on ESG investing is rather scarce, some regional developments in the provinces of Manitoba and Ontario are noteworthy. For example, amendments have been made to Manitoba's Trustee Act in 1995 and Pension Benefits Amendment Act, 2005, enabling trustees to lawfully consider non-financial criteria as long as the trustees exercise the judgment and care that a prudent person would do (Manitoba Law Reform Commission, 1993). As long as trustees demonstrate duty of care, investment decisions can be based on non-financial factors such as ESG criteria (Richardson, 2008). Similarly, in the province of Ontario, "Ethical" investing is permitted, if the positions are disclosed in the funds' statement of investment policies (SIP) and clearly communicated to the members of the plan (Financial Services Commission of Ontario, 1992; Richardson, 2008).

Furthermore, Ontario was the first Canadian province to enforce the South African Trust Investments Act in 1990 with the aim of discouraging Ontarian trusts, charities, and pension funds from making investments in companies with ties to the Apartheid system.

Despite countrywide legislation in Canada still being in its infancy, calls for increased disclosure on ESG concerns by pension funds and other financial institutions remain high. For example, a recent report urges Canadian pension funds to disclose, a) the degree to which ESG information is utilised in investment decisions, b) how this information is considered in proxy voting and corporate engagement activities, c) proxy voting activities (National Round Table on the Environment and the Economy, 2007). Other Canadian legislation, such as, Canada's Bank Act, S.C. 1991, however calls for, among other things, adequate portfolio diversification (Richardson, 2008).

After having reviewed landmark legal cases on the fiduciary duties of pension funds in common law countries in the last decade,[48] I come to conclude that several regulatory changes support a development towards increased flexibility, sustainability, and transparency. However, while there seems to be increasing advocacy for considering ESG issues in pension funds from a legal perspective, acts and initiatives are rather vague and it is far from clear

[48] For a comprehensive review of fiduciary duties related to ESG investing in civil law countries the reader is referred to the Freshfields Report (Freshfields Bruckhaus Deringer, 2005). There may have been further legal developments in civil law countries since its first publication in 2005.

how pension funds can actively integrate ESG criteria in a sensible way, without compromising their duty to act in the best interest of their beneficiaries. From a practical perspective, I see strict negative screening (promoted by the widely misinterpreted Cowan v. Scargill case) as major barrier to advance the topic. Thus, I advise pension funds to implement contemporaneous ESG investment strategies, many of which already incorporate corporate governance and related concerns into investment processes, as these are less likely to compromise fiduciary duties.

While pension fund legislation in the largest developed economies based on civil law (France, Germany, Italy, Japan, Spain) is possibly a little more open to ESG considerations than its common law counterparts, it can be barely interpreted to include any meaningful support of pension funds' ESG integration. As the traditional interpretation of pension funds legal duties is problematic for proponents of pension funds' ESG consideration especially in common law countries and foremost in the US, I limit my legal analysis to common law countries.[49]

4.3 Research Design

4.3.1 Rationale for Research Design

To address my research question, I develop a prudent test of the financial impact of the integration of ESG criteria into Defined Benefit (DB) and Defined Contribution (DC) pension fund equity investment strategies.[50] Although, my test applies more to DB pension plan types, due to their different underlying liabilities, ESG integration can also benefit DC pension plans (Sievänen et al., 2013). I limit my test to equity investment strategies for three reasons. First, motivating, developing and analysing realistic and prudent tests of large and potentially complex pension fund portfolio processes for multiple asset classes is simply beyond the scope of an individual chapter. Second, equities and fixed income are by far the largest asset

[49] It should be noted though that a few countries exist worldwide, whose pension funds legislation includes (some) support of the integration of ESG criteria in pension fund investment processes. Examples are the Netherlands and Sweden (Freshfields Bruckhaus Deringer, 2005; Hamilton and Eriksson, 2011; Renneboog et al., 2008b).

[50] My 25 hypothetical pension fund portfolios appear to be imitating one of four basic pension fund models established in Clark (2000). This type of pension fund is large and internally managed, and thus most commonly associated with Defined Benefit (DB) plans. I therefore implicitly assume that I integrate social responsibility criteria into DB pension funds' investment processes. Sievänen et al. (2013), however, recently determined that the funding type of pension plans is not a substantial driver of social responsibility in the European pension fund market. Based on their findings, it seems plausible to argue that my analysis is not only relevant for DB, but also DC and other hybrid pension fund models. While I aim to integrate sustainability criteria in all pension scheme types, I am aware of the different underlying liabilities of defined benefit (DB) and defined contribution (DC) pension schemes.

classes in international pension fund portfolios[51], and jointly represent the vast majority of pension funds' assets (OECD, 2013). Third, the integration of ESG criteria into investment portfolios is, from a financial performance perspective, criticised much more for equities than for fixed income which appears to be relatively compatible with the consideration of ESG risk factors (Derwall and Koedijk, 2009; Geczy et al., 2005; Menz, 2010; Munnel and Sundén, 2005)

In designing my test, I put special emphasis on two aims. First, I aim to embed my test in a doubtlessly prudent investment process to comply with the legal duty of prudence. With this ambition, I follow in the footsteps of three of the founding fathers of ESG investment, who aimed to outline an *"investment policy ... [that] is legally justifiable as a sophisticated attempt to maximise .. economic return[...] and therefore need not be defended - and cannot be attacked - as a social pursuit"* (Simon et al., 1972: 137). To develop a doubtlessly prudent investment process, I select the prudent (conservative) option whenever I have any discretion on any aspect of the investment process (e.g. I use long only investment and do not engage in complex and potentially risky financial engineering products). Further, my prudent investment approach is motivated by recent findings on pension fund investor sophistication and rationality. Dreu and Bikker (2012) find varying degrees of investor sophistication across pension funds. They establish that pension funds with low investment expertise tend to be more risk-averse. Generally, pension funds' investment policies signal investor (un)sophistication by rounding asset allocations to multiples of five percent, investing little to nothing in complex asset classes and favouring home markets. Additionally, Clark (2010, 2012) argues that individuals (including pension fund managers, but possibly to a lesser extent) are exposed to "self-defeating", or behavioural biases that strongly influence decision-making in a non-optimal manner.

Second, I aim to embed my test in a realistic and generic equity pension fund investment process, which can be customised according to any asset manager's investment style preferences, to achieve a high practical value for my results and therefore (substantially) reduce the uncertainties of real pension fund decision makers.[52] Indeed, my aim appears in line with a recent trend towards increased practical relevance not only in business ethics journals but more generally in research published across numerous journals which

[51] For example, US pension funds allocate approximately 50 percent to equities and 25 percent to fixed income (See OECD, 2013)

[52] In this ambition, I am inspired by Young (2007: 1), who assumes that *"[t]he challenge for business ethics is not so much enunciating the unyielding call of moral perfection but rather providing practical wisdom relevant to the needs of business decision-makers."*

investigates the relation between ESG factors and various aspects of business (e.g. Clark, 2012; Clark and Monk, 2011; Clark et al., 2008; Clark and Urwin, 2008; Figge and Hahn, 2004; Martin, 2009; Nilsson et al., 2008; Thamotheram and Wildsmith, 2007; Thomas et al., 2007; Woods and Urwin, 2010).

Technically, I develop my test by making research design choices on seven aspects: (i) investment universe, (ii) portfolio construction, (iii) ESG integration, (iv) ESG data provider, (v) ESG criteria, and (vi) financial performance assessment, and (vii) risk management assessment.

4.3.2 Investment universe, portfolio construction and ESG integration

I select stocks listed in the world's developed economies as the investment universe, since equity investments in emerging markets might be perceived as imprudent due to higher risks. Since I aim to nest my test in a doubtlessly prudent investment process, I limit myself to constructing long only portfolios and prohibit more complex and potentially risky transactions such as short selling or derivatives.[53] Similarly, to ensure prudent diversification, I value-weight all equities in my portfolios and prohibit other approaches such as equal-weighting.[54]

To realistically and prudently integrate ESG criteria into equity pension fund investment processes, I define three objectives: First, I need to construct equity portfolios which reflect the size of large pension funds and hence hold assets worth several billion US$ (Ferreira and Matos, 2008; OECD, 2010; Thamotheram and Wildsmith, 2007). Second, I aim to integrate ESG criteria into baseline equity pension fund portfolios, which asset managers can subsequently customise in any way according to investment style preferences (e.g. in terms of country, industry or small cap exposure). This aim allows my research design to

[53] Besides my concern for a prudent investment process, this research design practice acknowledges that some jurisdictions limit the types of assets selectable by pension funds and even the practice of loaning out pension fund shares to allow other financial market participants to short sell these. This practice is under close scrutiny from regulators, who are concerned about the effect of the resulting downward market pressure on the pension funds' and the economy's long term financial performance. Apart from legislative restrictions, most pension funds are simply too large to engage in less liquid trading activities at reasonable transaction costs or negative price impacts due to personal trading. For instance, the sheer size of many pension funds prevents them from short selling activities, as there are simply no market participants to lend them a meaningful number of shares given the size of their portfolios (Financial Services Authority, 2002; Freshfields Bruckhaus Deringer, 2005; OECD, 2010)

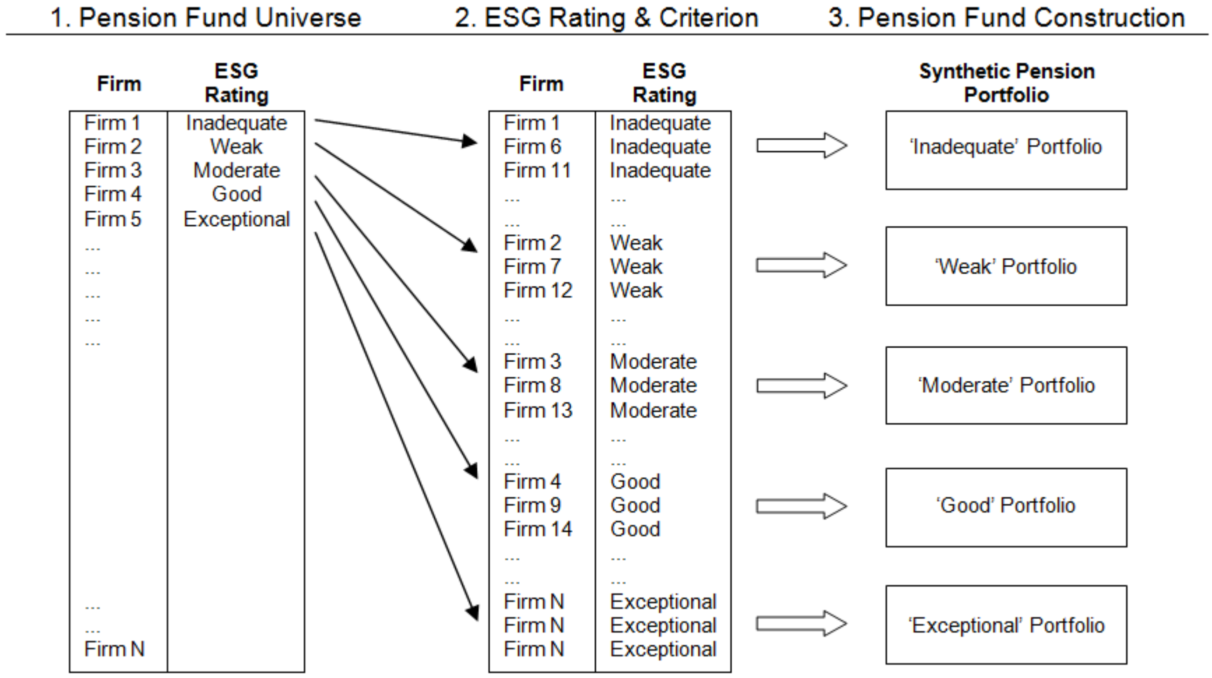
[54] This research design choice recognizes the large size of many pension funds. Having several billions US$ assets under management (Ferreira and Matos, 2008; OECD, 2010; Thamotheram and Wildsmith, 2007), these pension funds can unlikely equal- weight their entire portfolio without potentially affecting market prices themselves as consequence of their asset re-allocation. If I permitted equal- weighting, this scenario would represent a possibly substantial bias of my results.

isolate the effect of ESG integration from effects of other investment style choices.[55] Third, to prudently integrate ESG criteria into pension fund investment processes, I require a very simple integration approach which does not constrain portfolio diversification.

I meet these objectives by simply dividing my very large developed country investment universe in several, still very large, sub-universes according to the constituents' ESG ratings. For instance, I group all firms with the worst ESG rating in one portfolio, all firms with the second worst ESG rating in another portfolio and so on. In essence, I am creating prudent equity investment portfolios with different ESG ratings and study their monthly returns to inform my research question about the financial impact of ESG integration on equity portfolios of pension funds. This portfolio construction approach is inspired by Gompers et al. (2003) and recently common practice in the ESG Finance literature (Bebchuk et al., 2009; Edmans, 2011; Kempf and Osthoff, 2007). I illustrate my portfolio construction approach in Figure 2. My initial investment universe is drawn from the original equity universe of the FTSE All World Developed Index. The companies listed on the FTSE All World Developed Index are the ones that EIRIS aims to fully rate. For each year in my sample, I have obtained constituent lists from FTSE. Constitutent lists contain a list of active and dead firms that have been listed in a particular year on the FTSE All World Developed Index. My initial sample was then reduced by firms with no available total return data, no valid EIRIS criteria, and double or triple share class listings[56]. This resulted in my sample investment universe comprising on average 1,519 firms at the beginning of each year following an EIRIS end of year assessment (2004: 1,504 / 2005: 1,465 / 2006: 1,551 / 2007: 1,520 / 2008: 1,541 / 2009: 1,531 / 2010: 1,519). In Table 1, I report the actual number of equities per any of my 25 constructed portfolios per annum.

[55] With the aim to accommodate a flexible set of practical investment styles, which could be implemented in my ESG criteria considering baseline pension fund portfolios.
[56] Some companies appear more than once on the FTSE All World Developed Index due to double or triple share class listings. As EIRIS rates the company rather than the share class of a company, I combine different share classes to one share class by equally-weighting their financial returns. This approach to combine different share classes of the same company has been used in previous studies (See e.g. Da et al., 2008).

Figure 2: Synthetic Pension Fund Construction



Notes: This figure illustrates my hypothetical pension portfolio construction for the criterion "Quality of corporate environmental policy and commitment". I repeat the following procedure for the five portfolios: First, I retrieve EIRiS' five point assessment for 'corporate environmental policy and commitment' ('inadequate', 'weak', 'moderate', 'good', or 'exceptional') for each firm (1 to N) in the FTSE All-World equity universe. Then, I group all firms with the same rating and update the groups at the beginning of each year. Third, I value-weight my portfolios and update each firm's weight annually. I identify the weights of each firm in the portfolio by its market capitalisation. Value-weighting is a realistic approach for my empirical tests because it distinguishes between the weights for smaller and larger companies proportionally.

To reflect potential changes in ESG ratings, I update my portfolios annually at the end of December. Since I do not make any investment style choice prior to the construction of these baseline equity pension fund portfolios, I isolate the ESG integration from any other step in a pension fund portfolio construction. As long as I do not construct an excessive number of portfolios, even the smallest of my portfolios should be of sufficient size and diversification for a reliable analysis of the financial effects resulting from the integration of ESG criteria in equity pension fund investment processes. Since some researchers argue that the relationship between ESG criteria and financial performance is parabolic (e.g. U-shaped or inverted U-shaped) instead of linear (Barnett and Salomon, 2006; Ullmann, 1985), I aim to construct an unequal number of portfolios per ESG rating to analyse the financial performance difference between a median ESG rated portfolios and its peers with a more extreme ESG rating.[57] In addition, having a median value is helpful for the comparison and

[57] This research design cannot only be understood as a test of pension fund ESG integration at the portfolio level, it can equivalently be interpreted as analysis of the aggregated results from thousands of tests of pension fund ESG consideration at the level of an individual stock. In fact, if researchers wanted to conduct a statistical

interpretation of different degrees of corporate environmental responsbility. Furthermore, EIRIS' survey data is based on questionnaires that provide five possible outcomes for each environmental criteria. Thus, I use the same five groups to distinguish different degrees of corporate environmental responsbility.

4.3.3 ESG data

The Freshfields report suggests that any ESG criteria not harming financial performance should be voluntarily considered. Inevitably, I can only investigate if pension funds' fiduciary duties *prohibit* the integration of certain environmental, social or governance criteria. I cannot investigate in a single chapter if pension funds' fiduciary duties *permit* the integration of any environmental, social or governance criteria. Hence, I aim for modesty and select a feasible set of environmental, social or governance criteria thereby accepting the inevitable limitation that the investigation of my research question with regard to other ESG criteria will remain a challenge for future research.

Motivated by very large scale corporate environmental disasters (BP's Gulf of Mexico oil spill, Tepco's Fukushima nuclear catastrophe), which I expect to concern many pension fund beneficiaries across the world for years to come, I restrict my test to a set of corporate environmental responsibility assessments. Specifically, I employ EIRIS' assessments in four core processes of corporate environmental responsibility: (i) quality of corporate environmental policy and commitment, (ii) quality of corporate environmental management systems which implement the corporate environmental policy, (iii) improvements of actual environmental performance by corporation as result of the environmental policy and management systems, and (iv) quality of corporate environmental reporting on the previous three processes. All four criteria are assessed by EIRIS on a five point scale. The three quality measurements (environmental policy, environmental management, environmental reporting) are assessed from the worst to the best judgement as 'inadequate', 'weak', 'moderate', 'good', or 'exceptional' quality of the respective process. The actual environmental performance rating is assessed from the worst to the best judgement as 'no or inadequate data', 'no improvement', 'minor improvement', 'major improvement', or 'significant improvement'. In addition to these four individual (disaggregated) ratings, I calculate the average of these four ratings by transforming the

analysis of pension fund ESG integration at the level of the individual stock, it is very likely that they would employ a conceptually very similar research design, since statistical analysis always requires a sufficient high number of individual observations (i.e. ESG integrations at the individual stock level), which can be grouped or otherwise classified along a variable.

ordinal textual assessments in consecutive integer values following previous studies based on EIRIS data (e.g.Brammer and Pavelin, 2006; Cox et al., 2004; Cox et al., 2007; Dam and Scholtens, 2013). I use this 'average environmental rating' as fifth (aggregated) rating, whereby I sort the firms in five groups according to quintiles of the rating scale (i.e. firms rated with values in the smallest 20% of the rating scale are categorised in the worst rated group, companies with values above 20% but no larger than 40% of the rating scale are clustered in the second worst group and so on).

I have access to EIRIS' end of calendar year assessments from 2003 to 2009 for constituents of the FTSE All World Developed, one of the leading global stock market indexes for developed countries. During my sample period, this index listed companies from 26 developed countries and is hence an ideal investment universe for realistic prudent equity pension fund investment test. These 26 countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel (upgraded to developed country in 2008), Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand, Portugal, Singapore, South Korea (upgraded to developed country in 2009), Spain, Sweden, Switzerland, UK, US. This investment universe comprises, on average, around 1,850 firms, whereby a double-digit number of firms are listed with multiple share classes (i.e. A and B shares) each year. EIRIS makes every attempt to provide corporate ESG assessments for each firm in this investment universe, but naturally it needs a bit of operational time to react to each addition to FTSE's constituent list. This operational time lag effect and some random occasional unavailability of financial data from Datastream resulted in my sample investment universe comprising on average 1,519 firms at the beginning of each year following an EIRIS end of year assessment. The following list shows the annual mean number of firms with available ESG assessments:

2004: 1,504
2005: 1,465
2006: 1,551
2007: 1,520
2008: 1,541
2009: 1,531
2010: 1,519

In columns 7 to 13 in Table 1, I report the actual number of firms with valid ESG data for each portfolio from 2004 to 2010. As EIRIS is specialised in assessing a company's ESG performance, they also track the behaviour of a company's changes of its ESG performance over time. Whenever new information about a company's ESG performance becomes available EIRIS changes its ratings accordingly. To give one example, when a company has introduced a new environmental policy, then EIRIS will respond to that change by adjusting their rating upwards for that company. Generally, it is common for ESG criteria to change over time. To account for ESG rating changes, I update (re-balance) the constellation of my constructed portfolios based on ESG data at the end of each year. Updating my portfolios annually ensures that companies with improved ESG performance will be upgraded to a portfolio with higher ESG ratings, while companies with worsening ESG performance will be downgraded to a portfolio with lower ESG ratings.

4.3.4 ESG data provider EIRIS

I obtain my corporate environmental ratings from EIRIS, which are characterised by the following five features. First, EIRIS currently provides ESG data to large pension funds such as French FRR or Danish ATP. It is a reputable ESG ratings provider with its data being used by the FTSE4Good index series and other large asset managers such as BlackRock, Legg Mason, Legal & General or Morgan Stanley (EIRIS, 2011c). Second, EIRIS is an independent, non-for-profit organisation with over 25 years of experience in assessing and engaging with corporate ESG performance which does not offer any additional financial or legal advice to its clients (EIRiS, 2003, 2007, 2011a; Jahn, 2004; MISTRA, 2005; Schäfer et al., 2006). Third, EIRIS is a non-for-profit organisation that provides its clients with a broad selection of hundreds of individual ESG rating items in over 80 ESG research areas (EIRIS, 2011b; Schäfer et al., 2006). Fourth, EIRIS tends to have a good track record with academics and non-governmental organisations (NGOs). Although, some critique has been raised regarding the importance, validity, reliability, and reproducability of ESG data,[58] other ESG ratings data provider such as KLD are also affected (Chatterjii and Levine, 2006; Chatterjii et al., 2009; Dam and Scholtens, 2010; Dam et al., 2007; Delmas and Blass, 2010; Entine, 2003; Rowley and Berman, 2000; Semenova, 2010; Sharfman, 1996). EIRIS' standing with charities appears excellent, as leading charities such as Oxfam or WWF trust its ESG data.

[58] Some common issues related to the importance, validity, reliability, and reproducability of ESG data are ESG raters' lack of transparency with regard to their methodologies, data quality issues, and data standardisation across sectors (Chatterjii and Levine, 2006; Chatterjii et al., 2009; Dam and Scholtens, 2010; Dam et al., 2007; Delmas and Blass, 2010; Entine, 2003; Rowley and Berman, 2000; Scholtens, 2009; Semenova, 2010; Sharfman, 1996 2006). For example, many ESG raters do not fully disclose the methodologies of their data generation process (Scholtens, 2009). While this protective behaviour helps ESG raters to compete, it hampers the transparency and validity of ESG data. It has also been noted that some ESG raters outsource the collection of ESG ratings to lower-cost economies such as India and Mauritius, which could lead to data quality issues (Young et al., 2011).

WWF, for instance, employs EIRIS data for its own corporate ESG assessment reports and Oxfam even requests EIRIS to check its ethical supplier questionnaire (EIRIS, 2011c; Oxfam, 2004; WWF, 2007). Fifth, EIRIS' corporate ESG assessments are based on a number of information sources including public company data, a company questionnaire, NGO reports, information from other media sources or data provided by regulators. Information is collected by EIRIS' analysts based in its London, Boston or Paris office or its international partners in countries such as Australia, Germany or South Korea. For the interpretation of data points, EIRIS employs dedicated sector specialists, who analyse the information collected by their colleagues and update EIRIS corporate ESG assessment, whenever required due to relevant new ESG information. EIRIS is committed to reliable and valid corporate ESG ratings by ex-post audits of its ESG data (EIRIS, 2007, 2011d) [59].

4.3.5 Financial performance assessment

For this sample universe, I retrieve monthly simple return data and market valuations for all firms from Datastream for my 77 months sample period from January 2004 to May 2010.[60] The return data is inclusive of distributions and both data types are denoted in US$. Based on these simple return data, I construct 25 large equity portfolios, whereby each portfolio only includes firms with one of the five assessment steps of my five corporate environmental responsibility criteria. The portfolios are value weighted based on one month lagged information with multiple share classes being appropriately considered. The portfolio constituents are updated at the beginning of each January as reaction to EIRIS' new environmental responsibility assessments supplied annually at the end of December. Once portfolio returns are calculated based on the simple returns of the individual firms, the portfolio returns are transformed into continuously compounded returns to avoid an upwards bias in my statistical analysis. In line with Jensen's (1968) original data transformation, I subsequently deduct the continuously compounded risk free rate from my continuously compounded portfolio returns to calculate the continuously compounded excess returns of my portfolios. As the risk-free rate for my developed country universe, I employ the monthly investment yield on a thirteen weeks US Treasury bill supplied by Datastream, as I

[59] EIRIS seeks and obtains feedback from assessed companies and updates its ESG data accordingly.

[60] I select this sample period because EIRIS' corporate environmental ratings become available at the end of 2003 and are limited to the end of 2009 for this study. The sample period under investigation inlcludes the financial crisis of 2007/2008. The principal objective of this chapter is to investigate the financial and risk implications of ESG criteria consideration on naive equity pension fund portfolios over a historical time period. The research question did not intend to test specifically the financial and risk implications during the financial crisis of 2007/2008 or other economic crises.

acknowledge that the US is (still) the most powerful and hence potentially least risky economy in the world. A potential downgrade on US Treasuries might result in increasing interest rate yields, signalling an increasingly risky economy.

To assess the financial performance of my 25 large equity portfolios, I use the Carhart (1997) model, which has been used in related equity portfolio studies (Bauer et al., 2005; Kempf and Osthoff, 2007; Statman and Glushkov, 2009) and pension fund performance studies (Goyal and Wahal, 2008; Tonks, 2005). As performance measurements of institutional investors (including public and private retirement plans, endowments, and multi-employer unions) have been found to be sensitive to the choice of model employed, I follow Busse, Goyal and Wahal (2010) who also use a four-factor model. In particular, they find performance persistence using Fama and French's 3-factor model, however, the evidence vanishes after employing unconditional and conditional versions of Carhart's 4-factor model. The Carhart model can be written as in Equation (6).

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + s_i (r_{smb,t}) + h_i (r_{hml,t}) + m_i (r_{mom,t}) + \varepsilon_{i,t} \qquad (6)$$

where $r_{i,t}$ and $r_{m,t}$ represent the return of an equity pension fund portfolio (p) and my value-weighted investment universe of an average 1,519 firms denoted m. $r_{f,t}$ represents the risk free asset return. In the Carhart model, the financial performance assessment measure is α_i. It represents the financial performance differential between the portfolio and the investment universe benchmark controlling for the known equity portfolio performance drivers size (smb_t), value versus growth (hml_t) and share price momentum (mom_t) (Carhart, 1997; Fama and French, 1992, 1993). β_i denotes the portfolio's systematic exposure to the investment universe's equity market benchmark, while s_i, h_i, and m_i measure the exposure of a portfolio to the respective driver of equity performance. $\varepsilon_{i,t}$ captures the random components of a pension fund's portfolio's excess return for each observation (t).

For an equivalent developed country universe, I construct the control factors representing the known equity performance drivers 'size', 'value vs. growth', and 'momentum' using the online research tool of Style Research Limited, which are based on the Worldscope database and have been used extensively in previous research (e.g. Bauer et al., 2007; Bauer et al., 2005; Hoepner et al., 2011; Renneboog et al., 2008a). The size factor SMB is generated as the return difference between a portfolio of stocks in the lower half of the market capitalisation ranked investment universe and a portfolios of stocks in the upper half of the same universe. The value vs. growth factor (HML), is based on the investment universe ranked according to book value to market value ratio. It represents the difference between the return of a portfolio of the Top 30% stocks and the return of a portfolio of the Bottom 30% stocks. The momentum factor (MOM) originates from the investment universe ranked according to each stock's return over the previous twelve months. It is calculated as the return difference between a portfolio of the Top 30% stocks (previous winners) and a portfolio of the Bottom 30% stocks (previous losers) in this ranking. The MOM factor is updated monthly, while the SMB and HML factor are updated annually at the end of June in line with Fama and French (1993). All six portfolios underlying my three control factors are value weighted based on one month lagged information and their returns are continuously compounded.[61]

4.3.6 Risk management opportunities

Risk management is a central concern to pension funds of all funding types which are found to substantially change their asset management strategies depending on risk management ability and success (An et al., 2013; Rauh, 2009).[62] Hence, the impact of ESG integration on risk is the second big question to address in order to understand if fiduciary duty prohibits ESG integration (Becker and Strömberg, 2012; Warburton, 2011).

Inspired by Blake, Rossi, Timmermann, Tonks, Wermers (2013), I empirically examine the risk of my 25 hypothetical equity pension fund portfolios by comparing several risk performance measures. The risk analysis comprises the following four total, idiosyncratic, and downside risk performance measures: a) Standard deviation, b) Semi Standard Deviation, c) Lower partial moments (LPM), and d) Worst-Case Loss.

My first risk measure, standard deviation, is commonly used to calculate a portfolio's exposure to total volatility and risk (systematic and idiosyncratic risks). Generally, total volatility measures portfolio risk of upside and downside return swings. I therefore calculate total risk as in Equation (7),

$$s_{xp,t} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(r_{xp,t} - \overline{r}_{xp,t})^2} \qquad (7)$$

[61] As Style Research does not offer the construction of the size (SMB) and value vs. growth (HML) factor precisely according to Fama and French (1993) and Carhart (1997), I follow Renneboog et al.'s (2008a) slightly amended procedure. Renneboog et al. (2008a) find that their 'factors are virtually identical' to the ones of Fama and French (1993) .

[62] Besides return and risk, Goyal and Wahal (2008) show that the termination of investment managers by pension trustees is not always due to financial underperformance, but can also result from non-performance related attributes such as personnel turnover, merger of investment firms or regulatory actions.

where $s_{xp,t}$ represent the standard deviations of the excess return on each of my 25 hypothetical equity pension portfolios. $\overline{r}_{xp,t}$ is the mean excess return of pension portfolio i at time t.

My second risk measure, semi standard deviation, can be seen as a special case of the conventional standard deviation, where only negative deviations below the mean are taken into account. From the perspective of a portfolio manager, a distinction between upside (good) and downside (bad) variance is very desirable, because "good" variance increases portfolio returns, whereas "bad" variance decreases them. I compute the semi standard deviation as follows (Maginn et al., 2007) :

$$ssd_{xp,t} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}[\min(r_{xp,t} - \overline{r}_{xp,t}, 0)]^2} \qquad (8)$$

where $ssd_{xp,t}$ are semi standard deviations of the excess returns on each of the 25 hypothetical pension portfolios. The condition $r < \overline{r}$ restricts the inclusion of returns below the mean.

Lower Partial Moments (LPM) is my third risk measure that is commonly applied to compute downside volatility/risk in more severe market conditions. The model assumes highly risk-averse investors, such as prudent pension funds because it punishes larger negative returns stronger than smaller negative returns. Generally, the magnitude of risk-aversion increases when the exponent of the LPM increases (Eling and Schuhmacher, 2007; Kaplan and Knowles, 2004; Maginn et al., 2007). I calculate LPM as in Equation (9),

$$lpm_{xp,t} = \sqrt[3]{\frac{1}{N-1}\sum_{i=1}^{N}[\min(r_{xp,t} - \overline{r}_{xp,t}, 0)]^3} \qquad (9)$$

where $lpm_{xp,t}$ are the lower partial moments of the excess returns on the 25 hypothetical pension portfolios. I use an exponent and square root of 3.

Finally, to assess the highest possible loss of my hypothetical pension portfolios, during turbulent market conditions, I compute the worst-case loss over the invested sample period. Results of the highest loss provide a good indication, whether integrating ESG information into pension portfolios protects highly risk-averse investors. I calculate the risk measure as follows:

$$loss_{xp,t} = \min_{xp,t} \qquad (10)$$

where $\min_{xp,t}$ represents the minimum excess return on each of the 25 hypothetical pension portfolios.

4.4 Results

4.4.1 Descriptive Statistics and Correlations

I display descriptive statistics for my 25 hypothetical equity pension fund portfolios in Table 1, which offer five interesting indications. First, I succeeded in constructing large investment portfolios most of which holding hundreds of firms. Of course, pension funds would in reality never own 100% of all firms in each of my constructed portfolios. Hence, I make the prudent conservative assumption that an equity pension fund portfolio would own 1% of each firm in my entire portfolios, which still results in all my pension fund portfolios being worth, on average, between 7 and 115 billion US$. Second, firms average environmental rating and especially their actual environmental performance increases over the years with the better rated portfolios including proportionally more companies. This might reflect an increase in environmental awareness among developed countries' firms and populations as found by Barkemeyer et al. (2009).[63]

Third, the 25 equity portfolios of the pension funds' standard deviations are relatively evenly distributed, which indicates that there appears to be no diversification advantage for more or less environmentally responsible portfolios. The two portfolios with the lowest standard deviation (moderately rated on environmental management and significant improvement in environmental performance) include a medium and a small number of stocks, respectively. This suggests that all portfolios are well diversified, as larger portfolios do not seem to have any diversification benefits. Fourth, mean excess returns are also relatively evenly spread across portfolios with different ESG ratings implying that financial performance differences between them might be small. Fifth, while mean returns, standard deviations and maximum returns are all evenly spread across ESG assessments, minimum returns are not. Curiously, the portfolio with the best rating has clearly the lowest minimum return in case of any ESG criteria. [64] This suggests that portfolios with high corporate

[63] My sample is survivor-bias adjusted. See Chapter 4.3.2. 'Investment universe, portfolio construction, and ESG integration', for a more detailed discussion on how I adjust my sample for survivorship-bias.

[64] As suggested by my examiners, I also test the effects of my ESG variables (environmental management, environmental policy, environmental performance and environmental reporting) on companies' excess returns using panel regressions with random and fixed effects. In my panel regressions, I include all of the companies in my sample and regress companies' excess returns on my ESG variables, separately, and over my full sample period from 2004 to 2010. Overall, my results show a negative association between my four ESG variables (environmental management, environmental policy, environmental performance and environmental reporting) and companies' excess returns. While the coefficients on my four ESG variables are negative (environmental management: -0.000013; environmental policy: -0.000160; environmental performance: -0.003178; environmental reporting: -0.001809), they are generally not statistically significant (z-ratios of -0.02; -0.15; -2.79; and -1.53, respectively) and considerably small in magnitude. With one exception, the coefficient on environmental performance is statistically significant at the 5 percent significance level. Using panel regressions

environmental responsibility ratings could have additional goodwill based on their good rating that protects them from extreme losses. This finding is similar to Godfrey et al. (2009) who find that firms with strong ESG activities suffering a negative event, benefit from insurance-like protection through their strong ESG engagement.

To prepare for my regression analysis in the next chapter, I present correlations between my independent variables to test for Multicollinearity in Table 2 with the following results. As expected, the excess returns on the value-weighted market benchmark factor correlate somewhat with the SMB, HML, and MOM factors. My independent variables with the highest correlation are between the market and the SMB factor, with a positive correlation of 63.7 percent.[65] In Table 2, my correlation matrix also indicates that the HML and MOM factors negatively correlate with 55 percent. These correlations are statistically significant at the 1 percent significance level.[66] In conclusion, I can observe that although the factors are not orthogonal to each other, some correlation is expected, as originally observed by Fama and French (1993) and Carhart (1997).

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with fixed effects, my results show a consistently negative association between my four ESG variables (environmental management, environmental policy, environmental performance and environmental reporting) and companies' excess returns. The coefficients on my ESG variables are negative (environmental management: -0.014452; environmental policy: -0.014850; environmental performance: -0.012744; environmental reporting: -0.017520), and statistically significant at the 1 percent significance level (t-ratios of -4.84; -4.50; -5.30; and -5.46, respectively). To determine which of my tested panel models (fixed vs. random effects) is more efficient in producing the estimators, I also conduct the Hausman specification test (Brooks, 2008). My results of the Hausman specification test show that the random effects model is the more appropriate model for all four panel regression specifications (Chi Squared values for environmental management: 27.18; environmental policy: 23.46; environmental performance: 21.85; environmental reporting: 29.55). Based on my results, I can conclude that my ESG variables do not have an effect on companies' excess returns, except for one of my ESG variables, namely, environmental performance. In other words, increased environmental performance seems to reduce companies' excess returns, however, the relationship is not very strong. The reader is also advised that my panel regressions do not include any control variables to control for company-specific characteristics such as company size or company leverage and sectors, which could potentially have an influence on the association between my ESG variables and companies' excess returns.

[65] Fama & French (1993) observe correlations of 32 percent between the market and the SMB factor, and -38 percent between the market and the HML factor.

[66] Carhart's (1997) correlations between the HML and MOM factor are -16 percent.

Table 1: Descriptive statistics of pension fund portfolios

Criteria	EIRiS Rating	Portfolio Excess Return				Number of Firms							Market Values (in billion US$)						
		Mean	Std. Dev.	Max	Min	2004	2005	2006	2007	2008	2009	2010	2004	2005	2006	2007	2008	2009	2010
Average Environmental Rating	5th Quintile	0.0093	0.0483	0.1454	-0.1886	733	634	631	597	598	549	523	84,746	78,010	81,383	81,982	72,546	34,698	43,662
	4th Quintile	0.0080	0.0481	0.1243	-0.1816	179	180	195	181	169	177	184	27,561	23,505	28,886	33,061	29,963	19,485	32,261
	3rd Quintile	0.0085	0.0492	0.1180	-0.1917	193	232	246	241	253	247	255	24,998	44,593	47,419	55,374	62,574	36,220	38,594
	2nd Quintile	0.0074	0.0470	0.1143	-0.1805	283	297	339	350	360	386	397	52,432	52,668	59,621	71,651	69,169	42,638	66,642
	1st Quintile	0.0083	0.0486	0.1183	-0.1427	116	122	140	151	161	172	160	19,926	26,693	44,205	53,019	54,711	35,418	47,447
Environmental Policy	Inadequate	0.0089	0.0495	0.1459	-0.1902	633	387	391	516	520	467	434	70,782	43,589	45,070	59,796	53,092	23,829	31,868
	Weak	0.0116	0.0497	0.1440	-0.2129	99	77	84	109	102	105	112	10,669	7,394	10,917	20,310	18,134	11,842	15,299
	Moderate	0.0104	0.0489	0.1340	-0.1766	200	175	180	216	219	225	219	24,671	20,936	25,846	41,194	38,019	20,757	26,560
	Good	0.0074	0.0455	0.1021	-0.1749	493	503	536	589	609	622	634	90,274	93,904	111,895	144,458	146,898	90,820	121,570
	Exceptional	0.0089	0.0558	0.1650	-0.1512	79	94	104	90	91	112	120	13,268	20,753	26,701	29,329	32,819	21,211	33,309
Environmental Management	Inadequate	0.0089	0.0482	0.1440	-0.1813	644	542	549	507	509	462	429	76,140	69,435	74,423	72,129	64,340	29,967	36,823
	Weak	0.0082	0.0542	0.1293	-0.2318	64	46	47	58	66	68	80	7,970	5,022	7,176	12,250	12,022	7,295	12,818
	Moderate	0.0086	0.0447	0.1065	-0.1686	251	283	298	293	275	284	297	39,014	46,994	55,065	69,704	59,652	37,503	48,578
	Good	0.0075	0.0498	0.1104	-0.2015	201	228	239	231	252	266	262	37,100	47,409	48,860	53,691	61,518	38,840	57,970
	Exceptional	0.0082	0.0485	0.1325	-0.1598	344	366	418	431	439	451	449	49,439	56,609	75,991	87,313	91,432	54,854	72,318
Environmental Performance	No or inadequate data	0.0085	0.0478	0.1374	-0.1869	746	618	704	652	667	620	566	102,382	80,929	89,391	89,979	85,586	46,350	55,311
	No improvement	0.0090	0.0571	0.1572	-0.2284	121	156	207	194	168	175	233	20,475	34,764	36,933	30,794	34,314	18,010	36,541
	Minor improvement	0.0083	0.0457	0.0993	-0.1719	153	198	323	310	303	300	321	27,313	41,598	59,073	74,751	57,960	37,751	50,254
	Major improvement	0.0069	0.0481	0.1253	-0.1793	113	125	250	273	298	330	305	25,919	32,543	53,112	64,991	72,269	47,505	58,678
	Significant improvement	0.0062	0.0447	0.0991	-0.1275	30	31	67	91	104	104	94	9,558	9,191	23,005	34,573	38,464	18,557	27,823
Environmental Reporting	Inadequate	0.0089	0.0462	0.1287	-0.1746	926	868	890	857	850	819	809	111,834	122,334	130,987	140,260	132,388	73,665	92,530
	Weak	0.0076	0.0607	0.1781	-0.2328	159	161	170	168	177	163	160	18,861	16,689	20,157	25,276	30,806	12,185	17,259
	Moderate	0.0072	0.0465	0.1153	-0.1860	283	286	330	326	348	380	382	55,271	51,117	65,680	74,156	71,086	48,021	72,747
	Good	0.0093	0.0605	0.1615	-0.2440	55	55	45	50	45	43	48	7,296	8,173	7,358	12,437	8,592	4,090	6,329
	Exceptional	0.0079	0.0477	0.1203	-0.1330	81	95	116	119	121	126	118	16,401	27,156	37,333	42,959	46,091	30,497	39,640

Notes: This Table reports descriptive statistics on each of the 25 pension fund portfolios, which are updated at the beginning of each year. The first column displays the environmental criteria integrated in the respective portfolios. The second column represents the rating of the respective portfolio. The subsequent four columns provide the descriptive statistics each portfolio's excess return (mean, standard deviation, maximum and minimum) over the sample period from 01/2004 to 05/2010. The number of firms included in each portfolio is displayed as of January of each year in the following seven columns. The last seven columns display the market value (in billion US$) of a pension fund portfolio as of January of the respective year, whereby I make the prudent conservative assumption that a pension fund portfolio would own 1% of each firm in my constructed portfolios (see Research Design chapter for my portfolio construction approach).

Table 2: Correlations between Independent Variables

	MKT		SMB		HML		MOM
MKT	1						
SMB	0.6372	***	1				
	(6.5631)						
HML	0.3256	***	0.2279	*	1		
	(2.7331)		(1.8575)				
MOM	-0.4122	***	-0.2963		-0.5455	***	1
	(-3.5908)		(-2.4628)		(-5.1663)		

Notes: This table reports correlation coefficients between my four independent variables: Excess returns on the value-weighted market portfolio, SMB, HML, and MOM benchmark factors. I compute the correlations over the full sample period from 01/2004 to 05/2010. ***, **, and *, indicate statistical significance at the 1%, 5%, and 10% significance level, respectively. Below each correlation coefficient, I report t-statistics in brackets.

4.4.2 Return results

4.4.2.1 Aggregated Measure: Average Environmental Rating

I begin my discussion of my financial performance assessment results discussing the five portfolios constructed according to the aggregate measure (average environmental rating) to see, if there is any general trend. My results displayed in Table 3 show that not a single portfolio out- or underperforms the investment universe benchmark at any statistical significance level (1, 5 or 10 percent)[67]. Hence, the values of the α-coefficients, which are anyway small in absolute size, appear meaningless since there is a high probability that they occurred purely by chance. These results are highly reliable as shown by the Adjusted R-squared values of between 92.4% and 97.2%, which represent the degree to which my econometric (Carhart) model is able to explain the excess return variation of my equity portfolios. In other words, there is only a little bit of excess return variation left, which my model cannot explain, and the smaller the unexplained component in a regression analysis the larger is the confidence that the respective results are empirically 'true' and are not potentially biased by any omitted explanatory variable. However, this result for average

[67] Since the returns of the MKT and SMB factors as well as HML and MOM factors correlate somewhat (see Table 2), I repeat my analysis with orthogonalised benchmark factors. The orthogonalisation procedure helps to reduce the correlations between my independent variables. Different versions of the procedure have been applied in the literature (See e.g. Elton et al., 1993; Hoepner et al., 2011; Schröder, 2007). The results of my regressions with orthogonalised benchmark factors are consistent with my previous results: None of my portfolios significantly out- or underperforms the investment universe benchmark.

environmental rating does not necessarily mean that the integration of individual, disaggregated corporate environmental responsibility portfolios in pension fund investment processes may not be financially detrimental.

Table 3: Aggregated Measure: Average Environmental Rating

Environmental Criteria	EIRiS Rating	Carhart Model						
		α	β	SMB	HML	MOM	Obs.	Adj. R2
Average Environmental Rating	5th Quintile	-0.0012	0.9196***	-0.1936**	-0.0212	0.0087	77	0.9572
	4th Quintile	-0.0021	0.9464***	-0.1261	0.0372	0.0764**	77	0.9450
	3rd Quintile	-0.0003	0.9806***	-0.3089***	0.0297	0.1091***	77	0.9722
	2nd Quintile	-0.0007	0.9409***	-0.3308***	0.0746	0.0951***	77	0.9724
	1st Quintile	0.0001	0.9700***	-0.2962**	-0.0985	0.1461***	77	0.9241

Notes: This table reports Carhart model estimations over the full sample period from January 2004 to May 2010 for portfolios representing quintiles of average environmental rating, whereby the first (fifth) quintile portfolio includes firms with the highest (lowest) average environmental rating. Using market value weighted portfolios, I estimate the regressions according to equation (1) displayed in the text. The third column reports the results of the intercept (α). The next column is the market beta estimate. Column five to seven are coefficients of the common investment style factors size (SMB), intangible assets (HML), and momentum (MOM). The last two columns report the number of observations and the adjusted Rsquared, which can be understood as the percentage of explanatory power of my regressions. Coefficient covariances and standard errors are made heteroscedasticity and autocorrelation consistent based on Newey and West (1987). ***, **, and * indicate the 1%, 5%, and 10% significance level, respectively.

4.4.2.2 Disaggregated Measures: Environmental Policy, Environmental Management, Environmental Performance, and Environmental Reporting

The results for the equity pension fund portfolios with different assessments on the four disaggregated criteria are shown in Table 4. The estimations for the portfolios rated on environmental policy, environmental performance and environmental reporting are very similar to the overall results for the aggregated corporate environmental responsibility rating. No portfolio significantly under- or outperforms its market benchmark and α-coefficients are small in size. The Adjusted Rsquared values are again very high (89% to 98%), which indicates the reliability of the observation that my baseline equity pension fund portfolios considering corporate environmental responsibility perform financially insignificantly different from the market portfolio.

Of all 25 pension fund portfolios, only one of the five portfolios constructed based on corporate environmental management scores significantly underperforms its market benchmark. This equity pension fund portfolio comprises firms with a weak environmental management and does not only statistically significantly underperform but also has an absolute α-coefficient that is twice as large as any other α-coefficient. Hence, an investment in this portfolio can clearly not be recommended from a financial perspective. Pension funds with a preference for companies with weak environmental management would experience detrimental financial effects from integrating corporate environmental responsibility scores into their investment process. However, pension funds currently interested in the integration of corporate environmental responsibility criteria into their investment processes have a preference for high(er) degrees of environmental responsibility and might even disapprove of firms scoring low in this regard. Hence, the statistically and economically significant underperformance of a portfolio of firms with below average environmental management is not problematic but beneficial for them, as they aim to underweight these less responsible firms in their portfolio.

In summary, I have found no evidence that equity portfolios of pension funds with sub-standard environmental responsibility assessments outperform market benchmarks or that pension fund portfolios with average of above assessments underperform the investment universe. The adjusted R^2 values of all my econometric estimations provide us with a high degree of confidence regarding the reliability of my findings. Thus, I interpret my overall results as clear empirical support for the view that the integration of environmental responsibility criteria in the investment processes of equity pension funds concerned about the environment does not harm their financial performance. Hence, based on my results I conclude that pension funds' fiduciary duty does not appear to prohibit the integration of environmental responsibility criteria into their investment processes, at least with respect to environmental responsibility data supplied by EIRIS.

Table 4: Disaggregated Measures: Environmental Policy, Management, Performance & Reporting

Environmental Criteria	EIRiS Rating	Carhart Model						
		α	β	SMB	HML	MOM	Obs.	Adj. R2
Environmental Policy	Inadequate	-0.0019	0.9558***	-0.2048**	-0.0299	0.0099	77	0.9639
	Weak	0.0009	0.9110***	-0.0882	0.0479	0.0828**	77	0.9096
	Moderate	0.0007	0.9358***	-0.1109	-0.0292	0.0755***	77	0.9648
	Good	-0.0007	0.9325***	-0.3346***	0.0516	0.1203***	77	0.9765
	Exceptional	0.0005	1.0589***	-0.2279	-0.0619	0.1229*	77	0.9185
Environmental Management	Inadequate	-0.0014	0.9153***	-0.2427***	0.0279	0.0093	77	0.9492
	Weak	-0.0057**	1.1058***	0.0130	-0.1035	0.1178***	77	0.9301
	Moderate	0.0003	0.8951***	-0.3060***	0.0199	0.0934***	77	0.9626
	Good	-0.0004	1.0010***	-0.3418***	0.0582	0.1179***	77	0.9589
	Exceptional	-0.0006	0.9556***	-0.2131**	-0.0476	0.1044***	77	0.9615
Environmental Performance	No or inadequate	-0.0019	0.9232***	-0.1570*	-0.0325	0.0217	77	0.9582
	No improvement	-0.0012	1.1263***	-0.2665***	-0.0448	0.0755***	77	0.9692
	Minor improvement	-0.0001	0.9238***	-0.2914***	-0.0221	0.1248***	77	0.9734
	Major improvement	-0.0013	0.9545***	-0.2861***	0.0918**	0.0944***	77	0.9702
	Significant	-0.0012	0.8614***	-0.3057**	-0.0274	0.1291***	77	0.8902
Environmental Reporting	Inadequate	-0.0006	0.8960***	-0.2154***	0.0086	0.0560**	77	0.9616
	Weak	-0.0026	1.1745***	-0.1964*	0.0629	0.0513	77	0.9609
	Moderate	-0.0012	0.9239***	-0.2716***	0.0647	0.0873***	77	0.9692
	Good	-0.0012	1.1903***	-0.3773**	0.0341	0.1525***	77	0.9115
	Exceptional	0.0001	0.9645***	-0.3756***	-0.1188*	0.1554***	77	0.9064

Notes: This table reports Carhart model estimations over the full sample period from January 2004 to May 2010 for portfolios of firms with four different ratings with respect to four EIRiS corporate environmental responsibility criteria (environmental policy, environmental management, environmental performance, and environmental reporting). Using market value weighted portfolios, I estimate the regressions according to equation (1) displayed in the text. The third column reports the results of the intercept (α). The next column is the market beta estimate. Column five to seven are coefficients of the common investment style factors size (SMB), intangible assets (HML), and momentum (MOM). The last two columns report the number of observations and the adjusted Rsquared, which can be understood as the percentage of explanatory power of my regressions. Coefficient covariances and standard errors are made heteroscedasticity and autocorrelation consistent based on Newey and West (1987). ***, **, and * indicate the 1%, 5%, and 10% significance level, respectively.

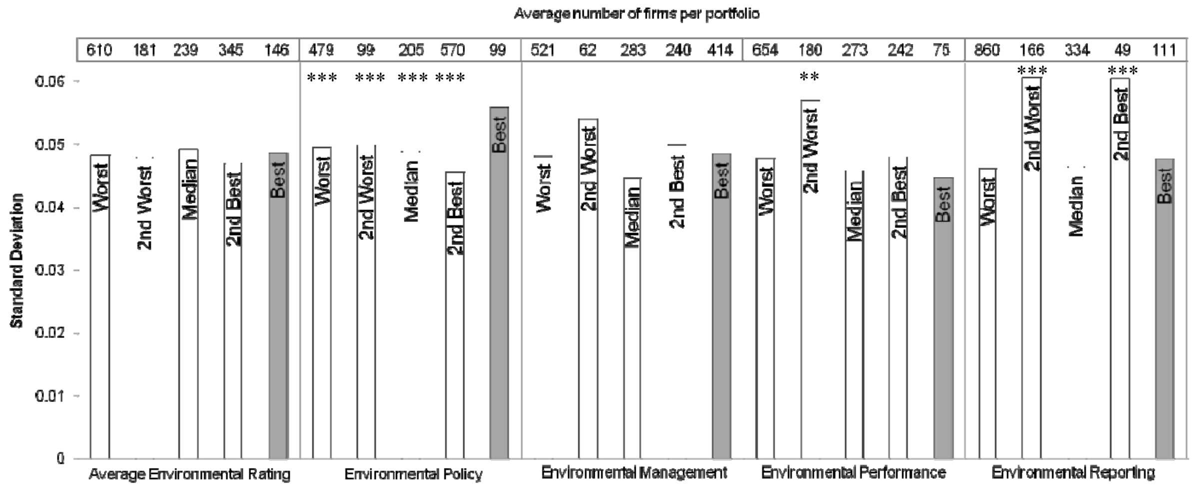
4.4.3 Risk results

I continue my discussion of my risk analysis assessment for 25 hypothetical equity pension portfolios based on aggregated and disaggregated corporate environmental sustainability criteria.

4.4.3.1 Aggregated Measure: Average Environmental Rating

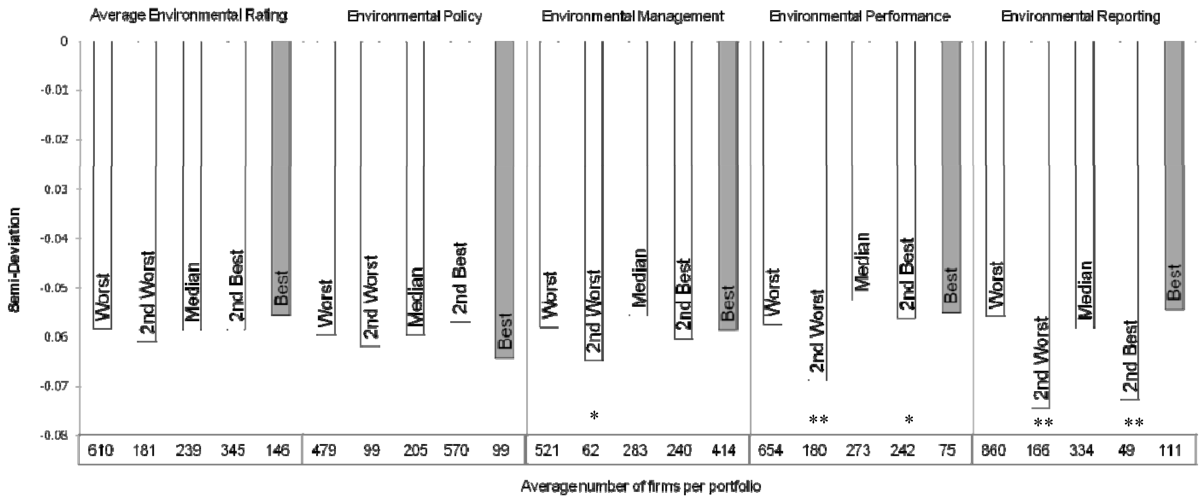
Figure 3 shows standard deviations across all 25 hypothetical pension portfolios. On the aggregated level, I find all pension funds to have undistinguishable total monthly volatilities below 5 percent. The results suggest very evenly distributed standard deviations and no diversification benefits for better or worst rated corporate environmental pension portfolios. Semi standard deviations are displayed in Figure 4. I can observe that some equity pension funds with outstandingly rated corporate environmental criteria have experienced lower downside volatilities relative to equity portfolios with weaker rated environmental criteria. This suggests that on average, exceptionally rated environmental portfolios provide somewhat better risk protection. This finding is intensified when I adopt the perspective of a highly risk averse investor, such as with the LPM risk measure. Figure 5 indicates that my 'Best' rated equity pension portfolio has a significantly lower downside variance relative to the 'Worst' and 'Median' rated equity portfolios, on average. My results are statistically significant at the 10 and 5 percent significance levels. For example, the difference between the downside variance of the 'Best' and 'Worst' rated pension portfolios is a remarkable 6.84 percent per annum. I can observe an even higher annual difference between the 'Best' and '2nd Worst' with 8.52 percent. These findings highlight the downside risk protection potential of pension funds with good corporate environmental ratings. My final risk measure takes the perspective of an extremely risk averse investor. In Figure 6, I present my findings on worst-case losses or minimum values across all 25 hypothetical equity pension fund portfolios. On average, the 'Best' rated portfolio protects the investor against large losses and excels in preserving value. Remarkably, the difference between pension portfolios based on outstanding as opposed to poor environmental responsibility is 4.6 percent. Although the differences between portfolios can be large, they are not statistically significant for the worst-case losses.

Figure 3: Standard Deviation of portfolios with varying EIRiS environmental responsibility ratings



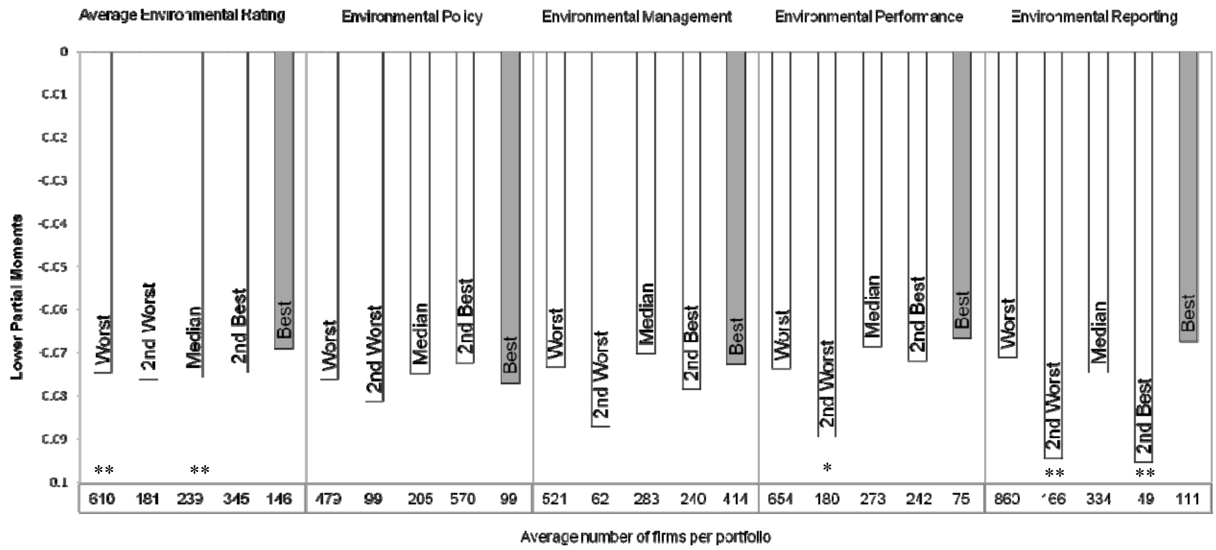
Notes: This figure shows standard deviations of annually updated investment portfolios including stocks with a specific EIRiS environmental responsibility rating. The horizontal axis (x-axis) displays the five corporate environmental ratings from EIRiS: Average Environmental Rating, Environmental Policy, Environmental Management, Environmental Performance and Environmental Reporting. The Average Environmental Rating is calculated as the mean rating from the other four. For each environmental rating, five value-weighted portfolios with increasing environmental performance are calculated. The grey bars represent the portfolios with the "best" environmental rating, whereas the white bars represent portfolios rated lower than "best", such as, "2nd best", "median", "2nd worst", and "worst". The numbers on top of each bar represent the number of average constituents in that portfolio. Statistical significances for the mean difference between the "Best" portfolio relative to the "2nd Best", "Median", "2nd Worst", and "Worst" portfolios are computed using a t-test. ***, **, and * indicate statistical significance levels at the 1, 5, and 10 percent statistical significance.

Figure 4: Semi Standard Deviation of portfolios with varying EIRiS environmental responsibility ratings



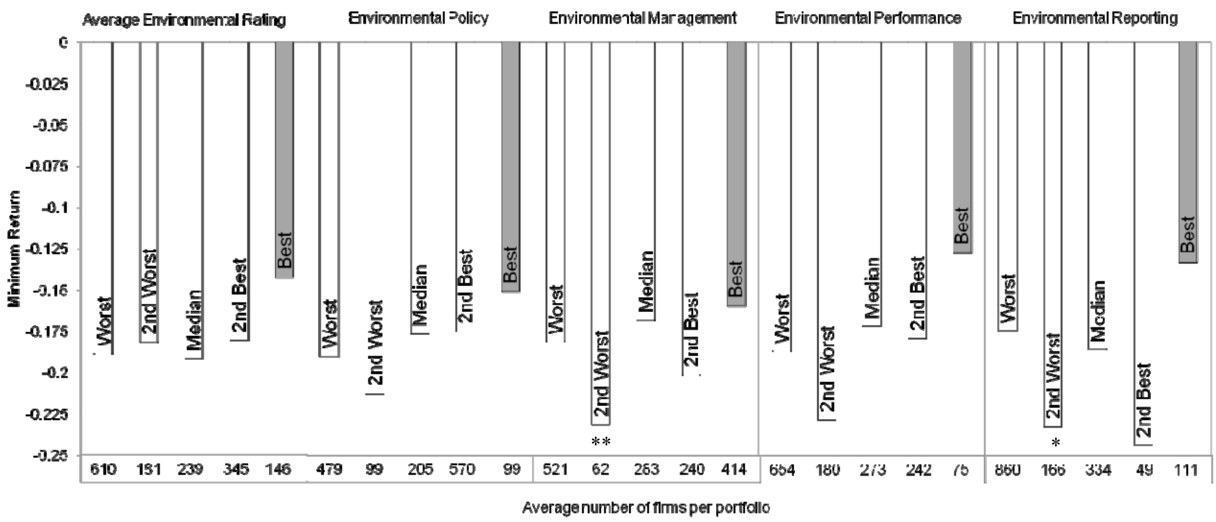
Notes: This figure shows semi standard deviations of annually updated investment portfolios including stocks with a specific EIRiS environmental responsibility rating. The horizontal axis (x-axis) displays the five corporate environmental ratings from EIRiS: Average Environmental Rating, Environmental Policy, Environmental Management, Environmental Performance and Environmental Reporting. The Average Environmental Rating is calculated as the mean rating from the other four. For each environmental rating, five value-weighted portfolios with increasing environmental performance are calculated. The grey bars represent the portfolios with the "best" environmental rating, whereas the white bars represent portfolios rated lower than "best", such as, "2nd best", "median", "2nd worst", and "worst". The numbers at the bottom of each bar represent the number of average constituents in that portfolio. Statistical significances for the mean difference between the "Best" portfolio relative to the "2nd Best", "Median", "2nd Worst", and "Worst" portfolios are computed using a t-test. ***, **, and * indicate statistical significance levels at the 1, 5, and 10 percent statistical significance.

Figure 5: Lower Partial Moment - Kappa 3 of portfolios with varying EIRiS environmental responsibility ratings



Notes: This figure shows lower partial moments of annually updated investment portfolios including stocks with a specific EIRiS environmental responsibility rating. The horizontal axis (x-axis) displays the five corporate environmental ratings from EIRiS: Average Environmental Rating, Environmental Policy, Environmental Management, Environmental Performance and Environmental Reporting. The Average Environmental Rating is calculated as the mean rating from the other four. For each environmental rating, five value-weighted portfolios with increasing environmental performance are calculated. The grey bars represent the portfolios with the "best" environmental rating, whereas the white bars represent portfolios rated lower than "best", such as, "2nd best", "median", "2nd worst", and "worst". The numbers at the bottom of each bar represent the number of average constituents in that portfolio. Statistical significances for the mean difference between the "Best" portfolio relative to the "2nd Best", "Median", "2nd Worst", and "Worst" portfolios are computed using a t-test. ***, **, and * indicate statistical significance levels at the 1, 5, and 10 percent statistical significance.

Figure 6: Minimum (worst-case) returns of portfolios with varying EIRiS environmental responsibility ratings



Notes: This figure shows minimum returns of annually updated investment portfolios including stocks with a specific EIRiS environmental responsibility rating. The horizontal axis (x-axis) displays the five corporate environmental ratings from EIRiS: Average Environmental Rating, Environmental Policy, Environmental Management, Environmental Performance and Environmental Reporting. The Average Environmental Rating is calculated as the mean rating from the other four. For each environmental rating, five value-weighted portfolios with increasing environmental performance are calculated. The grey bars represent the portfolios with the "best" environmental rating, whereas the white bars represent portfolios rated lower than "best", such as, "2nd best", "median", "2nd worst", and "worst". The numbers at the bottom of each bar represent the number of average constituents in that portfolio. Statistical significances for the mean difference between the "Best" portfolio relative to the "2nd Best", "Median", "2nd Worst", and "Worst" portfolios are computed using a t-test. ***, **, and * indicate statistical significance levels at the 1, 5, and 10 percent statistical significance.

4.4.3.2 Disaggregated Measures: Environmental Policy, Environmental Management, Environmental Performance, and Environmental Reporting

In this chapter, I continue my risk analysis assessment by separately investigating equity pension portfolios based on four individual environmental sustainability criteria. Figure 3 shows the distributions of standard deviations per portfolio. Broadly in line with my previous findings on aggregated environmental criteria, I find that standard deviations tend to be generally equally distributed. One exception is the 'Environmental Policy' portfolio whose total risk ranges between 4.45 to 6 percent. My findings indicate that none of the observed portfolios enjoy diversification benefits. Disaggregated semi standard deviations displayed in Figure 4, show that 'Best' rated portfolios have lower semi standard deviations relative to the '2nd Worst' rated portfolios. My results are consistent across three corporate environmental responsibility criteria and statistically significant at the 10 and 5 percent significance levels. One pension portfolio, 'Environmental Policy', tends to display marginally higher downside volatility than its peers, however, the difference is not statistically significant. My LPM risk results for the individual pension portfolios are shown in Figure 5 and indicate downside risk protection for 'Best' rated environmental portfolios relative to '2nd Worst' rated portfolios, and some evidence for better downside risk management for the 'Best' rated portfolios relative to 'Worst' rated portfolio. In particular, the 'Best' Environmental policy portfolio tends to outperform the '2nd Worst' portfolio, but performs rather equal to the 'Worst' Environmental policy portfolio. My results are statistically significant at the 10 and 5 percent significance levels for two corporate environmental responsibility criteria such as corporate environmental performance and corporate environmental reporting. Once again, my final risk measure, worst-case loss, shows preservation of investor value for the 'Best' rated pension portfolio across all disaggregated environmental ratings. These findings suggest that 'Best' rated pension funds tend to outperform their peers and protect institutional investors, such as extreme risk-averse pension funds, against large losses. For example, for two disaggregated portfolios I can observe a minimum difference of 2.2 percent (Environmental Management) and a maximum difference of 5.9 percent (Environmental Performance) between the "Best" and 'Worst' rated hypothetical pension portfolios. My findings are statistically significant at the 10 and 5 percent significance levels for two corporate environmental responsibility criteria including environmental management and environmental reporting.

4.5 Robustness tests

I conduct two broad sets of robustness tests, one for temporal stability of returns and another for sector bias. To investigate whether my findings are robust to different time periods, I divide my full sample into two sub-samples that cover the period from January 2004 to February 2007 and from March 2007 to May 2010. Table 5 and Table 6 indicate as per my previous findings over the full sample period, I do not find any statistically significant evidence of above and/or below average environmental responsibility in either sub-sample. My second set of robustness tests addresses the issue of sector bias. To eliminate the suspicion that my results are driven by certain sectors, I account for sector bias, by re-running Equation [1] with additional sector controls for clusters of ten industry groups in the Industry Classification Benchmark (ICB). These include Oil & Gas (0001), Basic Materials (1000), Industrials (2000), Consumer Goods (3000), Health Care (4000), Consumer Services (5000), Telecommunications (6000), Utilities (7000), Financials (8000), and Technology (9000). Table 7 shows that my additional regressions are not qualitatively different to the original analysis. Thus, I can confidently conclude that my analysis is stable over time and robust to sector bias.

Table 5: Aggregated & Disaggregated Measures - Sub-Period One (01/2004 to 02/2007)

Environmental Criteria	EIRiS Rating	Carhart Model						
		α	β	SMB	HML	MOM	Obs.	Adj. R2
Average Environmental Rating	5th Quintile	-0.0009	0.8236***	-0.1152	-0.1454	-0.0154	36	0.8395
	4th Quintile	0.0012	0.9493***	-0.3380***	-0.1471	0.0610	36	0.8838
	3rd Quintile	0.0001	1.0600***	-0.4878***	-0.0315	0.0931	36	0.9061
	2nd Quintile	-0.0013	0.9089***	-0.2637**	0.0027	0.0176	36	0.8666
	1st Quintile	0.0028	0.8840***	-0.4818**	-0.0824	0.3728***	36	0.7429
Environmental Policy	Inadequate	-0.0015	0.8177***	-0.1312	-0.0397	-0.0306	36	0.8315
	Weak	0.0059**	0.7533***	-0.0885	-0.2446**	0.2392**	36	0.7560
	Moderate	0.0015	0.9927***	-0.2234	-0.1568	0.0319	36	0.8841
	Good	0.0009	0.9148***	-0.4652***	-0.0517	0.1369***	36	0.9181
	Exceptional	-0.0017	1.1125***	-0.3581	0.0060	0.3566**	36	0.7915
Environmental Management	Inadequate	-0.0011	0.8199***	-0.1260	-0.1467	-0.0359	36	0.8055
	Weak	0.0028	0.9281***	-0.0828	-0.0743	0.1593	36	0.8432
	Moderate	0.0007	0.9454***	-0.4372***	-0.0721	0.0193	36	0.9208
	Good	-0.0003	0.9923***	-0.4423***	-0.0287	0.1490***	36	0.8525
	Exceptional	0.0002	0.9081***	-0.2954	-0.0482	0.1777	36	0.8145
Environmental Performance	No or inadequate	-0.0007	0.8917***	-0.1614	-0.1131	-0.0711	36	0.8852
	No improvement	-0.0003	1.1571***	-0.3868***	-0.0067	0.0362	36	0.9000
	Minor	0.0009	0.9266***	-0.2782***	-0.0307	-0.0107	36	0.8681
	Major	-0.0007	1.0403***	-0.4957***	-0.0468	0.1029*	36	0.8654
	Significant	0.0012	0.9976***	-0.5794***	-0.1937	0.1650	36	0.6223
Environmental	Inadequate	-0.0005	0.8635***	-0.2012	-0.1287*	0.0367	36	0.9149

Reporting	Weak	0.0023	1.0461***	-0.4220**	0.0775	0.0116	36	0.7315
	Moderate	-0.0008	0.9401***	-0.3911***	-0.0807	0.0723	36	0.9045
	Good	0.0003	1.0095***	-0.1497	0.3299**	-0.0642	36	0.7068
	Exceptional	0.0014	0.8857***	-0.4358**	-0.0534	0.3102***	36	0.7403

Notes: This table reports Carhart model estimations over the first sub-period from January 2004 to February 2007 for portfolios of firms with five different ratings with respect to five EIRiS corporate environmental responsibility criteria (average environmental rating, environmental policy, environmental management, environmental performance, and environmental reporting). Using market value weighted portfolios, I estimate the regressions according to equation (1) displayed in the text. The third column reports the results of the intercept (α). The next column is the market beta estimate. Column five to seven are coefficients of the common investment style factors size (SMB), intangible assets (HML), and momentum (MOM). The last two columns report the number of observations and the adjusted Rsquared, which can be understood as the percentage of explanatory power of my regressions. Coefficient covariances and standard errors are made heteroscedasticity and autocorrelation consistent based on Newey and West (1987). ***, **, and * indicate the 1%, 5%, and 10%

Table 6: Aggregated & Disaggregated Measures - Sub-Period Two (03/2007 to 05/2010)

Environmental Criteria	EIRiS Rating	Carhart Model						
		α	β	SMB	HML	MOM	Obs.	Adj. R2
Average Environmental Rating	5th Quintile	0.0000	0.9270***	-0.1427*	0.0393	0.0516***	41	0.9669
	4th Quintile	-0.0040	0.9344***	-0.0537	0.0447	0.0862*	41	0.9447
	3rd Quintile	-0.0011	0.9709***	-0.2237**	0.0210	0.1172***	41	0.9749
	2nd Quintile	-0.0009	0.9401***	-0.3271***	0.0835	0.1038***	41	0.9768
	1st Quintile	-0.0021	0.9433***	-0.2400*	-0.1797**	0.0963**	41	0.9398
Environmental Policy	Inadequate	-0.0015	0.9641***	-0.1362	0.0026	0.0476***	41	0.9727
	Weak	0.0006	0.9100***	-0.0852	0.0394	0.0702*	41	0.9167
	Moderate	0.0002	0.9251***	-0.0536	-0.0149	0.0869***	41	0.9686
	Good	-0.0018	0.9216***	-0.2826***	0.0407	0.1190***	41	0.9786
	Exceptional	-0.0011	1.0334***	-0.2314	-0.1448	0.0616	41	0.9283
Environmental Management	Inadequate	-0.0003	0.9245***	-0.2026**	0.0987	0.0563***	41	0.9612
	Weak	-0.0104***	1.0871***	0.0910	-0.1690	0.0944*	41	0.9376
	Moderate	0.0003	0.8953***	-0.2370**	0.0451	0.1208***	41	0.9646
	Good	-0.0008	0.9933***	-0.3300***	0.0357	0.1044**	41	0.9642
	Exceptional	-0.0022	0.9375***	-0.1590	-0.0841*	0.0867***	41	0.9675
Environmental Performance	No or inadequate	-0.0015	0.9268***	-0.0962	0.0160	0.0611***	41	0.9656
	No improvement	-0.0017	1.1228***	-0.1847	-0.0489	0.0918**	41	0.9737
	Minor	0.0004	0.9267***	-0.2605**	-0.0080	0.1429***	41	0.9775
	Major	-0.0018	0.9463***	-0.2632***	0.0628	0.0799***	41	0.9739
	Significant	-0.0030	0.8383***	-0.2854**	-0.0559	0.1021***	41	0.9286
Environmental Reporting	Inadequate	0.0002	0.8972***	-0.1730*	0.0557	0.0861***	41	0.9640
	Weak	-0.0076***	1.1559***	-0.0743	-0.0068	0.0408	41	0.9747
	Moderate	-0.0017	0.9133***	-0.2025*	0.0767	0.1011***	41	0.9723
	Good	-0.0020	1.2022***	-0.3017	0.0153	0.1799**	41	0.9215
	Exceptional	-0.0013	0.9522***	-0.3868**	-0.1970**	0.1052**	41	0.9231

Notes: This table reports Carhart model estimations over the second sub-period from March 2007 to May 2010 for portfolios of firms with five different ratings with respect to five EIRiS corporate environmental responsibility criteria (average environmental rating, environmental policy, environmental management, environmental performance, and environmental reporting). Using market value weighted portfolios, I estimate the regressions according to equation (1) displayed in the text. The third column reports the results of the intercept (α). The next column is the market beta estimate. Column five to seven are coefficients of the common investment style factors size (SMB), intangible assets (HML), and momentum (MOM). The last two columns report the number of observations and the adjusted Rsquared, which can be understood as the percentage of explanatory power of my regressions. Coefficient covariances and standard errors are made heteroscedasticity and autocorrelation consistent based on Newey and West (1987). ***, **, and * indicate the 1%, 5%, and 10% significance level, respectively.

Table 7: Aggregated & Disaggregated Measures - Sector Cluster Controls

Environmental Criteria	EIRiS Rating	Carhart Model							
		α	Industry Cluster 1	Industry Cluster 2	Industry Cluster 3	Industry Cluster 4	Industry Cluster 5	Obs.	Adj. R2
Average Environmental Rating	5th Quintile	-0.0002	0.0454	0.2642***	0.0306	0.0667	0.0773	77	0.9850
	4th Quintile	-0.0014	0.1292	0.1875***	0.0547	0.0596	0.1208	77	0.9593
	3rd Quintile	-0.0007	0.0634	0.0282	0.1282***	0.1381**	0.0470	77	0.9762
	2nd Quintile	-0.0013	0.1050	0.0361	0.0168	-0.0601	0.0713**	77	0.9691
	1st Quintile	-0.0005	-0.0170	0.1171	0.2127***	0.0457	-0.1928	77	0.9271
Environmental Policy	Inadequate	-0.0013	0.0505	0.2007*	-0.0108	0.0639	0.0409	77	0.9774
	Weak	0.0028*	0.0612	0.4044	0.1461***	-0.1026	0.0373	77	0.9360
	Moderate	0.0007	0.0898	0.0566	0.0814**	0.1163*	0.1227	77	0.9720
	Good	-0.0011	0.0867*	0.0656	0.1069***	0.0248	0.0348	77	0.9788
	Exceptional	-0.0009	-0.0897	0.1637	0.1764***	0.0903	-0.2562	77	0.9159
Environmental Management	Inadequate	-0.0003	0.0508	0.2960***	0.0085	0.0922*	0.0469	77	0.9827
	Weak	-0.0048*	0.1194	0.0426	0.0899	-0.1919	0.1843	77	0.9284
	Moderate	0.0004	0.1333***	0.1017**	0.1103***	0.1455***	0.0191	77	0.9760
	Good	-0.0010	0.0391	0.0597	0.1006	-0.1256	0.1742	77	0.9602
	Exceptional	-0.0014	0.0298	0.0733	0.1077***	0.0691	-0.1007	77	0.9549
Environmental Performance	No or inadequate	-0.0005	0.0639	0.2532	0.0335	0.0677	0.1052*	77	0.9887
	No improvement	-0.0012	0.0114	0.0229	0.0995**	0.0432	0.0002	77	0.9682
	Minor improvement	0.0006	0.0917	0.0139	0.0493	0.0059	0.0647	77	0.9682
	Major improvement	-0.0016	0.0833	0.0636	0.1547***	-0.0381	0.1092*	77	0.9716
	Significant	-0.0015	-0.0307	0.0183	0.2228***	0.2821*	-0.1813	77	0.9006
Environmental Reporting	Inadequate	-0.0001	0.1056***	0.1941***	0.1033***	0.1310***	0.0723	77	0.9888
	Weak	-0.0032	0.1469	0.1360	-0.0302	-0.1254	-0.2079	77	0.9536
	Moderate	-0.0016	0.0646	0.0446	0.0286	0.0075	0.0956	77	0.9687
	Good	-0.0003	-0.0633	0.0001	-0.1702	-0.3252*	0.1310	77	0.9091
	Exceptional	-0.0004	-0.0372	0.1070	0.2146***	0.0222	-0.1878	77	0.9166

Notes: This table reports Carhart model estimations in addition to five industry cluster controls for portfolios of firms with five different ratings with respect to five EIRiS corporate environmental responsibility criteria (average environmental rating, environmental policy, environmental management, environmental performance, and environmental reporting). Using market value weighted portfolios, I estimate the regressions according to Equation [1] displayed in the text. The third column reports the results of the intercept (α). The next column is Industry Cluster 1 which includes the Oil&Gas, Materials, and Utilities sectors. Column five is Industry Sector 2 representing the Industrials sector. Column six shows Industry Cluster 3 which includes Telecommunications, Technology, and Healthcare. In Column seven, I report coefficients for Industry Cluster 4, which includes Consumer Goods and Services. The next column shows Industry Cluster 5 representing the Financials sector. The last two columns report the number of observations and the adjusted Rsquared, which can be understood as the percentage of explanatory power of my regressions. Coefficient covariances and standard errors are made heteroscedasticity and autocorrelation consistent based on Newey and West (1987). ***, **, and * indicate the 1%, 5%, and 10% significance level, respectively.

4.6 Conclusion

In this chapter, I aim to extend the analysis of the Freshfields (2005) report. In line with other commentators, I recognise the Freshfields report as welcome contribution due to its conceptual value, but do not consider it to represent a practical breakthrough due to several uncertainties, which it leaves unaddressed. The possibly most important unaddressed uncertainty results from the Freshfields report providing little guidance on the question ‘what are the financial and risk implications of the consideration of an ESG criterion on a pension fund portfolio that complies with the legal duty of prudent action for proper purpose?’ I seek to empirically investigate this research question.

To the best of my knowledge, I am the first to empirically analyse this question. For my analysis, I develop prudent pension fund equity investment processes with realistic characteristics (e.g. billion US$ size, developed country universe) and integrate specific ESG data in these from January 2004 to May 2010. My specific ESG dataset comprises five corporate environmental responsibility ratings supplied by EIRIS for a universe of over 1,500 firms from 26 countries. As each rating includes five assessment steps, I generate 25 equity pension fund portfolios of firms sharing an assessment in one of the ratings. My two main results are as follows: First, my tests provide no indications that the integration of corporate environmental responsibility criteria into equity pension fund investment processes has detrimental financial performance effects, at least with respect to equity pension portfolios with a preference for corporate environmental responsibility as assessed by EIRIS. Second, my complementary risk analysis shows that from a risk management perspective specific ESG criteria have a positive effect on the downside risk protection of pension portfolios. The findings of my risk analysis are in line with related studies who investigate the association between ESG criteria and systematic/idiosyncratic risks and the risk mitigating effect of using ESG screens (See e.g. Bauer et al., 2009; Boutin-Dufresne and Savaria, 2004; Lee and Faff, 2009; Mishra and Modi, 2013; Oikonomou et al., 2012). These studies provide evidence that ESG criteria lowers the systematic and idiosyncratic risk of firms. Their findings seems plausible as some types of ESG criteria have been found to create "moral capital or goodwill" that preserves companies' financial performance from negative events such as monetary fines and sanctions (Godfrey et al., 2009). Under Modern Portfolio Theory, some scholars may argue that screened portfolios are riskier propositions than unscreened portfolios due to a potential diversification penalty (See e.g. Kurtz, 2005; Markowitz, 1952; Rudd, 1981; Sharpe, 1964). They argue that portfolios considering ESG criteria will represent a sub-set of the entire investable universe and therefore be less diversified and more risky. However, recent empirical evidence has shown that a reduced stock universe does not necessarily lead to less diversified, thus riskier portfolios (Bello, 2005; Kacperczyk et al., 2005; Schroeder, 2007).

Thus, based on my analysis, I conclude that the integration of corporate environmental responsibility criteria into the investment processes of pension funds does not seem to have any significant detrimental financial and risk implications. As the Adjusted R-squared values of my 25 analyses are very high (between 89 and 98%) and my results are consistent over time. Hence, I find that fiduciary duties or other legislation do not appear to prohibit the integration of environmental responsibility standards into pension fund investment processes in any of the nine large jurisdictions studied by Freshfields and us (US, UK, Canada, Australia, Japan, Germany, France, Italy and Spain). As such, this finding is in line with previous findings in the literature (Bauer et al., 2005; Galema et al., 2008; Renneboog et al., 2008a).

My study is, however, subject to a few limitations. First, I do not consider the expense a pension fund incurs in acquiring the environmental responsibility assessments from a data provider such as EIRIS. However, in relation to the billions of pension fund assets, subscription prices for ESG data are fairly small. Furthermore, Gil-Bazo et al. (2010) recently observed ESG integrating mutual funds to have similar expense ratios as equivalent peers with an alternative active investment strategy, which indicates that ESG integration is no more or less expensive than the average active management strategy. Second, my results are directly only applicable to the large equity component in pension fund portfolios. While equities and fixed income are arguably the most important asset classes for pension funds' financial performance (Aglietta et al., 2012; Ferreira and Matos, 2008; OECD, 2013), the less volatile asset classes bonds and cash are also relevant. Cash investments and low risk bond investments are very useful to manage liquidity or reduce a portfolio's leverage but they have a marginal impact on pension funds' financial performance compared to an equivalently leveraged market universe. Hence, their consideration would unlikely change my results in any meaningful way. The integration of ESG criteria into higher risk bonds could lead to a result different from mine. However, research on ESG criteria and bonds outside of pension fund investment processes does not observe any relevant harmful financial effects of ESG integration (Derwall and Koedijk, 2009; Menz, 2010). Third, my results directly only apply to corporate environmental responsibility criteria and of these only to those produced by EIRIS. Therefore, promising routes for future research might lie in conducting similar analyses for different ESG criteria, possibly using bond instead of equity investment processes in some cases.

5 Static and dynamic multi-factor performance and investment style of international renewable energy stock indexes

Static and dynamic multi-factor performance and investment style of international renewable energy stock indexes

Abstract

This chapter investigates risk premia and dynamic investment styles of global and regional renewable energy equity indexes. Risk premia are not persistent and very short-lived. My findings also show that positive investor sentiment, momentum trading, exposure to small capitalisation stocks, and high volatilities are likely causes for the beneficial performance of renewable energy indexes towards the end of the first phase EU ETS. Static multi-factor attribution models tend to explain return and risk variations of the renewable energy equity indexes well, but dynamic state-space multi-factor models provide substantially more detailed insight into the temporal behaviour of renewable energies during the first two phases of the EU ETS. I conclude that sustainable investors will be able to reap financial benefits from certain specialised renewable energy indexes that have been carefully monitored.

5.1 Introduction

While Europe is at the forefront of pricing carbon to reduce total greenhouse gas emissions through market policies such as the European Union Emissions Trading Scheme (EU ETS) and ambitious national renewable energy targets, governments elsewhere in the world are devising and implementing policies to develop low carbon economies. With the overarching aim of reducing total CO_2 emissions, many of these polices foster the development of low-carbon energy infrastructures with increasing investments in renewable energy technologies. Consequently, the demand for renewable energies worldwide has risen drastically in recent years (World Economic Forum, 2011).

In light of these developments, it seems plausible that Chia et al. (2009) find a renewable energy equity premium in financial markets. They observe an international portfolio of renewable energy firms to perform superior to their benchmark at a statistically significant level over a sample period from May 2005 to May 2008. Notably, they explain that the statistically significant outperformance of renewable energy stocks remains after controlling for renewable energy firms' tendencies to be smaller in size, more volatile and less value tilted than the average stock. Their result concurs with more recent evidence from Bohl et al. (2013), who find renewable energy equity indexes to significantly outperform their benchmarks in the German renewable energy sector between 2004 to 2007. A renewable energy equity premium is also theoretically plausible, if one assumes financial market participants to consistently underestimate the legislatively supported demand for renewable energies.

This persistent positive performance may, however, not be as straightforward as suggested by Ortas and Moneva (2013). During periods of market in-stability, they find renewable energy equity premia to differ geographically. While they observe a negative performance of renewable energy indexes with geographically focused investment objectives such as Asian, European and North American indexes, they find a significant positive performance of renewable energy indexes with global investment reach.

Nevertheless, a persistent renewable energy premium appears questionable based on Bohl et al. (2013) powerful bubble tests that indicate the explosive price behaviour of renewable energy stocks in the mid 2000s. While they find renewable energy indexes to be substantially exposed to high beta stocks (Sadorsky, 2012b), small caps and growth stocks, in line with Chia et al. (2009) self-selected renewable energy portfolio, they do not observe renewable energy indexes to consistently outperform their benchmarks. Similarly, Kumar et al. (2012) further shed light on the performance of three global renewable energy indexes and find that none leads to consistent positive risk premia.

The difference between studies supporting as opposed to rejecting the existence of a persistent renewable energy premium could be the result of omitted mutual fund management fees, or the careful self-selected composition of Chia et al.'s (2009) renewable energy portfolio that led to an abnormally good financial performance of its portfolio.

In this chapter, I explore whether a persistent renewable energy equity premium exists in financial markets while at the same time analyse pollution reduction through renewable energy equity indexes from the perspective of an investor.

I contribute to the extant literature by investigating the static and dynamic financial performance of a large international sample of renewable energy equity indexes, in a multi-factor framework, before the launch and during the first and second phase of the European Emissions Trading Scheme (EU ETS) [68]. For example, my analysis spans over the entire life, since the inception, of each renewable energy equity index as well as the two phases of the EU ETS. The reason to also study the financial performance of renewable energy equity indexes over the two phases of the ETS is driven by the decisions of the European Union and governments elswhere in the world to commit to ambitious renewable energy targets to reduce CO_2 emissions and increase the share of renewable energy generated electricity.[69]
My analysis is neither exposed to a potential bias of self-selecting a stock portfolio nor is it affected by fees or management skills of (active) mutual funds and their managers. Thus, I investigate the following research questions:

1) Is there a difference between the financial performance of international renewable equity stock indexes and conventional stock indexes?

2) Does the financial performance of international renewable energy stock indexes differ over the first two EU ETS time periods (P1:2005-2007 and P2:2008-2012)?

3) Does the financial performance of renewable energy stock indexes depend on the investment region?

[68] The European Union Emissions Trading System (EU ETS) is a market-based policy instrument and seen as the cornerstone of Europe's climate policy to reduce Greenhouse Gas Emissions (Oberndorfer, 2009). The principal aim of the EU ETS is to reduce the overall amount of Greenhouse Gases in circulation and to make energy producers more efficienct (European Union, 2013). The EU ETS is running over three phases or trading periods with increasing restrictions on Greenhouse Gas Emissions. Phase I: 2005-2007, Phase II: 2008-2012, Phase III: 2013-2020, and Phase IV: 2021-2028 (European Union, 2013).
[69] For example, the EU ETS' New Entrants' Reserve (NER) 300 fund demands that 300 million allowances are set aside to fund the integration of innovative renewable energy technologies and their deployment (European Commission, 2015).

My results, in brief, are as follows. My static and dynamic attribution analysis shows substantial differences in the behaviour of renewable energy indexes' financial performance, risk, and investment styles. In terms of financial performance, Global and Regional renewable energy indexes tend to underperform their respective benchmarks, on average. Some interesting patterns emerge when I dynamically investigate sub-samples such as phase 1 and 2 of the EU ETS. In particular, during the first phase EU ETS, I observe positive financial performance across renewable energy indexes and three even significantly outperform their benchmarks. Over the same period, two dynamic investment styles, size and momentum, indicate strong exposure to small capitalisation stocks and positive momentum exposure. It seems that the good financial performance of renewable energy indexes during the first phase EU ETS, or pre-crisis period likely benefited from small capitalisation stocks, momentum trading and positive investor sentiment. Remarkably, the positive financial performance during the first phase is extremely short-lived and does not persist. After the peak in mid 2007 and as a result of the financial crisis, all renewable energy indexes perform poorly. Additionally, corresponding to the same time period, momentum investing turns negative. My risk analysis shows time-varying beta coefficients to be substantially larger relative to conventional market benchmarks and in particular for global renewable energy indexes. Towards the end of 2007, beta coefficients tend to evolve particularly stable and noticeably below 1. This finding indicates that during the first phase EU ETS investors perceived renewable energy indexes as a lower risk investment than conventional equity market benchmarks. During the financial crisis, betas become more volatile and increase in size. This finding also indicates that investor risk increases substantially. Finally, my investment style findings show renewable energy indexes with strong exposure to small capitalisation stocks over the entire sample period. Over time, my dynamic size factor, SMB, is positive and significantly above zero during the first phase EU ETS and towards the end of 2007. In early 2008, the size factor decreases substantially for the majority of indexes. I argue that a decreasing size factor could be a result of increased bankruptcies in the renewable energy sector. In other words, liquidity constraints during the crisis may have forced renewable energy companies into bankruptcy, causing de-listings on renewable energy indexes. This could also explain the more recent exposure to mid- and larger sized renewable energy firms by renewable energy indexes.

The remainder of the chapter is structured as follows. Chapter 5.2. 'Background', is a comprehensive review of the related literature. Chapter 5.3. 'Empirical Analysis' introduces the empirical analysis and the static and dynamic multi-factor performance model employed.

In Chapter 5.4. 'Data Section', I describe my sample of renewable energy indexes and characterise investment objectives and market benchmark data. Chapter 5.5. 'Main Results' describes the main findings of my empirical analysis. Chapter 5.6. 'Conclusion' summarises and concludes.

5.2 Background

This study is also related to a substantial empirical literature that attempts to understand the relationship between environmental concerns and the financial performance of corporations (Hart and Ahuja, 1996; King and Lenox, 2001; Konar and Cohen, 2001). Yet, existing studies are largely unable to reach a collective agreement on the direction of the Environmental Performance (EP) and Financial Performance (FP) relationship, as results are inconclusive. Horváthová's (2010) meta-analysis therefore attempts to find explanations for such heterogeneity. Her meta study investigates 37 empirical studies with 64 outcomes on the EP and FP link. Across her sample of studies, she finds the majority of outcomes to indicate a positive relationship, approximately 20 are insignificant and only 10 indicate a negative relationship. She concludes that results are incredibly sensitive to the choice of empirical method employed. While simple correlations tend to increase the odds to find a negative relation, event studies and panel regressions indicate otherwise. Furthermore, as Derwall et al. (2005) and Griffin & Mahon (1997) point out, substantial variation in study outcomes are not only caused by different methodologies employed, but also by the different understanding and multitude of financial and environmental performance proxies.

Generally, the majority of studies use tangible and quantifiable environmental data related to corporate pollution such as toxic waste, chemical and oil spills, waste generation and CO_2 emissions as a measure for environmental impacts (Cordeiro and Sarkis, 1997; Cormier et al., 1993; Hart and Ahuja, 1996). As the proxy for environmental performance tends to affect the outcome of the EP and FP relationship, Horváthová (2012) attempts to overcome this shortage by aggregating several environmental variables into a unified pollution-weighted index of environmental degradation. She weights the importance of her 93 environmental variables according to environmental harmfulness of each variable. This is similar to King and Lenox (2002) approach, who create an aggregated variable for 246 toxic chemicals, weighted by its toxicity. Although, both studies find a positive relationship between environmental and financial performance, King and Lenox (2002) argue that pollution reductions do not directly lead to positive financial performance, while pollution prevention does. Horváthová (2012) provides additional insight as she finds that pollution reduction may not lead to an immediate financial gain (costly in short-term), but rather materialises into a financial gain in the long-term.

A second stream of studies uses environmental variables such as comprehensive corporate environmental ratings from Innovest, KLD or other similar data vendors.

Investigating whether eco-efficiency increases the market value of US corporations, Guenster, Bauer, Derwall, & Koedijk (2011) conclude that more eco-efficient companies increase their operating performance and market value over time, whereas less eco-efficient companies experience the opposite. The advantages of using readily supplied scores are their multi-dimensional character and the ex-post and ex-ante assessment of corporate environmental performance (Guenster et al., 2011). The major downside in using prepared environmental scores is the non-transparency of raters' methodologies. This, in fact, increases the difficulty in understanding how different environmental sub-dimensions are aggregated and weighted.

More recently, there is a growing trend to study environmental performance from an investors' portfolio perspective, whereby hypothetical investment trading strategies are related to environmental activities or initiatives. Following the portfolio approach, Derwall et al. (2005) produce two mutually exclusive portfolios based on companies with high (low) environmental eco-efficiency ratings to compare the stock return performance between the two portfolios. The authors find a positive and significant outperformance for the highly rated eco-efficient portfolio. In an earlier study, Cohen, Fenn, & Konar (1997) use the same approach to distinguish low polluting from high polluting US company portfolios. The environmental ratings are based on a collection of different measures primarily noncompliance penalties and chemical and oil spills from the Investor Responsibility Research Center (IRRC). In support to Derwall et al.'s (2005) study, their findings suggest that the low polluter portfolio performs at least as well and even better than the high polluter portfolio.

Furthermore, Halkos & Sepetis (2007) construct a "green" portfolio of Greek firms that apply systems of environmental management based on ISO 14000 certification and Eco-Management and Audit Scheme (EMAS) participation. Their findings indicate that a green portfolio reduces systematic risks. Using a similar approach, Ziegler et al. (2011) form a hypothetical trading strategy of buying stocks of companies with strong climate change disclosure and selling stocks of companies with no disclosure on climate change. They argue that a climate change leaders portfolio performed well in Europe between 2004 and 2006, but find no convincing green premium in the US.

All reviewed studies investigating the relationship between environmental and financial performance use some form of ex-post, ex-ante, or a combination of both, pollution reduction metric to proxy for the environmental performance of individual companies or portfolios of companies.

In this chapter, I investigate corporate pollution mitigation that particularly aims to reduce CO_2 emissions in the atmosphere and is an important climate policy instrument in many countries around the globe, i.e. renewable energy companies. At the same time I contribute to the recent debate on the environmental and financial performance of CO_2 reducing equity investments from an investors' portfolio perspective.

Several developments document the importance of renewable energies for mitigating climate change. First, many large utility and non-utility companies are increasingly generating electricity from renewable energy sources such as solar or wind energy. To give one example, non-utility companies such as IT giant Google claims to be the forerunner in powering their data centres from 100 percent renewable energy, planning to expand existing renewable energy capacities in the near future (Clark, 2013). In particular, Google invested 12 million USD in a South African solar power project and more recently signed a long-term deal to purchase electricity from a Swedish wind farm over the next ten years (Clark, 2013). Other large IT companies such as Yahoo and Facebook are following suit and lead the sector by its green initiatives (Greenpeace, 2012). Similarly, in the energy sector, conventional fossil-fuelled energy producers and utilities slowly increase their share from renewable energies to total electricity generation output. Hereby, traditional oil companies create new renewable energy ventures investing in renewable energy technologies. One example is EDF Energy Renewables which is a joint venture between EDF Energy and EDF Energies Nouvelles. The increasing interest of conventional energy producers and utilities in renewable energies seems to be driven less by rising demands and more by reputational objectives to improve corporate images.

Second, renewable energies have a strong potential for future growth. The IEA forecasts that renewable energy electricity generation will contribute 39 percent to the world total electricity generation mix by 2050 (Apergis et al., 2010).

Third, increasing the share of renewable energy produced electricity to 20 percent of the total energy mix, is besides establishing the EU Carbon Trading Scheme the cornerstone of the European Union's climate policy instrument to reduce greenhouse gas emissions by 2020. Worldwide, 66 countries are following suit in establishing national renewable energy targets to increase the use of renewables (Ren21, 2007). While developing countries set softer renewable targets that are predominantly related to increasing production capacities or primary energy from renewable sources, many developed countries pursue more ambitious targets such as increasing final energy consumption or electricity generation from renewable energies (International Renewable Energy Agency, 2012a, b, c, 2013).

Despite the beforementioned important developments in the renewable energy sector, very little is known about the price and return behaviour of renewable energy equity indexes worldwide. Henriques & Sadorsky's (2008) study is the first to shed some light on the financial performance of a sample of renewable energy companies. Using vector autoregression models, in particular Granger causality, the authors test the predictive causality between renewable energy stock prices, oil prices, technology stock prices and interest rates[70]. They find that oil prices and technology stock prices have an effect on the stock prices of renewable energy stocks. More recently, Kumar, Managi, & Matsuda (2012) extend the Henriques and Sadorsky study by investigating the attractiveness of renewable energy stocks under rising oil prices and higher carbon prices, applying the same econometric method. In particular, they test the hypothesis that oil prices and the prices of three clean tech indexes (Wilder Hill New Energy Global Innovation Index, Wilder Hill Clean Energy Index and S&P Global Clean Energy Index) are positively correlated. The authors present two interesting findings: Firstly, oil prices are significantly positively correlated with the returns of the three renewable energy indexes and secondly, carbon prices do not seem to be a significant driver for investors to move into renewable energies due to their potentially low price. While oil and technology stock prices seem to influence renewable energy stock prices, Bohl et al. (2013) further advance the understanding of the explosive price behaviour of German renewable energy stocks, using powerful bubble detection tests[71]. In particular, the authors find strong positive outperformance of two German renewable energy indexes between 2004 and 2007 followed by a significantly negative performance after 2008. Thereby showing that German renewable energy stock prices have been in a speculative bubble for some time. Finally, Ortas & Moneva (2013) study shows on a sample of 21 clean energy indexes, using a dynamic market model, that clean tech indexes outperform broad equity market benchmarks during periods of market stability and strongly underperform during the financial crisis. In other words, structural changes during the financial crisis negatively influence the return behaviour of renewable energy indexes which results in strong underperformance.

Thus, I add to the existing literature in several ways. First, to the best of my knowledge, this study complements the existing literature by analysing a comprehensive

[70] Brooks (2008:298) clarifies that "...'causality' is somewhat of a misnomer, for Granger-causality really means only a correlation between the current value of one variable and the past values of others; it does not mean that movements of one variable cause movements of another"

[71] Bubble detection tests are tests to identify speculative bubbles in asset prices (Bohl et al., 2013). Modern techniques to detect asset price bubbles are the Augmented Dickey-Fuller, and Markov regime-switching Augmented Dickey-Fuller test (see e.g. Bohl et al., 2013).

international sample of renewable energy risk premia using static and dynamic multi-factor asset pricing models before, during, and after the EU ETS. Second, I investigate renewable energy as a new form of corporate pollution mitigation from an investor perspective. Third, I investigate the static and dynamic financial performance in a multi-factor framework, thereby extending Ortas & Moneva (2013) renewable energy state-space market model by Fama & French's (1993) size and value factors and Carhart's (1997) momentum investment style factor. Fourth, I benchmark return and risk dynamics of renewable energy indexes against several tailored conventional market benchmarks to increase the accuracy of my estimates.

Renewable energy indexes as an asset class have been under-researched because they are a relatively new form of thematic indexes and therefore a very young asset class with some data limitations. Linear time-series investigations with less than 30 observations might not produce any meaningful results. In this study, I at least double the requirement as I have a minimum of 56 and maximum of 158 monthly observations, over the full sample period. Furthermore, the advantage of measuring the financial performance of renewable equity indexes over other equity related financial products, such as mutual funds or individual firms, is the opportunity to measure the impact of renewable energy screening more directly (Schröder, 2007). In other words, studies that investigate mutual funds, fund of funds and portfolios of individual stocks have to control for other factors that could potentially distort the financial performance, for example adjustments for imposed fee loadings (such as transaction costs and management fees), timing abilities of fund managers, different management skills and differences in investment policies. For example Gil-Bazo & Ruiz-Verdú (2009) and Gil-Bazo, Ruiz-Verdú, & Santos (2010) find that poor performing US and US SRI mutual funds tend to charge higher management fees than good performing mutual funds.

5.3 Empirical Analysis

5.3.1 Static Performance Analysis

In analysing the return and risk behaviour, as well as investment styles of my sample of fourteen renewable energy indexes, I follow a recent strand of literature using modifications of Carhart's multi-factor model to price renewable energy assets such as Bohl et al. (2013), Ortas & Moneva (2013), and Sadorsky (2012b). The model is based on the static Capital Asset Pricing framework developed by Treynor (1962), Sharpe (1964), and Lintner (1965). Later, empirically verified and extended by the size and value factors, SMB and HML, respectively (Fama and French, 1993). Carhart (1997) shows that the additional factors for size and value improve the accuracy of the model, however, some of the variation in stock returns is left unexplained. To improve the cross-sectional variation of stock returns he includes an additional factor to account for the momentum anomaly described by Jegadeesh & Titman (1993). I estimate Equation (6) as follows:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i (r_{m,t} - r_{f,t}) + s_i (r_{smb,t}) + h_i (r_{hml,t}) + m_i (r_{mom,t}) + \varepsilon_{i,t} \qquad (6)$$

Where,

where $r_{i,t}$ and $r_{m,t}$ represent the monthly logged return of renewable energy index i and equity benchmark i, in month t. $r_{f,t}$ represents the risk-free asset return. α is the intercept and measures the proportion of over- or underperformance of renewable energy index i relative to the respective equity market benchmark. smb_t is the return series for the size premium, which is the difference between small cap and large cap stock portfolio returns in month t. hml_t represents returns for the value premium, which is the difference between high book-to-market and low book-to-market portfolio returns in month t. mom_t is the momentum return series, which is computed as the difference between high and low portfolio returns over the last year in month t. Coefficients s_i , $h_{i,}$, and m_i measure the sensitivities towards small cap versus large cap firms, value versus growth firms, and momentum versus contrarian investment strategies, respectively. ε is the error term.

5.3.2 Dynamic Performance Analysis

Financial performance evaluation methods such as the commonly used four-factor Carhart rely on coefficient estimates from linear OLS regressions, which tend to stay constant over some investigation period. Recent studies show that systematic risk and style factors of stock returns are highly time-varying (Bauer et al., 2009). For example, mutual fund managers follow highly dynamic investment strategies, frequently adjusting their investment style exposures and asset allocations (Swinkels and Van Der Sluis, 2006).

As the basic assumption of constant factor loadings for risk and style factors across entire sample periods is very restrictive, two streams of literature attempt to relax this assumption by using (i) rolling-window and (ii) conditional macro-economic estimates. Both methods allow for some time-variation in estimated coefficients. According to Swinkels and Van Der Sluis (2006) rolling windows only partially solve the issue, for the following two reasons. First, empirical studies arbitrarily choose window lenghts between 26 and 60 months. Second, the estimated coefficients are still constant over the selected rolling window length. Another stream of literature uses macro-economic factors to inform future average coefficient estimates. Ferson and Schadt (1996) use conditioning information on so called public information variables (macro-economic variables that have been found to predict stock returns, such as dividend yields and interest rates). Although, conditional approaches can lead to more reliable average coefficient estimates they are obtained by linear OLS regression with the same basic assumption of constant factor loadings. Thus, in any case, estimated coefficients of OLS regressions are static over specific sample periods.

I overcome the shortcoming of constant OLS estimates by using a dynamic and time-varying method. In particular, I use the Kalman filter to allow for time-varying alphas and betas. The distinct advantages of using time-varying methods to forecast coefficients such as the Kalman filter over static OLS methods are the following: a) Accurate coefficient forecasts (Mamaysky et al., 2008) b) Capture of changing factor exposures over time due to business cycles (Bauer et al., 2009; Ferson and Harvey, 1999), market timing of fund managers (Mamaysky et al., 2008), style investment of fund managers (Swinkels and Van Der Sluis, 2006), and more generally volatile energy stock indexes (Bohl et al., 2013).

Time-varying alphas and betas are latent variables inferred from monthly stock returns.[72] For the latent alpha and beta coefficients I assume a pure random walk process. I estimate the following system of equations in linear state space form for each of the fourteen renewable energy indexes':

[72] Latent variables cannot be directly observed, but I can infer them from other variables that can be directly observed.

$$R_{it} = \alpha_{it} + \sum_{k=1}^{K} \beta_{ikt} F_{kt} + \varepsilon_{it}, \qquad \varepsilon_{it} \sim N(0, \sigma_{i\varepsilon}^2), \qquad (11)$$

$$\alpha_{it} = \alpha_{it-1} + \nu_{it}, \qquad \nu_{it} \sim N(0, \sigma_{i\nu}^2), \qquad (12)$$

$$\beta_{it} = \beta_{it-1} + \eta_{it}, \qquad \eta_{it} \sim N(0, Q), \qquad (13)$$

The coefficient vectors α_{it} and β_{it} at time t, are alphas and betas based on previously observed observations plus unobservable innovations. Equations (12) and (13) show that the coefficient vectors vary over time according to a first-order vector autoregression (Durbin, 2000). I assume these innovations or error terms ν_{it}, η_{it} to be normally distributed and independent over the sample period with zero mean and variances $\sigma_{i\varepsilon}^2, \sigma_{i\nu}^2$ and diagonal covariance matrix Q.

F_{kt} represents four independent variables, including monthly logged excess returns of the respective benchmarks, size, value, and momentum premium from Equation (11). The system of equations contains the signal or observation equation (Equation. (11)), and the two state or transition equations (Equations (12) and (13)). As the Kalman filter is a recursive algorithm, the recursion begins with some starting values or prior values for alpha and beta at time t. I obtain my starting values from the static performance analysis conducted previously, i.e. estimated coefficients from Carhart's multi-factor model. The recursion is updated by one observation at a time and is performed until it reaches the end of the respective renewable energy index' sample period.

Since the returns of SMB (size factor) correlate with HML (value factor), I apply an orthogonalisation procedure. The following procedure and variants of it have been applied elsewhere (Elton et al., 1993; Hoepner et al., 2011; Schröder, 2007). I orthogonalise the value factor by estimating the following Equation (14):

$$r_t^{HML} = \kappa + \delta r_t^{SMB} + \varepsilon_t^{HML} \qquad (14),$$

, where r represent excess returns. Then, I re-estimate equations (12) and (13) using the residual of Equation (14) ε_t^{HML}, which represents the return variation that is not explained by the size factor SMB and is uncorrelated to the HML factor.

5.4 Data Section

5.4.1 Renewable Energy Indexes and Benchmarks

My sample consists of fourteen renewable energy indexes for which I collect monthly total return data from three different data sources, Thomson Reuters Datastream, Global Financial Data (GFD), and Ardour Global (Alternative Energy Indexes). As I aim to understand the long-term financial performance of renewable energy indexes, I use monthly data instead of the more volatile daily or weekly data.[73] Also, some scholars (see e.g. Dimson, 1979; Roll, 1981; Scholes and Williams, 1977) report a trading infrecuency bias, that tends to overestimate the risk-adjusted returns of less frequently traded firms and underestimate the returns of more frequently traded firms. This bias tends to be of particular concern with short-interval data such as daily or weekly observations (Roll, 1981). I calculate monthly excess returns by reducing total returns, denominated in US Dollars, by the three month US Treasury Bill, which I also obtain from Thomson Reuters Datastream.

I restrict my attention to renewable energy indexes which track the performance of energy producing firms, specialised in renewable energy (such as solar, wind, and hydro), alternative fuels (bio-fuels) and related renewable technologies (such as storage and efficiency of clean energy). In defining whether a company qualifies as clean or renewable, the index providers employ the following three broad screens: (i) sector, (ii) clean income, and (iii) liquidity screens. First, the sector screen rules out any firms not having any business activities related to alternative energy firms. Second, the clean income screen ensures that companies generate sufficient revenues or net income from renewable business activities to be classified as clean. Third, renewable energy index providers use a liquidity screen, either a liquidity ratio[74] or minimum trading volume and market capitalisation, to screen out less frequently traded firms. The implementation of these screens across index providers varies to some extent. For example, indexes with global investment objectives tend to be broader and less selective in their inclusion of energy businesses. In contrast, among the specialised indexes are NASDAQ Clean Edge index, HFRX Alternative Energy, Ardour Global Alternative Energy Solar and S&P Asia Alternative Energy. The majority of indexes use a

[73] This is in line with related studies using the same methodology (See e.g. Carhart, 1997; Renneboog et al., 2011; Renneboog et al., 2008a)
[74] Liquidity ratios are calculated average 3-month daily trading volume divided by the average 3-month market capitalisation.

clean income threshold of over 50 percent[75], except for Ardour Global Alternative Energy Solar who uses 66 percent of gross revenues or net income. Finally, approximately half of the sample uses minimum average trading volumes of 1 million USD and average free-float market capitalisations of 100 million USD to keep more liquid renewable energy businesses.

Table 8 describes data characteristics and annualised summary statistics of my sample of fourteen renewable energy indexes' raw returns and their respective conventional market benchmarks. To accurately assess the return and risk dynamics of renewable energy indexes, I use geographically similar equity market benchmarks. In total, I use six market benchmarks for two reasons. First, as renewable energy indexes have different geographical investment objectives, using tailored benchmarks increases the robustness of my findings. Second, my diversified equity market benchmarks are commonly used indexes to evaluate financial performance. Third, whenever available, I use an index provider's self reported benchmark from its prospectus or factsheet.

More recently, additional renewable energy indexes have come into existence, but I focus on the ones with sufficient observations for reliable statistical estimates. Thirteen out of fourteen indexes are active, with a minimum of four year's monthly data. The European Renewable Energy Index was discontinued in January 2012. The first set of clean energy indexes were launched just at the end of the speculative dot.com bubble in January 2000. The latest addition is the S&P Asia Alternative Energy Index with increasing attention of developing economies in renewable energy businesses. Thus, on average I have 117 monthly observations available for analysis and define the sample period from the launch of the first index in December 1999 to February 2013. The indexes benchmark the performance of clean energy firms in various regions including Asia, Europe, US and Worldwide. In particular, eight have a global focus, three purely focus on US clean energy firms, two exclusively track European firms and one with Asian focus. S&P Asia Alternative Energy is the youngest index in my sample.

Panel A of Table 8 shows that annualised average returns for nine out of fourteen renewable energy indexes are negative. With the exception of the following four renewable energy indexes: DaxGlobal Alternative, S&P Global Alternative, NASDAQ Clean Edge and European Renewable Energy have positive annualised average returns of 1.14, 1.98, 3.28 and

[75] A threshold of either 50 percent gross revenues or net profit allows conventional energy producers (coal, nuclear and oil) to be included in virtually any of the nine renewable energy indexes. From a purist perspective, energy producers might join for the wrong reasons. As (Collison et al., 2009) study shows, companies that joined the FTSE4Good index are mainly concerned with their reputational rather than their environemtnal and social impact to society. In this chapter, I am primarily interested in the direct financial performance of renewable energy indexes and not their degree of 'renewable purity'.

1.08 percentage points, respectively. The results are not likely driven by geographies as the positive performance comes from European, US and two Global indexes. The only Asian renewable energy index, SPAALE$, displays the highest negative annualised mean return of -13.02 percent. Two related studies observe similar return dynamics of renewable energy indexes. While, Bohl et al. (2013) observe negative mean returns for German renewable energy indexes, Ortas & Moneva (2013) find negative mean returns for a sample of 21 clean tech indexes.

Renewable energy indexes' total risk as proxied by the standard deviation indicates very volatile investments. Generally, annualised standard deviations are in the range of 35 to 40 percent. In line with my risk findings, Henriques & Sadorsky (2008) and Kumar et al. (2012) find that renewable energy companies tend to be twice as volatile as conventional benchmarks. Reviewing return distributions of renewable energy indexes, I find all fourteen indexes to have non-normal distributions with normality hypotheses strongly rejected, using Jarque-Bera's normality test. In addition, I find negative Skewness and Kurtosis exceeding three, which also indicates a leptokurtic return distribution with negative symmetry.

While the Ardour Global Solar index performed worst compared to all other clean energy indexes in absolute terms, with annual average returns of -15.67 percent, worst loss of -54.79 percent, and annualised standard deviation of 54.63 percent, the NASDAQ Clean Edge index performed best with the highest maximum return, a worst loss of only -21.88 percent and an extremely low annualised volatility of just 17.72 percent.

Panel B of Table 8 summarises my conventional market benchmarks. To increase the reliability of my performance estimates, I assign to each renewable energy index a suitable conventional market benchmark that has the same investment scope. This results in six market benchmarks such as MSCI World, MSCI Europe, S&P World, S&P 500, S&P Asia, and NASDAQ Composite index.

Annualised mean returns are positive for all six equity benchmarks. The absolute performance lies between 2 and 3 percent per annum. The S&P Asia and NASDAQ Composite benchmark indexes have the highest observed annualised mean return of 7.48 percent and 6.92 percent, respectively. The improved absolute performance for S&P Asia is driven by higher absolute risk, but not for NASDAQ. While total volatilities for all benchmark indexes range between 16 and 21 percent, S&P Asia has a standard deviation of 25.68 percent, clearly above the others. Testing return distributions of my selected equity benchmarks, I observe that the null hypothesis of normality is strongly rejected for all six indexes. Meaning that none of the index' returns are normally distributed. Skewness and Kurtosis statistics show return distributions with fat tails and negative symmetry.

Table 8: Summary Statistics of Renewable Energy Indexes and Conventional Market Benchmarks

Index	Data Availability From	Ann. Mean	Ann. Median	Ann. Std.Dev	Jarque-Bera	Skewness	Kurtosis	Market	Conventional Market Benchmarks
Panel A: Renewable Energy Indexes									
AGIGL	31/12/1999	-0.0515	0.1755	0.3795	66.47***	-0.9045	5.6123	World	MSCI World
AGIXL	31/01/2000	-0.0790	0.1058	0.3869	82.58***	-0.9955	5.9428	World	MSCI World
AGINA	31/12/1999	-0.0737	0.0019	0.3977	25.20***	-0.5270	4.6483	N. America	S&P 500
AGIEM	30/06/2005	-0.0950	0.1371	0.4063	56.24***	-1.0789	6.1646	Europe	MSCI Europe
SOLRX	31/12/2004	-0.1086	0.2196	0.5463	22.26***	-0.9441	4.3730	World	MSCI World
DAXGAK$	29/12/2000	0.0114	0.1545	0.2839	20.40***	-0.5916	4.3979	World	MSCI World
RENIXXI	31/01/2002	-0.1567	0.1251	0.3943	26.92***	-0.8038	4.5075	World	MSCI World
SPGATE$	28/11/2003	0.0198	0.2274	0.2747	134.20***	-1.4888	7.4888	World	S&P World
SPAALE$	30/06/2008	-0.1302	-0.0810	0.3570	5.96*	-0.6600	3.8999	Asia	S&P Asia
HFRXALE	31/01/2006	-0.0714	0.2146	0.3618	181.09***	-1.7386	8.2023	World	MSCI World
NASCEUL	30/11/2006	0.0328	0.0723	0.1772	99.08***	-1.4447	7.4301	US	NASDAQ Composite
SPGCLE$	28/11/2003	-0.0880	0.2122	0.3569	28.60***	-1.1807	4.8913	World	S&P World
ERIXIN$	30/09/2003	0.0108	0.1831	0.4110	85.21***	-1.2547	6.7620	Europe	MSCI Europe
WHNEGI$	29/12/2000	-0.0090	0.1638	0.2976	140.73***	-1.3086	7.0354	US/World	S&P 500
Panel B: Benchmarks									
MSCI World	31/12/1999	0.0223	0.1021	0.1685	37.43***	-0.8328	4.7063	World	
MSCI Europe	31/12/1999	0.0211	0.1070	0.1610	19.21***	-0.6658	4.0696	Europe	
S&P World	31/12/1999	0.0293	0.0778	0.2036	29.77***	-0.7553	4.4965	World	
S&P 500	31/12/1999	0.0267	0.1213	0.1731	36.27***	-0.8309	4.6575	US	
S&P Asia	31/12/1999	0.0748	0.1589	0.2568	12.95***	-0.5339	3.9096	Asia	
NASDAQ	31/10/2003	0.0692	0.1732	0.1834	13.81***	-0.6911	4.0114	US	

Notes: This table summarises general information for each of the 14 Clean Energy Indexes and their Conventional Peers. The first column indicates the identifier of an Index. The second column indicates data availabilities for each renewable and conventional benchmark index. The following six columns report annualised summary statistics including mean, median, standard deviation, Jarque-Bera, skewness, and kurtosis.

5.4.2 Benchmark Factors

As my sample of clean energy indexes have diverse investment objectives[76], I account for this diversity in my benchmark selection to avoid potential mismatches. I initially assign renewable energy indexes to market benchmarks specified in their respective index factsheets. A similar approach is used in mutual funds studies, where market benchmarks are allocated to mutual funds according to fund prospectuses. Using the index providers' self-reported benchmark increases the accuracy of my coefficient estimates for financial performance and risk, thus avoiding misclassifications of funds (Angelidis et al., 2013). In addition to equity market benchmarks, I collect data for the following three independent

[76] See Table 2 for additional details on renewable energy indexes' investment objectives and benchamarks.

variables: size premium, value premium and momentum factor. The variables are based on a value-weighted, all-industry classification following ICB (Industry Classification Benchmark)[77].

In particular, I compute three investment style factors that represent difference portfolios of stocks and control for size, value vs. growth, and momentum investing. In line with previous studies, I name these three factors SMB (small minus big), HML (high minus low) and MOM (momentum), respectively. I create all investment style variables with StyleResearch's Markets Analyzer as follows: The SMB (small minus big) or size premium is the difference of small market capitalisation stocks (0-50 percent) and big market capitalisation stocks (50-100 percent). I compute the HML benchmark factor by taking the difference of high price to book securities (70-100 percent) and low price to book securities (0-30 percent). The securities of the SMB and HML factors are rebalanced annually, always at the end of June.[78] Finally, I construct the MOM factor by taking the difference of past outperforming return portfolios (70-100 percent) and past underperforming portfolios (0-30 percent) with a monthly rebalance date at the end of June each year. In the construction of the three benchmark portfolios SMB, HML and MOM I closely follow Renneboog, Ter Horst, & Zhang (2008a). Their computed benchmark variables correlate to 99 percent with Fama and French's original benchmark factors and are therefore identical.

[77] ICB classifies industries into 10 groups including: Oil&Gas, Basic Materials, Industrials, Consumer Goods, Health Care, Consumer Services, Telecommunications, Utilities, Financials and Technology.

[78] The SMB and HML factors are constructed following Fama and French's (1992, 1993) portfolio formation methodology. Fama and French (1993:429) explain that portfolios are formed at the end of June "To ensure that the accounting variables are known before the returns they are used to explain."

5.5 Main Results

5.5.1 Static Performance Analysis

Table 10 summarises my main results of assessing the static financial performance for my sample of fourteen renewable energy indexes and their respective market benchmarks over different sample periods. In Panel A of Table 10, I report findings for Carhart's multi-factor model over the full sample period from December 1999 to February 2013. While my analysis shows no significant over- or underperformance for Asian, European, or US renewable energy indexes, there is evidence of a significant underperformance for several Global renewable energy indexes. 7 out of 8 global indexes show a significant negative alpha, with the exception of DaxGlobal Alternative Energy Index. On average, the worst performers are Renewable Energy Index (Renix) and Ardour Solar with -2.63 and -2.33 percent, respectively. Although this finding clearly speaks against a consistent risk premium for renewable energy firms as observed by Chia et al. (2009), a natural question is whether the patterns I observe can also be generalised to different time periods and particularly persist over the two phases of the EU ETS.

In Panel B of Table 10, I report my findings for the financial performance of my sampled renewable energy indexes over the first phase of the EU ETS. In contrast to the findings of the full sample period, I observe the first phase as extremely beneficial for all renewable energy indexes. Three indexes even outperform their respective benchmark considerably. Nasdaq, S&P Global, and Wilderhill generate remarkable alphas of 1.04, 2.5, and 2.02 percent, respectively.

Despite the beneficial first phase of the EU ETS, the second phase was hit by the financial crisis and thus shows devastating performances across all renewable indexes. The initial outperformance completely reverts to a clear underperformance of virtually all renewable energy indexes. In particular, 12 out of 14 renewables experience significantly negative alphas ranging from -1.85 to -5.15 percent. Related research supports my findings and shows that during stable market conditions renewable energy indexes tend to over-perform broad equity market benchmarks, but during financial crises, renewable energy indexes become even riskier and as a result substantially underperform (Ortas and Moneva, 2013). It appears that the somewhat more restricted stock universe of the renewable energy indexes due to their environmental screens relative to the more diversified conventional indexes leads to a riskier investment strategy during the financial crisis (Ortas and Moneva, 2013). In accordance with Modern Portfolio Theory, more diversified portfolios should outperform less diversified or screened portfolios[79]. In Chapter 2.6.1. 'Diversification and ESG information', I discuss the potentially reducing performance implications of employing environmental, social, and governance screens on the optimal diversification of portfolios within the context of Modern Portfolio Theory. Similarly, Bohl et al. (2013) discover that German renewable energy indexes have been fuelled by a speculative bubble during 2004 to 2007, and turned into substantial underperformers after the financial crisis in 2008.

Over the trading periods of the EU ETS, renewable energy subsidies played a role in the promotion of innovate renewable energy technologies (Fischer and Newell, 2008). Table 9 shows worldwide subsidies to renewable energies rising from 57 billion USD in 2009 to 120 billion USD in 2013. On average, the renewable energy sector is estimated to have received about 86.4 billion USD in subsidies, over that period. While these figures may indicate a committment to tackling climate change by governments worldwide, renewable energy subsidies have been tiny compared to the heavy amount of subsidies supplied to the fossil fuel sector. According to the International Energy Agency (IEA) (see Table 9), fossil-fuels received at least 5 times the amount of subsidies compared to renewables over the same period. The IEA estimates that fossil-fuel subsidies have increased from 90 billion USD in 2005 to over half trillion USD in 2013. These figures reveal that there is a clear misconception about energy subsidies. As a result, investors receive mixed signals about the future prospects of the energy sector which could affect their capital investment decisions (Morales, 2014; Overseas Development Institute, 2013).

Table 9: Worldwide Energy Consumption Subsidies[80]

	Renewable Energy (in billion USD)	Fossil Fuel Energy (in billion USD)	Difference (in billion USD)	Ratio Fossil to Renewable
2013	120	550	430	5
2012	101	544	443	5
2011	88	523	435	6
2010	66	409	343	6
2009	57	299	242	5
2008	Not reported	557	na	na
2007	Not reported	342	na	na
2006	Not reported	300	na	na
2005	Not reported	90	na	na

Notes: Figures are based on annual International Energy Agency (IEA) subsidy estimates and collected from annual "World Energy Outlook" reports.

[79] However, several studies have shown that this is not always the case and that environmental, social, and governance screens could actually improve the financial performance of screened portfolios (See e.g. Hamilton et al., 1993).

[80] Access to accurate subsidy figures is difficult to obtain, measure and not always readily available (REF). IEA energy subsidies in this table are based on estimates and not actual values.

Table 10 further discusses relative risk characteristics, i.e. regression beta coefficients of my static multi-factor model for my diverse sample of renewable energy indexes. Over the full sample period I find the majority of renewable energy indexes to have beta coefficients substantially larger than 1. This is particularly the case for renewable energy indexes with global investment objectives. Previous studies investigating the risk behaviour of renewable energy firms document that renewables tend to be among the riskiest investments and at least twice as risky as their conventional market benchmarks (Henriques and Sadorsky, 2008; Sadorsky, 2012b). Kumar et al. (2012) and Sadorsky (2012a) explain that renewable energy risk is highly driven by the strong correlation of renewable stock prices to technology stock prices, meaning that technology companies have much in common with renewable energy companies, considering their high future uncertainty as a result of few specialised renewable projects, especially during the start-up phase.

Surprisingly, I find 11 out of 14 beta coefficients to be noticeably lower during the first phase of the EU ETS compared to the second phase. This finding indicates that although renewable energy firms have likely benefited from positive investor sentiment between 2005 and 2007 they became extremely risky during and after the financial crisis in 2008.

Rather than only examine the market model, I extend the analysis in Table 10 to include a full-fledged investment style analysis of renewable energy indexes. In my style analysis, particularly the size factor, I show a significant positive correlation between renewable energy indexes' excess returns with the SMB investment factor. Meaning that renewable energy indexes invest in companies with small market capitalisations. I observe this for 13 out of 14 renewables over the full sample period, 12 out of 14 during the first phase EU ETS, and 8 out of 14 during the second phase EU ETS. Evidence on whether renewable energy indexes prefer growth over value companies is, however, less conclusive. While there is some minor evidence of positive momentum investing over the full sample period, I find strong evidence of positive momentum especially during the first phase EU ETS. In particular, 13 out of 14 renewable energy indexes experience positive momentum, which subsequently disappears during the second stage of the EU ETS. My finding reinforces the evidence of explosive price behaviour of German and potentially other renewable energy indexes such as European, Global, and US indexes before the crisis (Bohl et al., 2013). My investment style findings are very similar to Chia et al. (2009) study, whereby their portfolio of renewable energy companies includes small cap, growth and above average volatility stocks.

The adjusted R^2 from my static Carhart regression give a simple indication for how closely renewable energy index returns are related to variations in conventional market benchmark excess returns and investment styles. In the last column of Table 10, I report adjusted R^2 values and show that my regressions have an average adjusted R^2 of 66 percent across all renewable energy index regressions over the full sample period.

Table 10: Static Carhart Four-Factor Performance

Renewable Energy	Benchmark	Carhart Model					Obs.	Adj. R2
		α	β	SMB	HML	MOM		
Panel A: Full sample period 12/1999 - 02/2013								
AGIGL	MSCI World	-0.0089*	1.7440***	0.6640**	-0.0818	-0.0364	158	0.676
AGIXL	MSCI World	-0.0105*	1.8399***	0.4521***	-0.2211	-0.0029	157	0.699
AGINA	S&P 500	-0.0089	1.6611***	0.8093***	0.2196	0.0293	158	0.598
AGIEM	MSCI Europe	-0.0102	1.6518***	1.1566***	-0.0034	0.0752	92	0.759
SOLRX	MSCI World	-0.0233*	2.2935***	1.3365***	0.1959	0.5017*	98	0.583
DAXGAK$	MSCI World	-0.0062	1.3742***	0.4349***	0.0393	0.1562	146	0.646
RENIXXI	MSCI World	-0.0263***	1.6636***	0.8111***	-0.0347	0.2325	133	0.515
SPGATE$	S&P World	-0.0087**	1.4130***	0.5763***	0.1150	0.2450*	111	0.794
SPAALE$	S&P Asia	-0.0105	0.8418***	-2.0345**	-0.0863	-0.5334***	56	0.433
HFRXALE	MSCI World	-0.0181***	1.8182***	0.5685***	0.0182	0.2472*	111	0.723
NASCEUL	NASDAQ Comp. US	0.0018	0.6137***	0.3685***	0.2151***	0.0980	85	0.583
SPGCLE$	S&P World	-0.0134**	1.5996***	0.4434**	-0.1423	0.1272	75	0.793
ERIXIN$	MSCI Europe	-0.0062	1.6843***	1.0654***	0.0432	0.0908	100	0.684
WHNEGI$	S&P 500	-0.0061	1.4762***	0.5417***	0.1812***	0.0736	146	0.716
Panel B: ETS Phase I 01/2005 - 12/2007								
AGIGL	MSCI World	0.0045	1.5148***	0.3902**	-0.9269***	0.5680**	36	0.613
AGIXL	MSCI World	0.0034	1.4546***	0.3268	-1.0456***	0.5674**	36	0.575
AGINA	S&P 500	-0.0012	1.3888**	0.5822*	-0.2036	0.8655**	36	0.356
AGIEM	MSCI Europe	0.0040	1.4827***	0.9478***	-0.0986	1.5422***	30	0.690
SOLRX	MSCI World	0.0222	0.2655	1.7022***	0.2271	1.5296*	36	0.333
DAXGAK$	MSCI World	0.0142	0.7893*	0.5221*	0.2294	1.2386***	36	0.507
RENIXXI	MSCI World	0.0147	0.9492***	0.7984***	-0.2668	1.3022***	36	0.505
SPGATE$	S&P World	0.0065	1.4082***	0.3973***	-0.2293	0.5631***	36	0.733
SPAALE$	S&P Asia							
HFRXALE	MSCI World	0.0091	1.2851***	0.4647*	-0.5264*	0.8022***	36	0.616
NASCEUL	NASDAQ Comp. US	0.0104**	0.5922***	0.7875***	0.4692	0.8095*	23	0.521
SPGCLE$	S&P World	0.0250**	0.1962	0.2622	-1.1702***	0.0263	13	0.261
ERIXIN$	MSCI Europe	0.0124	1.8443***	0.6801***	-0.1345	1.0495***	36	0.616

WHNEGI$	S&P 500	0.0202***	0.9986***	0.8767***	-0.0560	0.6174**	36	0.600
Panel C: ETS Phase II 01/2008 - 12/2012								
AGIGL	MSCI World	-0.0260***	1.6473***	0.5272**	0.0010	0.0200	60	0.821
AGIXL	MSCI World	-0.0289***	1.6770***	0.3785	-0.0912	-0.0335	60	0.800
AGINA	S&P 500	-0.0185**	1.5344***	0.5254***	0.1345*	0.2484	60	0.758
AGIEM	MSCI Europe	-0.0239***	1.5127***	1.1121***	0.3510	-0.0924	60	0.809
SOLRX	MSCI World	-0.0515***	2.3422***	0.3463	-0.2699	0.0263	60	0.695
DAXGAK$	MSCI World	-0.0191***	1.2177***	0.4035**	0.0754	0.0267	60	0.765
RENIXXI	MSCI World	-0.0445***	1.4525***	0.6225	-0.1114	-0.1864	60	0.657
SPGATE$	S&P World	-0.0204***	1.3421***	0.6149***	0.1314	0.0719	60	0.838
SPAALE$	S&P Asia	-0.0114	0.8542***	-2.2087**	-0.0715	-0.5731***	54	0.443
HFRXALE	MSCI World	-0.0356***	1.7868***	0.3577	-0.0777	-0.0189	60	0.775
NASCEUL	NASDAQ Comp. US	-0.0005	0.5965***	0.3008**	0.1951***	0.0056	60	0.631
SPGCLE$	S&P World	-0.0212***	1.6289***	0.3829	-0.1650	0.0815	60	0.845
ERIXIN$	MSCI Europe	-0.0236*	1.5613***	1.0853***	-0.0204	-0.1833	49	0.750
WHNEGI$	S&P 500	-0.0221**	1.5424***	0.4282**	0.1614**	-0.1091	60	0.751

Notes: This table presents Carhart four-factor regression results for the sample of fourteen clean energy indexes over three different sample periods using eq. 6: $r_t^{REN} - r_t^f = \alpha_i + \beta_i (r_t^M - r_t^f) + \gamma_i r_t^{SMB} + \lambda_i r_t^{HML} + \theta_i r_t^{MOM} + \varepsilon_t$. Panel A shows regression results for the full sample period from December 1999 to February 2013. Panel B presents estimations over the first phase of the ETS from January 2005 to December 2007. Panel C reports estimations over the second phase of the ETS from January 2008 to December 2012. Alpha (α) represents the risk-adjusted excess return, which I obtain by regressing each of the fourteen clean energy indexes excess return on the respective market benchmarks, size (smb), value (hml), and momentum (mom) premiums. Beta (β) is the systematic risk exposure of the indexes, relative to their benchmarks. I compute T-statistics based on Newey and West (1987) heteroskedasticity and autocorrelation robust standard errors. *, **, and *** denote statistical significance levels at 10, 5, and 1 percent signficance, respectively.

5.5.2 *Dynamic Performance Analysis*

In Tables 11 and 12, I report the results of investigating the dynamic financial performance and investment styles of my renewable energy sample, using a dynamic state-space multi-factor model. This analysis adds to my previous static analysis, as it provides substantially more insight into the temporal development of alphas, betas, and investment styles of renewable energy firms and the transition through two phases of the EU ETS. To give one example, findings based on the static analysis are prone to changing significances depending on the observed sample period. In contrast, my dynamic analysis based on the Kalman filter, illustrates the continous development of investment performances and styles over the entire sample period, within at least the 90 percent confidence interval (or at least 10 percent significance levels). Meaning that the Kalman filter allows me to compute smoothed state estimates as well as confidence intervals or significance levels for those estimates.

The first column of Tables 11 and 12 show time-varying alpha coefficients from the inception date of each renewable energy index. While some alphas appear very smooth over time, others are somewhat more erratic. This nicely reflects the dynamic return behaviour of renewable energy indexes.

During 2004 to 2007, the first phase of the EU ETS, the financial performance of 11 out of 14 renewable energy indexes tends to move around zero. This indicates that renewable energy indexes neither over- nor underperformed their respective conventional benchmarks significantly. Towards the end of the first phase EU ETS in 2007, I observe substantially increasing dynamic alphas, which were likely driven by positive investor sentiment. The increase in alphas is, however, short-lived and does not persist. The performance drastically collapses as a consequence of the financial crisis at the end of 2007. I can observe the same pattern (alphas substantially falling below zero) across numerous renewable energy indexes. To be more precise, renewable energy indexes with Global, European, and Asian focus performed worst after their peak performance mid 2007. My findings are in line with Bohl et al. (2013) study, who find the same pattern for German renewable energy equity indexes and argue that the steep and short-lived increase at the end of 2007 is a clear indication for the creation of a market bubble. While Ortas and Moneva (2013) find that renewable energy indexes with global focus tend to be more profitable relative to specific regionally focused indexes, I can support their findings for only one renewable energy index with global investment objectives, Dax Global Alternative. In contrast, one of the regional indexes, Nasdaq Clean Edge US Liquid, seems to be very profitable compared to its broader equity benchmark Nasdaq composite. All remaining global renewable energy indexes perform as badly as regional renewable energy indexes in my sample.

One might argue that if global renewable energy indexes perform badly, regional renewable energy indexes will be unprofitable, too, as they are believed to be based on the same stock universe. Therefore, I investigate this dilemma further by observing index components of global and regional renewable energy indexes. I find differences in the composition of companies, whereby some global renewable energy indexes do not necessarily list the same companies, regional indexes list. In other words, the composition of renewable energy companies can differ from regional to global, and even from global to global indexes. For example, Nasdaq Clean Edge US Liquid lists only companies on US stock exchanges. Some US companies on the Nasdaq tend to be different US companies on other global indexes. In particular, while Nasdaq lists approximately 55 US companies, S&P Global lists about 13 US companies and Renix World lists only 6 US companies. As a result, I believe the performance differential between global and regional renewable energy indexes not to be driven by geographical differences, but rather sector driven. In other words, the composition of renewable energy companies within sub-sectors of the renewable energy equity index seem to matter more.

In column two of Tables 11 and 12, I present time-varying beta coefficients of all sampled renewable energy indexes. Renewable energy betas tend to move clearly above 1, which indicates higher risk exposure compared to the respective general market. This risk finding is well established in the literature (Bohl et al., 2013; Henriques and Sadorsky, 2008; Sadorsky, 2012b). Although, the variation of dynamic beta is not substantial in most cases, few indexes can experience variations of approximately one beta over time. Examples include Renewable Energy Index, Ardour Solar, all three S&P Renewable Energy Indexes, and Wilderhill New Energy Index.

My investigation shows that towards the end of phase one of the EU ETS and shortly before the financial crisis, beta coefficients become relatively stable. This situation changes dramatically at the beginning of the second phase and after the financial crisis. With increasing volatility after the financial crisis, I find beta coefficients to increase for 5 out of 14 renewable energy indexes, to decreases for 6, and to be unchanged for 3 indexes. Remarkably, no matter whether beta coefficients tend to increase, decrease, or stay unchanged they all seem to revert to similar beta coefficients in ranges of approximately 1.2 and 2.5, after the financial crisis. These findings are similar to my static beta findings from the previous chapter. In particular, I established that during the first phase EU ETS beta coefficients were generally somewhat lower than during the second phase EU ETS, on average. Findings from my time-varying risk analysis shed more detailed insight into the temporal dynamics of renewable energy indexes' beta exposure.

Columns 3 to 5 in Tables 11 and 12, show the findings of my dynamic investment style analysis of renewable energy indexes. The size factor SMB, measuring the exposure towards small cap. versus large cap. stocks, is positive and clearly above zero for 10 out of 14 renewable energy indexes, over the entire respective sample periods. After the financial crisis, the size factor decreases for the majority of indexes. This finding indicates that before the financial crisis, primarily small cap companies have been listed on renewable energy indexes, which could explain the outstanding financial performance of renewables during 2004 and 2007. As a possible result of liquidity constraints and bankruptcies during and after the financial crisis, many of the initial small cap companies could have been delisted. This would also explain the more recent exposure to mid- and larger sized renewable energy businesses by renewable energy indexes.[81]

My controls for additional dynamic investment style variables such as HML (value versus growth exposure) show significantly more insight compared to the static HML factor from the previous chapter. In particular, I find HML coefficients to be generally negative. In line with previous studies, this means that renewable energy indexes have a preference for growth companies. However, the observed exposure does not apply over the entire sample period. From 2004 to 2007, HML coefficients tend to steadily revert towards zero, which could indicate a change of index components to increasingly reduce the number of growth companies listed. Alternatively, increasing HML coefficients could indicate changes in investor valuations of renewable energy companies. As the HML factor is based on companies' price-to-book ratios, sharp increases in the share prices of renewable energy companies could have increased HML coefficients, everything else equal. Renewable energy companies experienced such rapid share price increases during the first phase of the EU ETS (See e.g. Bohl et al., 2013). The trend of the HML coefficient tends to peak at the end of 2007 and stagnate through the second phase EU ETS. This means that the returns of renewable

[81] My dynamic performance analysis allows me to observe changing factor exposures over time such as the declining factor exposure of the SMB factor. A negative SMB factor indicates exposure to firms with larger market capitalisations. One potential reason for a negative SMB factor could be the de-listing of firms with smaller market capitalisations due to bankruptcies in the renewable energy sector. For example, Bohl et al. (2013:41) show that due to the economic downturn, many "once pioneering German solar companies had to file for insolvency...". Similarly, bankruptcies of wind farm companies such as Prokon, Breeze Two Energy and others could explain the declining factor exposure of the SMB factor (Latsch et al., 2014). Alternatively, the negative exposure to the SMB factor could be related to an increase in the market capitalisation of renewable energy stocks given their sharp price increases between 2004 and 2007 (Bohl et al., 2013).

energy indexes, from the inception date, had initially more in common with the returns of growth companies, but over time and the first phase of the EU ETS the returns have become more similar to the returns of value companies, peaking approximately at the financial crisis and continuing to stagnate at this new level. This finding could either mean that the renewable energy sector saw a substantial consolidation of small renewable energy firms that had been forced out of business by not being able to penetrate the market with their one specific renewable energy technology, and as a result were bought by larger renewable energy firms with more diversified technologies, or changes in investor valuations of renewable energy companies, driven by the sharp share price increases of renewable energy companies during the first phase of the EU ETS.

Finally, my last investment style factor measures each renewable energy index exposure to momentum investing over time. Generally, I can observe some dynamic behaviour of the momentum factor, but for the majority of indexes this variation is fairly stable. In particular, renewable energy indexes tend to have positive momentum exposure during 2004 to 2007, and negative momentum from 2008 to 2013. I observe this pattern for the majority of renewable energy indexes, particularly 9 out of 14 sampled indexes. These findings could indicate that momentum traders were bidding up the prices of renewable energy firms with high expectations for the second phase of the EU ETS.

Table 11: Dynamic Carhart Four-Factor Performance

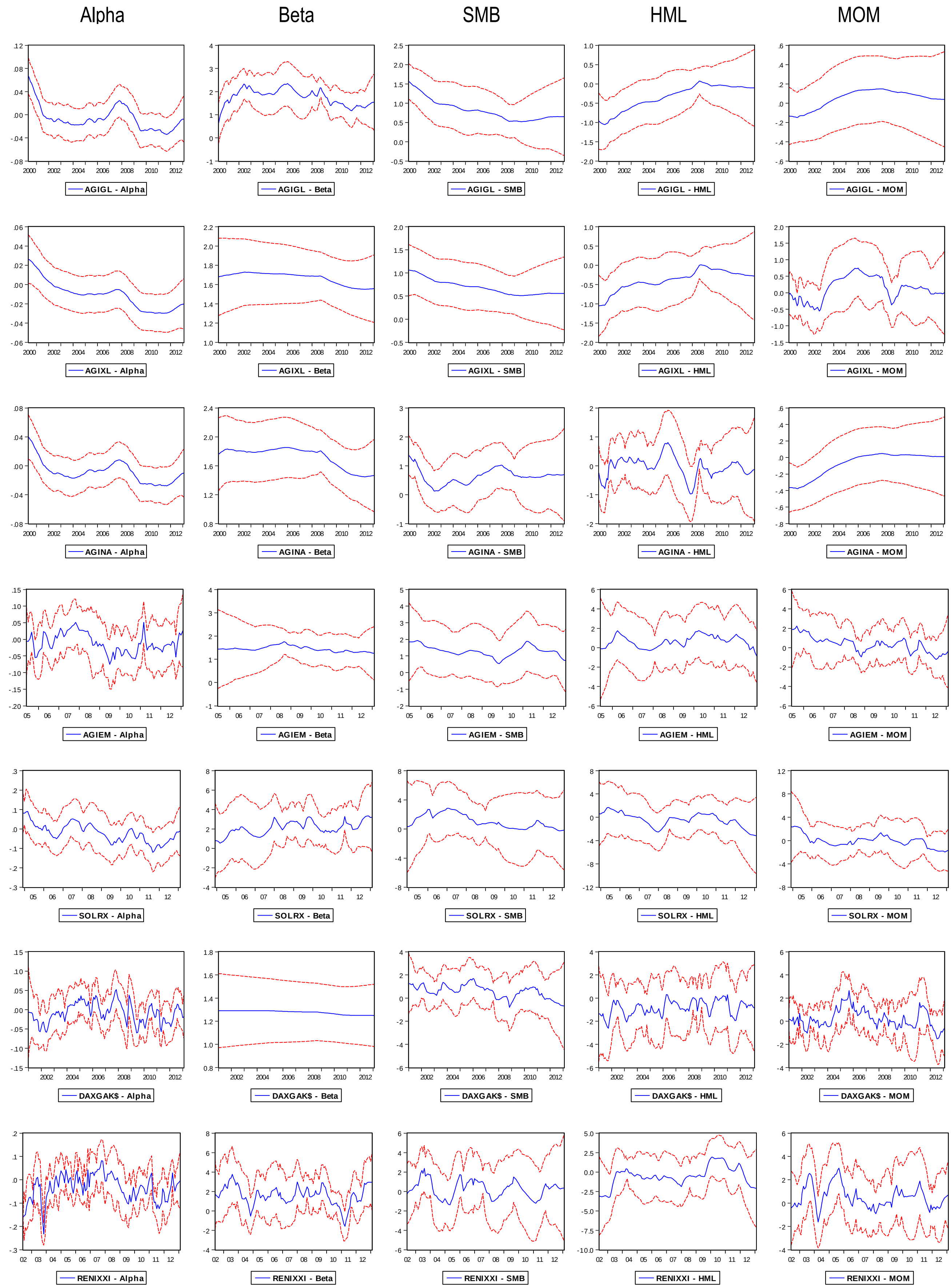
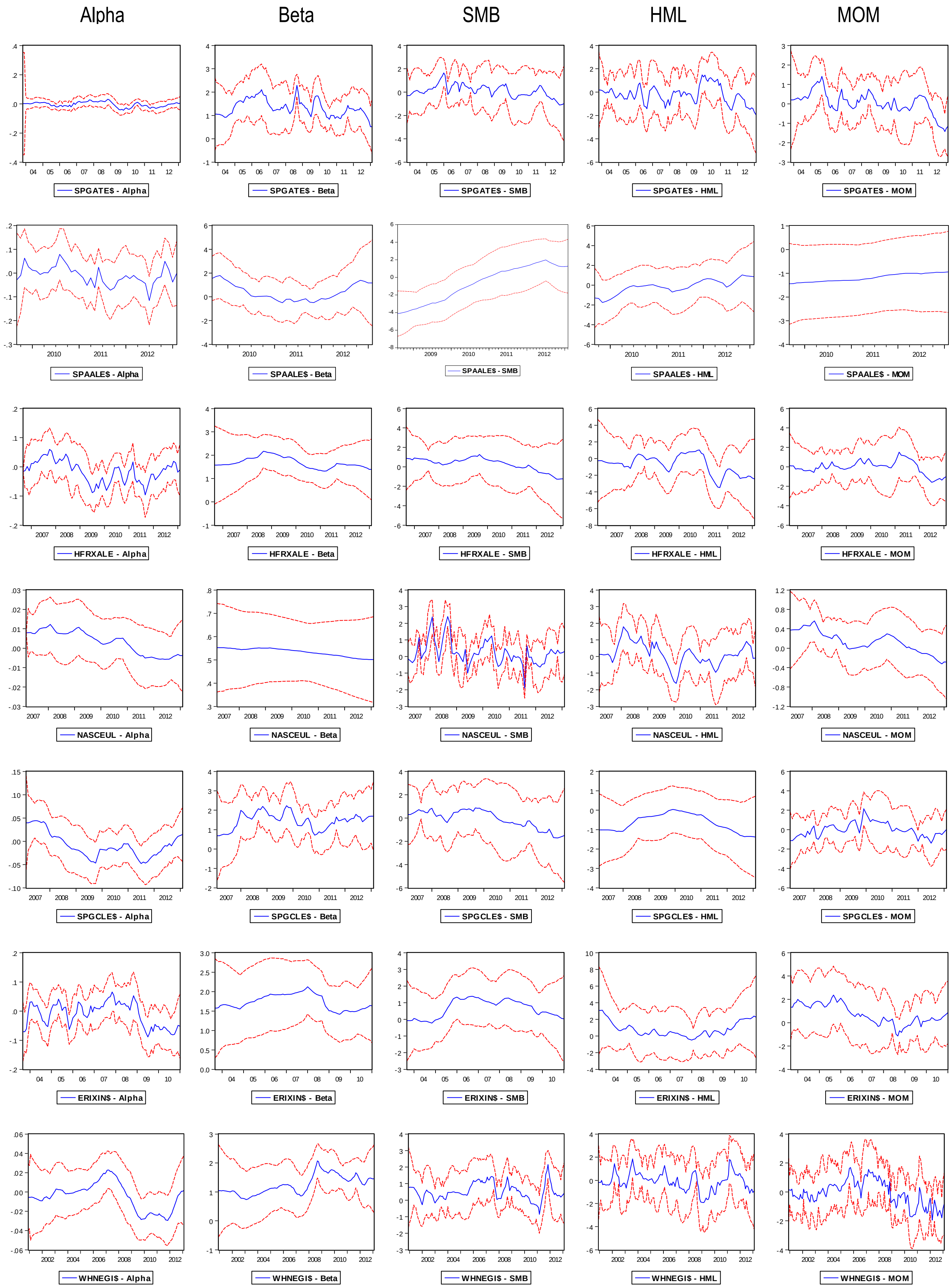


Table 11: Dynamic Carhart Four-Factor Performance



Notes: This table shows dynamic multi-factor model regression results for my sample of 14 renewable energy indexes from the individual inception date to February 2013 using equations [7]-[9]. For each index I display five graphs that represent my estimated dynamic coefficients from the dynamic multi-factor model including alphas, betas, smb, hml, and momentum exposures over time. Solid lines represent time-varying coefficients and dashed lines are 10% significance level boundaries.

Table 12: Dynamic Carhart Four-Factor Performance - Standardised Y-Axes

Alpha | Beta | SMB | HML | MOM

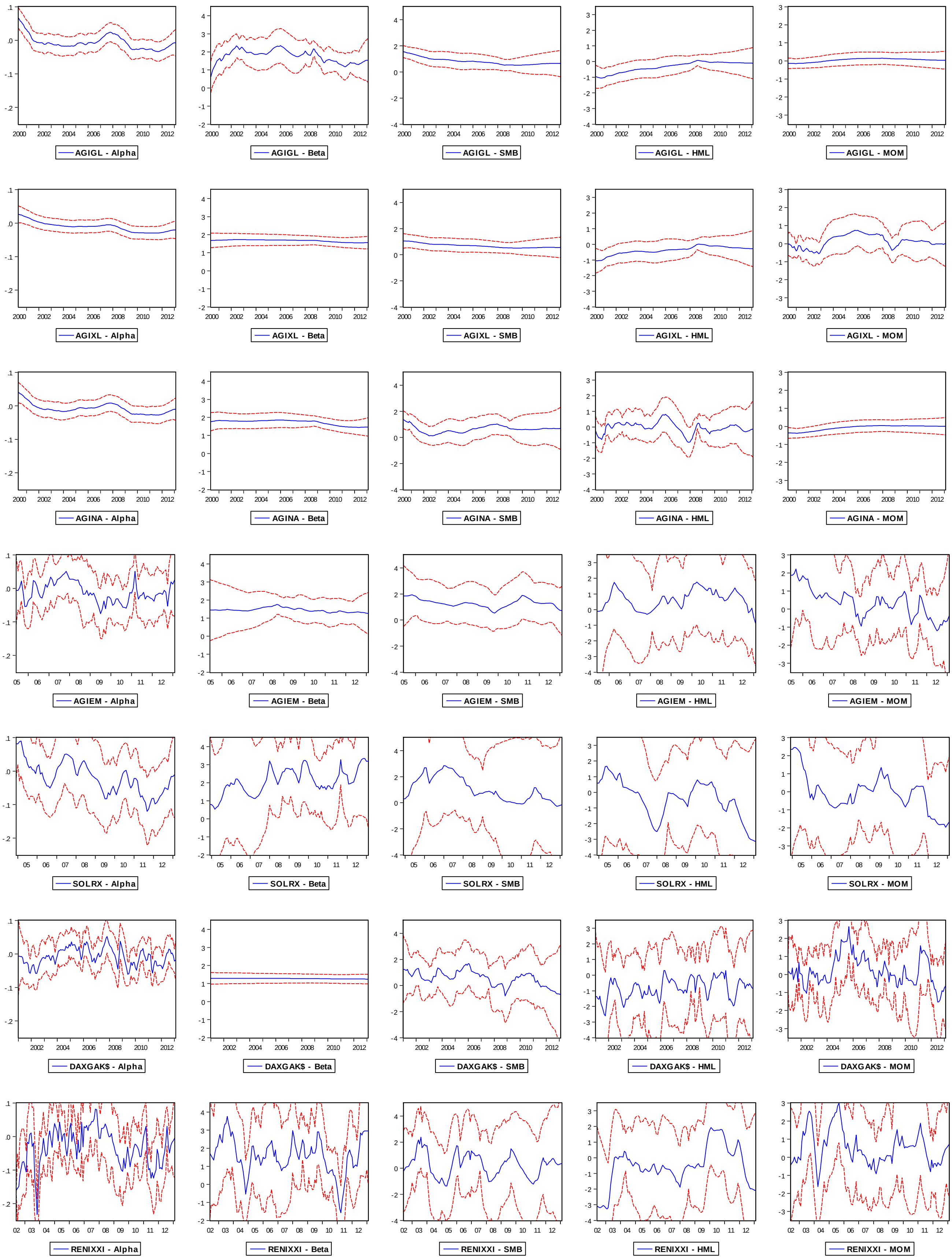
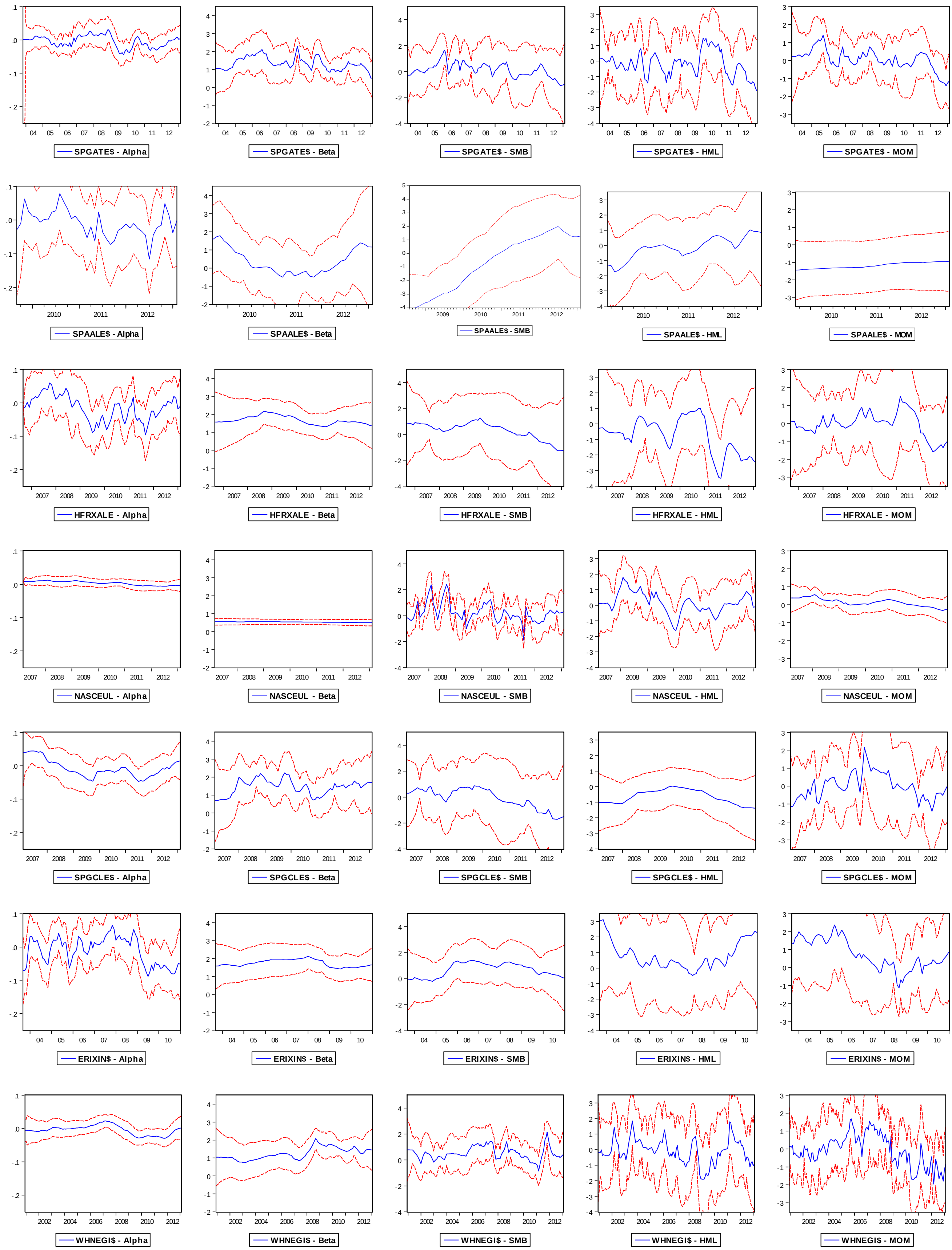


Table 12: Dynamic Carhart Four-Factor Performance - Standardised Y-Axes

Alpha | Beta | SMB | HML | MOM



Notes: This table shows dynamic multi-factor model regression results for my sample of 14 renewable energy indexes from the individual inception date to February 2013 using equations [7]-[9]. For each index, I display five graphs that represent my estimated dynamic coefficients from the dynamic multi-factor model including alphas, betas, smb, hml, and momentum exposures over time. Solid lines represent time-varying coefficients and dashed lines are 10% significance level boundaries.

5.6 Conclusion

This study comprehensively investigates renewable energy indexes' return, risk, and investment style characteristics using static and dynamic multi-factor models and a sample of global and regional renewable energy equity indexes. I provide new evidence on time-varying investment styles and their influence on the financial performance of renewable energy investments. My main findings are as follows:

First, renewable energy equity premiums are not persistent over time. In particular, I find alpha coefficients to evolve dynamically. Alpha variation can be substantial. Second, positive investor sentiment, significant momentum trading, and a strong exposure to small capitalisation renewable energy firms, could be reasons for the exceptional performance of renewable energy indexes during the first phase of the EU ETS and before the financial crisis in 2008. It could be that herding behaviour of investors caused substantial positive momentum with subsequent steep stock price appreciations of renewable energy indexes. Further, I find the initial strong exposure of renewable energy indexes to small cap stocks to be substantially declining during the second phase of the EU ETS and after the financial crisis. It could be that a declining size factor is the result of liquidity constraints of renewable energy businesses during the crisis with subsequent defaults. In other words, it could be that renewable energy businesses violated obligatory liquidity threshold set by index providers and were de-listed from the indexes. This could explain the increasing factor exposure towards mid-and large sized firms after the financial crisis. Fourth, renewable energy indexes temporal risk exposure is generally stable and high, with beta coefficients clearly above one. After the financial crisis, variation in beta coefficients temporarily increases, while beta coefficients revert back to about twice the size (1.85, on average) of conventional market benchmarks. Related studies also highlight the fact that renewable energy indexes experience relatively high betas (Bohl et al., 2013; Kumar et al., 2012; Ortas and Moneva, 2013; Sadorsky, 2012b).

According to the Modern Portfolio Theory (MPT) as discussed in Chapter 2.6 'Systematic risk, Idiosyncratic risk, and Diversification', higher risk exposures shall lead to higher expected returns. While the MPT explains the return and risk relationship of renewable energy equity indexes in the pre-crisis period, it fails to do so in the post-crisis period as beta coefficients continue at a high rate throughout. It could be that my findings concur better with behavioural finance explanations because it seems more likely the case that irrational investors were rapidly driving up the prices of renewable energy companies towards the peak in mid 2007, creating a price bubble. The over-valued renewable energy indexes then reverted to their fundamental prices as a result of the financial crisis.

My empirical analysis leads to the conclusion that time-varying fundamental investment styles help explain the sudden rise and fall of global and regional renewable energy indexes before and after the financial crisis, as well as during two phases of the EU ETS. This finding aligns with results from the performance and risk literature of specific regional renewable energy indexes and portfolios, while it also provides fresh evidence on global renewable energy equity indexes' return and risk behaviour over a long sample period.

This chapter is subject to the following limitations, which could potentially be useful to inform future research directions. First, due to data availability restrictions, my empirical analysis focuses on renewable energy indexes from predominantly developed economies. Future research could comprehensively and directly investigate the financial performance differences between renewable energy stocks in developed and emerging economies. Second, my analysis does not distinguish between the screening intensity or purity of a renewable energy equity index. While some indexes are more liberal in their selection of businesses, others tend to be pure-play renewable indexes only. Analysing renewable equities with this distinction could provide additional insight into the financial performance and risk characteristics of renewable energies. Finally, while Ortas and Moneva (2013) suggest geographical differences between renewable energy investments, future reserach could focus on the substantial heterogenity within sub-sectors of renewable energy such as biofuels, solar, and wind energy and use sector rather than geographical benchmarks.

6 The Risks of Investing in Renewable and Conventional Energy Stock Markets

The Risks of Investing in Renewable and Conventional Energy Stock Markets

Abstract

This chapter studies investment risks between an international sample of fourteen renewable energy equity indexes and eighteen fossil-fuel based energy equity indexes. The majority of renewable energy equity indexes' return volatilities are much higher compared to conventional energy equity indexes. This suggest they carry more investment risk. Concentrated renewable energy indexes within sub-sectors of renewables, such as technology-focused indexes, tend to experience lower return volatilities. Lower volatility renewable energy indexes also correlate stronger with conventional energy indexes. My findings are robust to different measures of risk and benchmark settings.

6.1 Introduction

Energy markets impact on the economy (Filis and Chatziantoniou, 2013; Hedi Arouri and Khuong Nguyen, 2010; Jones and Kaul, 1996). According to the International Energy Agency (2013), global investments in renewable energy are continuing at a high rate with USD 240 billion in 2012. European governments collectively agree that renewable energy investments are an integral part of achieving the abatement objective of the European Council of an 80 percent reduction of greenhouse gas emissions of the 1990 levels by 2050 (ECF, 2010). Despite continuing investments in existing renewable energies, RD&D (Research, Development, and Demonstration) and innovation spending by major governments has only been about 3 to 4 percent since 2000 (International Energy Agency, 2013). Although European governments find it difficult in the current recessionary economic environment to invest in RD&D and Innovation, the interest and investment in renewable energy has been steadily rising, in particular from emerging markets (Bloomberg New Energy Finance, 2013: 3; The Pew Charitable Trusts, 2012). Other indicators of increased investing and financing activities in renewable energy are the mere amount of existing and newly launched thematic renewable energy mutual funds and renewable energy indexes. Recent figures of mutual funds with renewable energy themes total between 107 (Muñoz et al., 2013) and 139 (US SIF, 2013) with 14 renewable energy equity indexes covering several geographic regions (see Table 13).

I aim to study the return volatilities of investing in international renewable energy equity indexes relative to conventional (fossil-fuel) energy equity indexes. Investigating the risk relationship between renewable and conventional energy stocks is essential to understanding whether renewable energy investments can act as a substitute for conventional fossil-fuelled energy stocks in the future. The rapid advent of renewable energy in the past couple of years has shown that the business model of many traditional energy and utilities firms may have become obsolete. Hence, investors need to focus on renewable energy assets too. My study tries to contribute to the understanding of the risk properties of renewable energy indexes. I investigate how the risk behaviour of renewable energy firms varies across regions and compares to conventional energy businesses operating in coal, gas, nuclear, and oil sectors. First, I investigate whether there is a positive relationship between risk with renewables and conventional energy indexes in my sample. Second, I use tracking error volatility to advance my understanding of this relationship. Third, I model a *downside tracking error*, based on the regression-based tracking error volatility of Cremers and

Petajisto (2009), to further enhance my understanding of risk. These analyses increase my understanding of the differences in the risk pricing of international renewable energy firms and their interrelations and dependencies with conventional energy firms.

Related studies investigating the drivers of renewable energy company risk (Sadorsky, 2012b) and the relation between oil prices and renewable energy stock prices (Henriques and Sadorsky, 2008; Kumar et al., 2012) shed some light on the impact of this relationship. Rising oil prices increase systematic risk and may therefore encourage energy producers to diversify into renewable sources of energy. A direct assessment of the investment risk characteristics between renewable and conventional energy sources adds to this discussion. Hence, my research question is the following:

1) Does the risk of international renewable energy equity indexes relate to that of fossil-fuel ones?

2) How does this relation differ geographically?

3) Do returns of renewable energy companies trail those of fossil fuel energy companies?

To my knowledge, this is the first study to investigate the investment risk behaviour of a comprehensive international sample of renewable energy equity indexes that establishes a direct comparison between the returns of traditional (fossil-fuelled) and renewable equity indexes.

I observe a strong and positive relationship between the traditional and the renewable energy index returns. Strikingly, I find very high correlations for a specific sub-set of index pairs, namely the most focussed renewable indexes. I show that there are substantial absolute and relative investment risks across the renewable energy equity indexes. My investment risk proxies such as annualised return volatilities, semi-standard deviations and lower partial moments of renewable energy indexes are about twice the size of conventional energy equity indexes. These findings are in line with Sadorsky (2012b) and Lüthi and Wüstenhagen (2012; 2012b), and highlight the fact that renewable energy businesses are volatile, probably as a result of high uncertainties related to their current business models (i.e. small start-ups with specialised individual projects) and local government incentive programmes that intend to support the development of renewable energy, both of which require a substantial risk-premium from investors.[82] I also find positive and substantially varying tracking errors for all

[82] Clearly, conventional energy companies carry high risks, too. For example, Kawashima and Takeda (2012) show that after the Fukushima nuclear accident, stock prices of utilities with nuclear plants declined sharply

pair-wise relations. My findings suggest that about 70 percent of sampled renewable energy equity indexes tend to have relatively more return volatility than their conventional peers. As volatility is a measure of the dispersion of returns in both directions, positive and negative, it does not distinguish between good and bad variation and thus could under-estimate downside volatility that is of major concern to the risk-averse investor (Ang et al., 2006). Economists have long established that investors care differently about losses than gains (Ang et al., 2006; Roy, 1952)[83]. Hence, I will also try to account for asymmetric risk behaviour by the *downside tracking error.* I observe that also with this measure most renewable energy indexes are to be regarded as riskier than conventional ones. More concentrated renewable energy indexes within the renewable energy sector tend to experience lower investment risk than more diversified renewable energy indexes, especially in the case of North America, given that diversification reduces risk.[84] These findings are in line with studies investigating the performance of concentrated mutual fund holdings in selected industries and degrees of specialisation in socially responsible investments (Gil-Bazo et al., 2010; Huij and Derwall, 2011; Kacperczyk et al., 2005). In all, I contribute to the existing literature by extending the methodologies used and investigate hitherto unexplored financial instruments.

The remainder of this chapter is structured as follows. Chapter 6.2. 'Background' provides the background of investing in renewable energy (indexes). The data is introduced in Chapter 6.3. 'Data Description'. The methods applied to analyse my data are presented in Chapter 6.4. 'Methods'. Chapter 6.5. 'Results' presents my results. My conclusions are in Chapter 6.6.

6.2 Background

I investigate risk deviations between the returns of renewable and conventional energy equity markets such as oil, coal, gas and nuclear energy. There is a vast empirical literature on the

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after the accident relative to utilities without nuclear plants. However, during normal market conditions one would expect the return volatilities of conventional energy companies to be lower. Lower investment risks are also plausible due to the enourmous subventions that go to the conventional energy sector each year (See Table 9 'Worldwide Energy Consumption Subsidies').

[83] The idea that investors care (more) about losses is also compatible with a Behavioural Finance view and the observed cognitive bias of loss aversion (See e.g. Kahneman and Tversky, 1983). From a psychological perspective, loss averse investors strongly dislike losses (Kahneman and Tversky, 1983).

[84] In the context of the Modern Portfolio Theory, and as previously discussed in Chapter 2.6.1. 'Diversification and ESG information', environmental screens (or any ESG screen for that matter) tend to reduce the investible stock universe and leave the investor with a suboptimal portfolio (Markowitz, 1952; Sharpe, 1964). A suboptimal portfolio within the mean-variance efficiency frontier that is tilted towards a less favourable risk-return tradeoff relative to a conventional portfolio without any ESG screens (Renneboog et al., 2008a). Thus, renewable energy equity indexes are thought to underperform relative to conventional energy equity indexes due to a diversification penalty.

role of oil price changes and their impact on the economy (Hamilton, 1983, 2003), developed and emerging stock markets (Asteriou and Bashmakova, 2013; Driesprong et al., 2008; Park and Ratti, 2008), and industry stock market returns (Scholtens and Yurtsever, 2012). Most papers predict a negative relation between rising oil prices and the economy or stock markets for mainly two reasons. First, rising oil prices lead to increases in the production costs of goods and services resulting in lower cash flows for the business and ultimately depreciating stock prices (Kumar et al., 2012). Second, rising oil prices affect discount rates which are used in cash flow calculations to assess the valuation of stock prices[85] (Mohamed, 2012). Recent studies show that the predicted negative relationship is not necessarily homogenous across industries (Mohamed, 2012; Scholtens and Yurtsever, 2012).

I am especially interested in the relationship between renewable energy stock prices and conventional energy stock prices. To date, only a very small number of studies investigate how macroeconomic variables affect renewable energy stock prices. Henriques and Sadorsky (2008) empirically analyse whether the generally accepted view that increasing oil prices positively affect the financial performance of renewable energy companies can be verified. Using vector autoregression methods they establish that a dynamic relation exists between the Wilderhill Clean Energy Index, the Arca Tech 100 Index, and West Texas Intermediate crude oil futures contracts over the period from January 2001 to May 2007. Expanding the empirical analysis to three renewable energy indexes, Kumar, Managi and Matsuda (2012) confirm this positive relationship. Both studies show that oil price changes are a significant driver of renewable energy stock returns, however, other factors such as technology stock prices and interest rates, seem to matter as well. Especially, prices of technology stocks tend to correlate strongly with renewable energy stocks (Sadorsky, 2012a). Two arguments explain the close relationship between technology and renewable energy stocks. First, there are similarities in company size between the two sectors. Renewable energy companies tend to be small start-ups concentrating on specific alternative technologies to produce energy and are thus highly dependent on the success or failure of specific projects, similar to the information technology sector (Sadorsky, 2012a). Second, due to the small size and unexpected outcome of specific stocks, the risk of renewable energy investments is much higher than that of conventional energy producers. However, so far, very little is known about the risk behaviour of international renewable energy equity indexes compared to conventional, fossil-fuel intense energy equity indexes. In particular, the direct

[85] The value of a stock equals the sum of discounted future cash-flows, which are influenced by economic conditions and macroeconomic events such as oil shocks (Mohamed, 2012).

risk relationship between renewable and conventional energy equity indexes is unexplored in the existing literature.

In studying an international sample of renewable and conventional energy equity indexes across regions, I also want to investigate geographical aspects of the risk profiles of my sampled indexes. Geographical investment risks tend to be driven by the resourcefulness of the local natural environment and promotion policies by local governments. The first argument is straightforward: Some countries or regions tend to have more favourable conditions with regard to the availability of natural resources such as oil rich members representing the Organization of Petroleum Exporting Countries (OPEC) (Hamilton, 2009). Similarly, some forms of renewable energy will realise their full potential better in some regions than in others (Iskin et al., 2012). Another influential reason why investment risks might differ geographically are the different approaches taken by governments to promote or hamper conventional and alternative ways of energy production through policies, subsidies, taxes and other regulations (Fischer and Newell, 2008). I also observe shifting investor interest towards risk management and risk reduction, especially due to the aftermath of the 2008 economic downturn. This shift towards improved beta management is generally desired by large institutional investors such as pension funds (Franzen, 2010; McKillop and Pogue, 2010) and more recently, a growing interest from alternative investments such as highly volatile renewable energy companies (Sadorsky, 2012a, b).

This chapter relates to a small number of studies that examine the risks of investing in renewable energy equity indexes. Henriques and Sadorsky (2008) provide evidence that the Wilderhill Clean Energy Index, a renewable energy index, is about 40 percent riskier than the S&P 500, a broad all-industry equity index. Sadorsky (2012b) investigates drivers of systematic risk for renewable energy companies and finds that rising oil prices tend to increase systematic risks (or beta) of renewable energy firms during periods of steep oil price increases. Only moderate oil price increases coupled with rising company sales growth can reduce systematic risks for renewable energy firms. Kumar et al. (2012) and Sadorsky (2012a) find positive and significant correlations between the returns of renewable energy indexes, oil prices and one technology index.

I aim to complement this literature in several ways. First, none of the previous studies directly compares the risk characteristics of renewable with conventional, fossil-fuel intense energy equity indexes. Second, I extend the analyses in the literature by including a very diversified sample of 14 international renewable energy and 18 conventional energy equity indexes. Third, I compare the risk characteristics between renewable and conventional energy equity indexes by using risk measures for relative residual volatilities, which are widely used in practice. Fourth, I introduce an alternative measure to allow for investors' asymmetric risk appetites and tolerance.

6.3 Data Description

6.3.1 Renewable Energy Indexes

I seek to examine the risk relationship between a sample of renewable and conventional energy equity indexes. My sample consists of fourteen renewable energy indexes for which I collect monthly total return data from three different data sources, Thomson Reuters Datastream, Global Financial Data (GFD), and Ardour Global (Alternative Energy Indexes). I restrict my attention to energy indexes which track the performance of energy producing firms, specialised in renewable energy (such as solar, wind, and hydro), alternative fuels (bio-fuels) and related renewable technologies (such as storage and efficiency of renewable energy). In defining whether a company qualifies as renewable, the index providers employ the following three screens: (i) sector, (ii) renewable income, and (iii) liquidity. The sector screen is to rule out any firms not having any business activities related to alternative energy firms. The renewable income screen is to ensure that companies generate sufficient revenues or net income from renewable business activities to be classified as such. In addition, renewable energy index providers use a liquidity screen, either a liquidity ratio (calculated as average 3-month daily trading volume divided by the average 3-month market capitalisation) or minimum trading volume and market capitalisation, to screen out less frequently traded firms.

Panel A of Table 13 summarises how and to what extent each renewable energy index uses the screens. Sector screens vary to some extent. For example, indexes with global investment objectives tend to be broader and less selective in their inclusion of energy businesses. This contrasts with more specialised indexes such as NASDAQ Renewable Edge index, HFRX Alternative Energy, Ardour Global Alternative Energy Solar and S&P Asia Alternative Energy. Table 13 shows that the majority of indexes use a renewable income threshold of over 50 percent, except for Ardour Global Alternative Energy Solar who uses 66 percent of gross revenues or net income. Finally, approximately half of the sample uses minimum average trading volumes of 1 million USD and average free-float market capitalisations of 100 million USD. The sample of renewable energy indexes tracks the performance of renewable energy firms in various regions such as Asia, Europe, US and Worldwide.

Panel A of Table 13 also presents annualised summary statistics for the full sample period of fourteen renewable energy indexes. I find annualised average returns of ten renewable energy indexes to be negative. This is in line with previous studies (Bohl et al., 2013).

However, DaxGlobal Alternative, S&P Global Alternative, NASDAQ Renewable Edge and European Renewable Energy, generate low, but positive annualised average returns. Although absolute positive performances of these four renewable energy indexes are not dominated by one specific region (one European, one US and two Global indexes), it appears that specific sub-segments of renewable energy are much more attractive than others. I argue that the observed positive performance specifically relates to the industry rather than to geography. To give one example, the pure solar energy index (AGAE Solar) produced the lowest annualised return combined with the highest volatility and the worst loss. In contrast, the more specific and technology focused NASDAQ Renewable Edge generates, on average, a positive return with the lowest maximum loss and volatility. This finding is in line with that of Statman (2006), who compared socially responsible with conventional indexes.

Total volatility, proxied by the annualised standard deviation, shows that all renewable energy indexes are volatile investments indeed. Annualised standard deviations range from 35 to 40 percent. In contrast, standard deviations for conventional oil and gas indexes cluster at around 15 to 30 percent (see Panel B of Table 13). Annualised semi-standard deviations and lower partial moments are on average 7 to 10 percent higher than for traditional energy companies. Previous studies confirm high volatilities and Sadorsky highlights this by pointing out that "Renewable Energy companies are often among the riskiest types of companies to invest in" (Sadorsky, 2012b:39). They are risky for mainly two reasons. First, renewable energy companies tend to be small start-up types of businesses that concentrate their resources to develop one specific type of renewable energy technology. From an investor perspective, the uncertainty attached to one project is very high, as its success or failure wholly depends on individual projects. Adding to uncertainty, it is questionable which of the alternative energy technologies will penetrate the market in the future. Second, due to relatively high up-front investment costs, the renewable energy sector has received governmental support in various industrial countries (Morris et al., 2012). One example is the European solar sector, where the dominant method of subsidies are "feed-in-tariffs" and where the growth of the overall Photovoltaics market was "largely driven by policy investments" (Lüthi and Wüstenhagen, 2012: 1001). Notable risks of policy investing are the administrative process, policy stability, and support duration. Thus, it is not surprising that high uncertainty about the outcome of policy investing requires a risk premium by investors and justifies my findings of high absolute volatilities across different renewable energy indexes. Descriptive statistics such as the third and fourth moments show additional characteristics of renewable energy return distributions. The sample skewness is about -1 for all renewable energy indexes and indicates return distributions skewed to the left. The sample Kurtosis strongly exceeds three, which implies fat-tailed distributions. I reject the hypothesis of normality from the Jarque-Bera test statistic for all returns of the renewable indexes.

Table 13: Renewable and Conventional Energy Sample and Summary Statistics

ID	Clean Energy Index	From	To	Obs	Ann. Mean	Ann. Median	Ann. Std.Dev	Jarque-Bera	Region	Clean Income Screen: Income Ratio (Ann.)	Liquidity Ratio^	Liquidity Screen: Trading Volume (Min)	Liquidity Screen: Market Cap (Min)	Index Impurity: % of Non-Renewable firms listed
Panel A: Renewable Energy														
C1	Ardour Global Alt. Energy	31/12/1999	28/02/2013	158	-0.0515	0.1755	0.3795	66.47***	World	> 50% of gross revenues	>25%			6%
C2	Ardour Global Alt. Energy Extra Liq.	31/01/2000	28/02/2013	157	-0.0790	0.1058	0.3869	82.58***	World	> 50% of gross revenues	>25%			13%
C3	Ardour Global Alt. Energy N. America	31/12/1999	28/02/2013	158	-0.0737	0.0019	0.3977	25.20***	N-America	> 50% of gross revenues	>25%			7%
C4	Ardour Global Alt. Energy Europe	30/06/2005	28/02/2013	92	-0.0950	0.1371	0.4063	56.24***	Europe	> 50% of gross revenues	>25%			0%
C5	Ardour Global Alt. Energy Solar	31/12/2004	28/02/2013	98	-0.1086	0.2196	0.5463	22.26***	World	> 66% of gross revenues		> $1 million		0%
C6	Daxglobal Alternative Energy	29/12/2000	28/02/2013	146	0.0114	0.1545	0.2839	20.40***	World	> 50% of gross revenues		$1.2 million	$150 million	33%
C7	World Renewable Energy (Renixx)	31/01/2002	28/02/2013	133	-0.1567	0.1251	0.3943	26.92***	World	> 50% of gross revenues			Highest f-f mkt. cap.	7%
C8	S&P Global Alternative Energy	28/11/2003	28/02/2013	111	0.0198	0.2274	0.2747	134.20***	World	> 50% of gross revenues		$3 million	$300 million	46%
C9	S&P Asia Alternative Energy	30/06/2008	28/02/2013	56	-0.1302	-0.0810	0.3570	5.96*	Asia	Not available		> $2 million^^	> $250 million	45%
C10	HFRX Alternative Energy	31/01/2006	28/02/2013	111	-0.0714	0.2146	0.3618	181.09***	World	Not available		Not available	Not available	Not available
C11	NASDAQ Renewable Edge US Liq.	30/11/2006	28/02/2013	85	0.0328	0.0723	0.1772	99.08***	US	> 50% of gross revenues		100,000 shares	$150 million	0%
C12	S&P Global Renewable Energy	28/11/2003	28/02/2013	75	-0.0880	0.2122	0.3569	28.60***	World	> 50% of gross revenues		$3 million	$300 million	18%
C13	European Renewable Energy	30/09/2003	31/01/2012	100	0.0108	0.1831	0.4110	85.21***	Europe	> 50% of gross revenues		10 largest in sector	10 largest in sector	0%
C14	Wilderhill New Energy Global Inn.	29/12/2000	28/02/2013	146	-0.0090	0.1638	0.2976	140.73***	US	> 10% to > 50% of market value		$1 million	$100 million**	8%
Panel B: Conventional Energy														
D1	MSCI World Oil, Gas & Cons. Fuels	30/12/1994	28/02/2013	158	0.0824	0.1196	0.1982	5.61*	World					
D2	FTSE World Oil & Gas	30/12/1992	28/02/2013	158	0.0857	0.1214	0.2042	5.06*	World					
D3	ThomsonReuters Global Oil & Gas	30/12/1992	28/02/2013	158	0.0762	0.1234	0.1984	5.55*	World					
D4	Dow Jones Titans Oil & Gas 30	30/12/1991	28/02/2013	158	0.0761	0.1239	0.2108	5.92*	World					
D5	MSCI World Metals & Mining	30/12/1994	28/02/2013	158	0.0803	0.1721	0.2926	143.83***	World					
D6	S&P 500 Oil, Gas & Cons. Fuels	30/09/1989	28/02/2013	158	0.0778	0.0865	0.1948	6.83**	US					
D7	Dow Jones US Int. Oil & Gas	29/02/1992	28/02/2013	158	0.0687	0.0540	0.1836	2.65	US					
D8	NYSE Arca Oil	16/11/1984	28/02/2013	158	0.0734	0.1157	0.2191	2.94	US					
D9	Dow Jones US Coal	02/01/1992	28/02/2013	152	0.0386	0.1417	0.4870	12.46***	US					
D10	EURO STOXX Oil & Gas	31/12/1992	28/02/2013	158	0.0249	0.0980	0.1850	4.96*	Europe					
D11	Dow Jones Europe Oil & Gas	31/12/1992	28/02/2013	158	0.0163	0.0662	0.2197	7.49**	Europe					
D12	Daxglobal Coal Perf.	28/09/2001	28/02/2013	137	0.1258	0.2029	0.3757	37.76***	World					

Table 13: Renewable and Conventional Energy Sample and Summary Statistics

ID	Clean Energy Index	From	To	Obs	Ann. Mean	Ann. Median	Ann. Std.Dev	Jarque-Bera	Region	Clean Income Screen	Liquidity Screen			Index Impurity
										Income Ratio (Ann.)	Liquidity Ratio^	Trading Volume (Min)	Market Cap (Min)	% of Non-Renewable firms listed
D13	Daxglobal Nuclear Energy Perf.	28/09/2001	28/02/2013	137	0.0024	0.0543	0.2621	1.52	World					
D14	Daxglobal Asia Oil & Gas Perf.	28/09/2001	28/02/2013	137	0.1773	0.0529	0.2714	209.61***	Asia					
D15	DJGL Asia Pac. Dev. Int. Oil & Gas	30/03/2001	28/02/2013	143	0.0121	0.0118	0.3292	1.54	Asia					
D16	DJGL Asia Pac. Dev. Oil & Gas	30/03/2001	28/02/2013	158	0.1198	0.1678	0.2740	83.96***	Asia					
D17	HFRX EH Energy Basic Materials	31/01/2005	28/02/2013	97	0.0423	0.0762	0.1377	79.03***	World					
D18	NASDAQ/SIG Oil Explor. & Prod.	28/06/2005	28/02/2013	92	0.0849	0.2153	0.3354	7.52**	US					

Notes: This table reports descriptive statistics and general information for each of the fourteen renewable and eighteen conventional energy indexes. The first two columns display my ID and full index name. The next three columns indicate data availability. Columns 6 to 9 display descriptive statistics. I compute descriptive statistics over the sample period December 1999 to February 2013. Note that mean, median, and standard deviation are annualized numbers. I annualize my monthly estimates by multiplying that number with twelve. Standard deviations are multiplied with the square root of twelve. Column 10 represent investmen regions of each index. The next four columns summarise three most frequently used screens for identifying eligible energy companies by clean energy index providers. First, index providers calculate clean income screen as the annual income ratio of gross revenues from renewable sources to total gross revenues. At least 50 percent of a companies' income has to be generated through clean business activities. Second, liquidity screens are based on either liquidity ratios (trading volume to market capitalization) or a combination of minimum trading volume and market capitalization. Third, sector screens exclude companies with activities other than sourcing energy from renewable activities. All three screens are equally important in excluding non-compliant companies. The final column shows whether and to what extent the indexes are "pure play". For this, I manually check the holdings of each index and count companies that are considerably or partially operating in the coal, metals & mining, nuclear, and oil & gas sector. I report proportions of impure companies to total companies in each respective index. ^ Defined as average 3-month daily trading volume divided by the average 3-month market capitalization in USD. ^^ Three-month average market capitalisation. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

6.3.2 Conventional Energy Indexes

My aim is to compare the risk characteristics of renewable energy indexes with conventional energy indexes. Thus, I collect total monthly return data for 18 conventional energy indexes with similar characteristics relative to my sample of renewable energy indexes from Thomson Reuters Datastream and Global Financial Data. Panel B of Table 13 lists my sample of 18 conventional energy indexes and their characteristics. I restrict my sample to oil and gas, coal and nuclear energy indexes, to provide a direct counterpart to my sample of renewable energy indexes. I broadly select conventional energy indexes according to four criteria: (a) index factsheet benchmarks, (b) index family, (c) investment objective/market, and (d) age. Panel B of Table 13 shows that I choose my sample of 18 conventional energy indexes according to similar characteristics that correspond to renewable energy index characteristics such as time frame and regional characteristics. In other words, I select the same geographical regions for my conventional energy indexes which are Asia, Europe, US and Worldwide. The only noteworthy difference between my two samples is that, generally, conventional energy indexes tend to be somewhat older than their renewable energy counterparts. This finding is intuitive as most renewable energy companies have only developed in the last decade.

Panel B of Table 13 reports annualised summary statistics for my full sample of conventional energy indexes over the period from December 1999 to February 2013. Average annualised returns for all eighteen indexes are positive. I observe that fifteen out of eighteen conventional indexes produce mean returns of at least seven percent. Four conventional indexes generate annualised returns between one and four percent, and one index generates 0.24 percent. Compared to my sample of renewable energy firms, the conventional sample performs much better. Total volatilities indicate that conventional energy firms tend to be less volatile than their renewable counterparts during my sample period. For the majority, annualised return standard deviations range from 15 to 30 percent. This is in line with findings of Sadorsky (2001) and Boyer & Filion (2007). Using multifactor oil beta models, they investigate the expected return on Canadian oil companies and find the oil and gas industry to be somewhat less risky than the Canadian market. My computed total volatilities for conventional energy firms are in line with annualised price volatilities for crude oil, which was found to be about 25 percent per annum (Sadorsky, 2001).

From an investor perspective, these findings suggest that the oil sector carries less systematic risk on an absolute basis. At this point, I cannot make any assumptions about relative volatilities between conventional and renewable energy firms. Neither can I state how their downside risk behaves relative to renewable energy producers. The next chapter describes the methods used to facilitate a direct comparison of the volatility and downside risk of renewable and conventional energy stock indexes.

6.4 Methods

6.4.1 Renewable vs. Conventional Energy Stock Index Returns

The goal of this chapter is to compare the risk profiles of renewable and conventional equity index returns. In particular, I aim to investigate what drives the risk behaviour in international renewable energy firms. To facilitate a direct comparison, I compute pair-wise correlations and tracking errors of the returns of renewable and conventional energy indexes. Table 14 shows correlation coefficients between the returns of each of the fourteen renewable and eighteen conventional energy indexes. Over the entire sample period, both sets of indexes show strong positive correlations, ranging from 28 to 84 percent. This suggests that there are similarities between the composition of renewable and conventional indexes, and some scope for diversification.

I find region-specific renewable energy indexes correlate strongest with regional-themed conventional energy indexes. For example, S&P Asia Alternative has the strongest exposure to MSCI Metals and Mining (64 percent) and DJGL Asia Int. Oil and Gas (59 percent). Another example is the European Renewable Energy index which correlates strongly with DJ Europe Oil & Gas (72 percent). Furthermore, I arrive at high correlations for a specific sub-set of index pairs. In particular, the four renewable energy indexes with positive mean returns tend to be highly correlated to the identical set of seven conventional energy indexes. The correlations range between 70 and 85 percent. I find correlations of NASDAQ Renewable Edge and S&P Global Alternative with conventional energy counterparts to be the highest. Given these strong correlations, I assume that renewable energy indexes are more likely to have a positive mean return if they correlate stronger with conventional energy indexes. An explanation for this strong relation is the liberal renewable income screen of 50 and 66 percent. Such screens aim to filter out energy companies that rely heavily on burning fossil fuels to generate energy. However, after investigating return differences of renewable and conventional energy indexes, I observe that almost all of the renewable energy indexes correlate strongly and significantly with their conventional counterparts. It seems that the screening is not as rigorous as suggested and that many conventional energy producers, manage to be listed on renewable energy indexes. The final column of Table 13, 'Index Impurity: % of Non-renewable firms listed', illustrates that many conventional energy producers (particularly in the gas sector) happen to be listed on renewable energy indexes due to their broader definition and understanding of 'Renewable Energy'. For example, the S&P Global Alternative Index, lists the highest number of non-renewable firms with 46 percent. Other renewable energy indexes such as the Daxglobal Alternative Energy has a proportion of 33 percent of non-renewable firms. Among the full sample, only four renewable energy indexes are pure plays, and without the influence of non-renewable firms.

Table 14: Correlations

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18
C1	0.54*	0.57*	0.57*	0.60*	0.61*	0.49*	0.43*	0.51*	0.56*	0.46*	0.53*	0.65*	0.56*	0.53*	0.44*	0.50*	0.69*	0.69*
C2	0.55*	0.58*	0.58*	0.61*	0.62*	0.49*	0.42*	0.53*	0.59*	0.49*	0.56*	0.64*	0.54*	0.54*	0.42*	0.51*	0.67*	0.68*
C3	0.46*	0.49*	0.48*	0.51*	0.51*	0.42*	0.36*	0.43*	0.53*	0.43*	0.44*	0.65*	0.54*	0.53*	0.36*	0.40*	0.67*	0.69*
C4	0.75*	0.77*	0.78*	0.78*	0.79*	0.69*	0.61*	0.74*	0.64*	0.57*	0.76*	0.59*	0.52*	0.48*	0.65*	0.79*	0.68*	0.65*
C5	0.67*	0.68*	0.70*	0.70*	0.70*	0.60*	0.52*	0.67*	0.60*	0.55*	0.67*	0.60*	0.54*	0.53*	0.53*	0.70*	0.61*	0.59*
C6	0.74*	0.76*	0.77*	0.77*	0.74*	0.71*	0.65*	0.74*	0.65*	0.61*	0.73*	0.62*	0.54*	0.52*	0.52*	0.71*	0.75*	0.70*
C7	0.58*	0.60*	0.61*	0.61*	0.60*	0.56*	0.50*	0.59*	0.50*	0.56*	0.56*	0.55*	0.56*	0.55*	0.43*	0.59*	0.62*	0.60*
C8	0.80*	0.81*	0.83*	0.82*	0.85*	0.72*	0.63*	0.78*	0.71*	0.64*	0.80*	0.69*	0.66*	0.53*	0.61*	0.83*	0.76*	0.72*
C9	0.48*	0.49*	0.50*	0.49*	0.64*	0.43*	0.41*	0.47*	0.42*	0.28	0.44*	0.42*	0.45*	0.41*	0.59*	0.54*	0.43*	0.41*
C10	0.72*	0.74*	0.76*	0.75*	0.78*	0.65*	0.57*	0.71*	0.66*	0.55*	0.73*	0.63*	0.53*	0.53*	0.56*	0.77*	0.67*	0.66*
C11	0.77*	0.77*	0.79*	0.78*	0.85*	0.68*	0.57*	0.73*	0.72*	0.64*	0.76*	0.76*	0.63*	0.45*	0.65*	0.80*	0.76*	0.71*
C12	0.75*	0.76*	0.79*	0.78*	0.77*	0.69*	0.58*	0.76*	0.69*	0.62*	0.74*	0.71*	0.60*	0.57*	0.60*	0.77*	0.68*	0.71*
C13	0.71*	0.73*	0.73*	0.74*	0.73*	0.66*	0.60*	0.71*	0.61*	0.53*	0.72*	0.57*	0.48*	0.47*	0.57*	0.75*	0.66*	0.61*
C14	0.71*	0.73*	0.74*	0.74*	0.80*	0.65*	0.57*	0.70*	0.65*	0.58*	0.71*	0.66*	0.59*	0.55*	0.47*	0.75*	0.73*	0.69*

Notes: This table reports pair-wise correlation coefficients between the returns of renewable and conventional energy indexes. "*", indicates statistical significance at the 1% significance level.

6.4.2 *Conventional Tracking Error*

Investment risk is the unexpected future outcome of price changes in an investors' (stock) holdings (Welch, 2011). Variability of price changes is therefore regarded as a fundamental source of investment risk. Risk can be idiosyncratic (firm-specific) or systematic (market-wide) and absolute or relative (see Eling and Schuhmacher, 2007; Ross et al., 2008 for a comprehensive overview of risk measures). The simplest methods for assessing idiosyncratic investment risks are measures such as variance, standard deviations, semi-standard deviations, Sharpe ratios, which compare the variability within one investment. In contrast, popular methods to evaluate systematic investment risk are Beta (estimated using the capital asset pricing model), Treynor Ratio, and Lower Partial Moments (if the benchmark target return is a broad market return). Systematic risk measures compare return variability between two or more investments, generally in relation to a benchmark such as global or country stock indexes. Following my assessment of absolute risk properties between renewable and conventional energy equity indexes in Table 15, I continue my empirical risk analysis on relative risk measures, in particular, tracking error volatilities. The traditional tracking error is defined as the standard deviation of the time-series difference between a portfolio return and a selected benchmark portfolio return (Ammann and Zimmermann, 2001; Cremers and Petajisto, 2009). To give one example in how to interpret the tracking error in statistical terms, a tracking error of 5 percent, assuming a normal distribution [86] with mean 0 and standard deviation of 1, will have a 68 percent chance (one standard deviation) of losing or gaining up to 5 percent in excess of benchmark returns (Polakow, 2011). Tracking error volatility as a relative risk measure can be used for three purposes. First, it is used to determine the level of portfolio risk (Ammann and Zimmermann, 2001). Second, it is used to value active management. In other words, it describes to what extent a fund manager's portfolio deviates from a given benchmark portfolio. Third, it is an alternative risk-adjusted performance measure (Treynor and Black, 1973).[87]

[86] Excess return data of my sample is leptokurtic rather than normally distributed. Assuming normally distributed excess returns when they are leptokurtic could lead to an under-estimation of the tracking error (Huisman et al., 1998). However, a potential under-estimation of the tracking error would affect all sampled energy indexes to the same extent. For my sample this means that both, renewable and conventional energy indexes would be affected to the same degree.

[87] Several studies discuss the "tracking-error problem" or "optimization problem", which aims to reduce tracking error volatility when replicating a selected benchmark given security selection restrictions (see e.g. Jorion, 2003; Stoyanov et al., 2008). I do not enter this discussion, but focus on the tracking error as an index/portfolio risk measure.

I will use tracking error volatility as my preferred risk measure for the following reasons: First, due to their simplicity and intuitive appeal, tracking errors are widely used risk measures in practice. It is "one of the main industry standards as a measure of relative risk" (Berkelaar et al., 2006:64). Furthermore, many institutional investors explicitly state a maximum acceptable tracking error in mandates to limit investment risks of their fund managers (Maspero and Saita, 2005). This allows us to draw practically relevant conclusions regarding the risk behaviour of renewable and conventional energy investments. Finally, studies show that tracking error volatility accurately predicts investment risks for both small and large portfolios in the short-term (Scowcroft and Sefton, 2001). Critics of the tracking error mainly argue against its ability to assess and compare the financial performance of competing actively managed funds (Cremers and Petajisto, 2009; Huij and Derwall, 2011; Israelsen and Cogswell, 2007). They feel it is not a sufficiently robust indicator for ranking and selecting superior investments. In particular, Huij & Derwall (2011), and Israelsen & Cogswell (2007) argue that tracking error should not be used as the only indicator for financial performance. These critiques are mainly targeted at the ability to compare financial performance across mutual funds. In my study, tracking error is expressed as the residual volatility of renewable energy index returns in excess of conventional energy index returns, which emphasise bets on systematic risks in the conventional energy industry.

Directly comparing renewable with conventional energy index returns is sensible from a research design and a practical perspective (see also Schröder, 2007). A direct comparison between the risks of renewable and conventional energy indexes is also intuitive from a practical perspective, because trustees of large institutional funds such as pension funds tend to have very specialised investment mandates with selected investment funds. The contracted mutual funds can have different investment styles (such as growth, emerging markets, long/short) that require specialised benchmarks, rather than a broad and general equity benchmark. Thus, the selection of appropriate benchmarks in itself requires some expertise (Ansell et al., 2003; Bailey, 1992). I choose to benchmark my sample of renewable energy indexes with conventional energy indexes to mimic a specialised energy mandate from investors. I obtain the tracking error by (i) regressing excess returns of renewable energy indexes on conventional energy indexes and (ii) computing the standard deviation of the resulting regression residual. Thus, I compute the traditional regression-based tracking error[88] (*TE*) as shown in Equation (15) and (16):

$$R_{clean,t} - R_{f,t} = \alpha_{clean} + \beta_{clean}(R_{conventional,t} - R_{f,t}) + \varepsilon_{clean,t} \qquad (15)$$

$$TE = \sigma(\varepsilon_{clean,t}) \qquad (16)$$

where,

$R_{f,t}$ = Risk-Free Rate

$R_{clean,t}$ = Return on Clean Energy Index i

$R_{conventional,t}$ = Return on Conventional Energy Index i

$\varepsilon_{clean,t}$ = Residual Clean Energy Index

$\sigma(\varepsilon_{clean,t})$ = Standard Deviation of Residual

I will estimate Equation (15) using ordinary least squares and Newey-West corrected standard errors, which are robust to heteroskedasticity and serial correlation. The interpretation of tracking error is straightforward. High (low) tracking errors indicate large (small) return deviations from a portfolio to its benchmark and vice versa. In the context of this chapter, high tracking errors increase relative return volatility of renewable energy firms compared to conventional energy firms, whereas a low tracking error results in a reduction of the relative return volatility of the firms in the renewable energy index.

6.4.3 Downside Tracking Error

Several studies assert that risk-averse investors are more concerned about how much they can lose versus how much they can profit from their investments (Alles and Murray, 2013; An et al., 2013). According to the principle of Safety First, investors try to minimise the probability of catastrophic events to shelter their wealth (Roy, 1952). This phenomenon has been widely recognised and can also be explained from a behavioural perspective (Kahneman and Tversky, 1979) which suggests that people do not always exhibit rational behaviour when making decisions under risk. For example, Kahneman and Tversky (1979) show that people are loss averse, a phenomenon where investors are reluctant to sell stocks that lose value (Shleifer, 2000). People also tend to systematically over-estimate probability outcomes of

[88]Some studies use a measure labelled *Active Share*, which simply computes "the fraction of the portfolio that is different from the benchmark index" (Cremers and Petajisto, 2009: 3330). I refrain from computing *Active Share* for two reasons. First, I do not intend to assess active management. Second, in order to compute *Active Share*, holdings data is necessary, which I do not have available. Thus, I limit my study to computing tracking error in the traditional way.

future uncertain events, which results from emphasising on recent historical events that may have resulted by chance alone and disregarding events over longer past periods.

Traditional tracking errors from Equation (16) do not account for investors' asymmetric risk tolerance because the volatility is computed as the standard deviation and therefore assumed to be symmetric. In light of the convincing evidence that investors perceive risk differently, the major drawback of the standard deviation, as a proxy for volatility, is that it measures upside and downside volatilities equally. In order to overcome this shortcoming, I modify the traditional tracking error. My modified tracking error acknowledges the fact that investors have different risk appetites and will worry much more about losses than about gains. I implement the asymmetric risk tolerance by following Markowitz's (1959) recommendation to use semi-variance in the denominator, instead of the standard deviation. The advantage of the semi-variance is that it better captures downside volatilities which are of greater concern to risk-averse investors. More specifically, I develop an alternative to the traditional regression-based tracking error, which accounts for the asymmetric risk tolerance of investors. The *Downside Tracking Error* measures residual return volatilities below the mean. More specifically, the downside tracking error increases my understanding of the magnitude of below average volatilities relative to a benchmark.

I obtain the downside tracking error by (i) regressing excess returns of renewable energy indexes on conventional energy indexes and (ii) computing the semi-standard deviation of the resulting regression residual. Thus, I compute the regression-based downside tracking error TE_{DOWN} as shown in Equations (17) and (18).

$$R_{clean,t} - R_{f,t} = \alpha_{clean} + \beta_{clean}(R_{conventional,t} - R_{f,t}) + \varepsilon_{clean,t} \tag{17}$$

$$TE_{DOWN} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}[\min(\varepsilon_{c,t} - \overline{\varepsilon}_{c,t}, 0)]^2}\,(\varepsilon_{clean,t}) \tag{18}$$

where,

$\varepsilon_{c,t} =$ Residual Clean Energy Index

$\overline{\varepsilon}_{c,t} =$ Average Residual of Clean Energy Index

The interpretation of the downside tracking error from Equation (18) is very similar to the conventional tracking error, which I have discussed in the previous chapter. High (low) downside tracking errors indicate large (small) below mean return deviations from a portfolio to its benchmark and vice versa. In other words, high downside tracking errors increase relative downside return variance of renewable energy firms compared to conventional energy firms, which makes them very risky investments. I expect to find even higher downside tracking errors between renewable and conventional energy index returns than with the traditional tracking error.

6.5 Results

I examine the riskiness of renewable and conventional energy index returns by investigating how far the volatility of returns deviates from one another. I begin my discussion of investment risks, proxied by traditional and downside tracking errors, for renewable energy and conventional energy equity indexes and conclude by contrasting the two.

6.5.1 Renewable Energy

Table 15 reports my regression results for the traditional tracking error from Equations (15) and (16). I observe traditional tracking errors of about 2 to 13 percent for all renewable energy indexes on a monthly basis. Asian, European, North American, and Global renewable energy equity indexes have positive tracking error volatility. This means that their total volatility is larger than that of the conventional energy firms. To be specific, I find for about 70 percent of my sample of renewable energy indexes that they are more volatile than their conventional energy peers. Similarly, when using my adjusted measure for relative volatilities, my results show that downside tracking errors are positive and tend to be somewhat larger in magnitude than traditional tracking errors. Downside tracking error volatilities range from 2.5 to 15.4 percent on a monthly basis. This finding indicates that, on average, downside variance is greater and that renewable energy indexes tend to be more volatile than traditional energy index benchmarks.

I argue that there are three reasons behind the relatively high volatilities for renewable energy indexes. First, as previous studies note, renewable energy companies are risky because they seem to relate very closely to technology-intensive companies due to the similarities in their core businesses, which is to develop innovative technologies to produce renewable sources of energy (Sadorsky, 2012b). Second, renewable energy index returns also are driven by changes in macroeconomic factors such as carbon and oil prices[89]. Particularly the carbon price, as a fundamental influence to stock returns of renewable energy companies, has been very low during the second phase of the EU ETS and arguably appears to be

[89] Kumar et al. (2012) test the contemporaneous relationship between carbon prices and renewable energy prices and find carbon prices to be significantly related to renewable energy prices, using a multifactor model. While the carbon price correlates negatively with the returns of the Wilderhill New Energy Global Innovation Index and the S&P Global Clean Energy Index, it correlates positively with the Wilderhill Clean Energy Index (Kumar et al., 2012).

systematically undervalued (Creti et al., 2012). During the first phase of the EU ETS, generous permit allocations depressed the carbon price even further to almost zero Euros in 2007, down from about 20 Euros per ton of carbon dioxide at the beginning of the scheme in 2005 (Ellerman and Buchner, 2008). Clearly, the carbon price measured by the EU ETS applies to carbon emitted in European countries, as a truly global carbon emission scheme does not exist, at this moment in time. However, recent mandatory regional developments in North America and Asia show that more governments are willing and committed to put a price on carbon (Haug et al., 2014). For example, the Regional Greenhouse Gas Initiative was the first mandatory carbon emission trading scheme in the US and covers companies in nine[90] federal states since 2009. This was followed by the Western Climate Initiative, a carbon trading system covering the four[91] largest Canadian provinces and California in the US (Haug et al., 2014). Mandatory emission trading schemes also exist in Asia since 2010. Japan and Korea (being the second biggest after the EU ETS) were the first Asian countries to launch such schemes, with China's mandatory ETS following in 2016 (Haug et al., 2014). Third, although public capital investments in the renewable energy sector are crucial, they have been stagnating due to the lasting recession which restrained governments to continue with public funding for that sector (International Energy Agency, 2012, 2013). In the recent past, major capital investments for the construction and development of renewable energy technologies have originated from public finance. Yet, governments find it increasingly difficult to support the sector due to the lasting recession. A recent report highlights this situation: "The current economic crisis has reduced the amount of public finance available to support low-carbon energy technologies" (International Energy Agency, 2012: 68). With lacking capital investments from public finances and insufficient demand from the private sector, uncertainty will remain high and as a result investment risks as well.

On closer inspection of my empirical results, I find four out of fourteen (about 30 percent) renewable energy indexes to have substantially lower tracking errors (less return volatility), these are Daxglobal Alternative, S&P Global Alternative, Nasdaq Renewable Edge, and S&P Global Renewable Energy. The first three indexes invest in global renewable energy businesses and the last one in purely US-based renewable energy technology firms. Tracking errors for those four range from 2.68 to 8.46 percent. Surprisingly, the returns of these four indexes have been previously found to generate positive annualised mean returns

[90] Including Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermon (Haug et al., 2014).
[91] British Columbia, Manitoba, Ontario, and Québec (Haug et al., 2014).

as well as correlate more strongly with traditional energy indexes (see Panel A of Table 13 and Table 14, respectively). Interestingly, Nasdaq Renewable Edge, a highly technology oriented index, reports the lowest tracking error volatility among my sample of renewable energy indexes. Sector screens, highlight that this index only includes renewable energy firms from three very specific business areas including solar photovoltaics, biofuels, and advanced batteries. As such, these findings suggest that more concentrated renewable energy indexes tend to have lower relative investment risks compared to broader renewable energy indexes. Although this finding contradicts Modern Portfolio Theory and what would be expected of a less diversified portfolio, recent related studies on portfolio concentration in the mutual fund environment show that investment managers with more concentrated holdings in specific market sectors report better financial performance than broadly diversified funds (Huij and Derwall, 2011; Kacperczyk et al., 2005). Furthermore, Statman (2006) finds industry concentration to be the major reason for low tracking errors between socially responsible and conventional equity indexes.

6.5.2 Conventional Energy

The regression results in the previous chapter reveal that major renewable energy indexes tend to be more risky relative to conventional (fossil-fuelled) ones. In Table 15, I report regression results for the traditional tracking error from Equations (15) and (16) and for the downside tracking errors from Equations (17) and (18).

Across my full sample of conventional energy indexes, I observe that 13 out of 18 energy indexes have monthly pair-wise tracking errors of 9 percent or more. To interpret tracking error volatilities from the perspective of a conventional energy investor, rather than a renewable energy investors (see previous chapter), higher pair-wise tracking errors actually indicate lower investment risks for conventional energy investors. The reason is that my dependent variables are renewable energy index returns and my independent variable are conventional energy index returns. Higher pair-wise tracking error volatilities should therefore be interpreted as high for renewable energy indexes relative to conventional energy indexes. My finding supports the argument that major conventional energy indexes have lower investment risks relative to renewable energy indexes. Similarly, downside tracking error estimates support my finding of lower downside tracking error volatilities for conventional energy indexes, while being generally somewhat larger in magnitude than the traditional risk measure.

Based on my findings, there could be two plausible explanations why the return volatilities of conventional fossil-fuelled energy producers have been historically lower relative to the returns of renewable energy firms. First, lower return volatility in the conventional energy sector such as oil and gas producers is driven by the level of capital investment (Sadorsky, 2001). Historically, as Sadorsky (2001) notes, capital investments to develop more advanced energy technologies, have been much higher in the oil and gas sector than in the renewable energy sector. A direct relationship between capital investment and return volatility was documented by Haushalter et al. (2002), who find that increased capital investment reduces stock return volatility. This means, when capital investments to the oil and gas sector remain high, then this could reduce the return volatilities of oil and gas companies. Second, an influential driver that could lower return volatilities of conventional (fossil-fuelled) energy companies is a high price for crude oil. Several studies have found that crude oil positively impacts on the stock returns of conventional energy producers, whereby increasing oil prices result in higher profit margins/cash flows for conventional energy companies and ultimately materialise in a higher stock price (Mohamed, 2012; Scholtens and Yurtsever, 2012). It is evident that during my sample period the oil price was on a steady increase. An increasing oil price could have been driven by strong demand, but it seems likely that the enormous subventions to the coventional fossil-fuel sector (see Table 9 'Worldwide Energy Consumption Subsidies') have played its role as well. For example, since 2009, the oil and gas sector has received at least 5 times the amount of subsidies relative to the renewable energy sector. Another indication for conventional energies' lower return volatilities can be found in the volatility of the crude oil price. As the volatility of the firm is largely driven by changes in the crude oil price and the volatility of crude oil has been found to be around 25 percent, energy producers' stock return volatility is expected to be about the same (Boyer and Filion, 2007; Sadorsky, 2001).

I further partition Table 15 into four panels in order to group renewable and conventional energy indexes according to geographic characteristics. Panel A of Table 15 contrasts different geographic regions of renewable and conventional energy indexes. Panel B, C and D compare European, North American and Asian energy equity indexes, respectively. I find North American energy equity indexes to experience the lowest tracking and downside tracking errors. This implies that renewable and conventional energy indexes have more similar return volatility patterns in North America than in any other region. Global energy indexes have the second lowest risk profile. European and Asian conventional energy equity indexes have lower return volatilities, i.e. lower investment risk compared to Global and North American energy equity indexes. In particular, Euro Stoxx Oil & Gas and DJ Europe Oil & Gas, have the lowest investment risk compared to their European renewable energy peers, AGAE Europe and European Renewable Energy. Comparing average investment risks across all geographic regions and the full sample of 18 conventional energy indexes, I find four indexes to have the lowest return volatilities. In particular, these are Euro Stoxx Oil & Gas, HFRX EH Energy, DJ US Int. Oil & Gas, and Daxglobal Asia Oil & Gas.

Table 15: Tracking Error and Downside Tracking Error Regressions

		Global								Europe		North America					Asia		
		D1	D2	D3	D4	D5	D12	D13	D17	D10	D11	D6	D7	D8	D9	D18	D14	D15	D16
Panel A: Global																			
C1	TE	0.0923	0.0899	0.0903	0.0880	0.0870	0.0745	0.0811	0.0729	0.0972	0.0929	0.0955	0.0991	0.0940	0.0861	0.0743	0.0827	0.0902	0.0945
	TE Down	0.0931	0.0897	0.0903	0.0878	0.0846	0.0819	0.0903	0.0905	0.1030	0.0984	0.0969	0.1035	0.0952	0.0903	0.0867	0.1010	0.0981	0.0963
C2	TE	0.0932	0.0907	0.0908	0.0888	0.0876	0.0772	0.0843	0.0767	0.0973	0.0924	0.0972	0.1012	0.0947	0.0846	0.0773	0.0840	0.0928	0.0959
	TE Down	0.0941	0.0913	0.0941	0.0905	0.0852	0.0852	0.0947	0.0948	0.1065	0.0999	0.0994	0.1051	0.0970	0.0954	0.0880	0.0974	0.1066	0.0981
C5	TE	0.1179	0.1152	0.1131	0.1131	0.1130	0.1265	0.1332	0.1251	0.1316	0.1175	0.1259	0.1353	0.1175	0.1259	0.1261	0.1338	0.1333	0.1129
	TE Down	0.1200	0.1142	0.1146	0.1138	0.1146	0.1500	0.1539	0.1432	0.1520	0.1230	0.1269	0.1445	0.1191	0.1396	0.1342	0.1541	0.1411	0.1151
C6	TE	0.0549	0.0528	0.0526	0.0520	0.0547	0.0635	0.0680	0.0563	0.0649	0.0564	0.0580	0.0622	0.0550	0.0617	0.0594	0.0689	0.0695	0.0577
	TE Down	0.0602	0.0566	0.0584	0.0562	0.0539	0.0638	0.0698	0.0626	0.0680	0.0623	0.0604	0.0655	0.0588	0.0671	0.0642	0.0717	0.0740	0.0630
C7	TE	0.0926	0.0909	0.0903	0.0900	0.0909	0.0952	0.0939	0.0900	0.0944	0.0942	0.0945	0.0989	0.0915	0.0987	0.0925	0.0948	0.1028	0.0919
	TE Down	0.0987	0.0988	0.0977	0.0970	0.0887	0.1054	0.0992	0.1113	0.1005	0.1028	0.0996	0.1038	0.0961	0.1108	0.1063	0.1074	0.1143	0.0992
C8	TE	0.0481	0.0466	0.0448	0.0455	0.0422	0.0572	0.0592	0.0551	0.0606	0.0476	0.0551	0.0613	0.0501	0.0556	0.0588	0.0668	0.0624	0.0443
	TE Down	0.0480	0.0456	0.0470	0.0452	0.0416	0.0615	0.0719	0.0651	0.0694	0.0515	0.0591	0.0661	0.0496	0.0631	0.0637	0.0791	0.0639	0.0419
C10	TE	0.0724	0.0703	0.0683	0.0687	0.0653	0.0810	0.0883	0.0820	0.0870	0.0717	0.0790	0.0858	0.0733	0.0786	0.0843	0.0886	0.0862	0.0671
	TE Down	0.0770	0.0730	0.0731	0.0721	0.0674	0.0931	0.1145	0.1063	0.0996	0.0796	0.0870	0.0948	0.0754	0.0975	0.0988	0.1085	0.0975	0.0698
C12	TE	0.0677	0.0665	0.0636	0.0651	0.0652	0.0720	0.0823	0.0757	0.0805	0.0695	0.0745	0.0843	0.0669	0.0744	0.0724	0.0846	0.0821	0.0660
	TE Down	0.0758	0.0757	0.0717	0.0745	0.0706	0.0789	0.0962	0.0909	0.0927	0.0776	0.0822	0.0941	0.0719	0.0799	0.0806	0.1051	0.0874	0.0667
Panel B: Europe																			
C4	TE	0.0778	0.0753	0.0739	0.0734	0.0721	0.0941	0.1004	0.0862	0.0967	0.0760	0.0852	0.0927	0.0792	0.0903	0.0893	0.1026	0.0890	0.0719
	TE Down	0.0776	0.0752	0.0747	0.0709	0.0748	0.1068	0.1146	0.1067	0.1129	0.0792	0.0891	0.0982	0.0798	0.1057	0.1018	0.1203	0.0921	0.0687
C13	TE	0.0837	0.0815	0.0808	0.0799	0.0815	0.0977	0.1043	0.0952	0.1004	0.0822	0.0889	0.0949	0.0832	0.0939	0.1014	0.1043	0.0973	0.0779
	TE Down	0.0818	0.0772	0.0790	0.0773	0.0797	0.1070	0.1241	0.1142	0.1098	0.0820	0.0920	0.1042	0.0795	0.1029	0.1130	0.1255	0.1071	0.0759
Panel C: North America																			
C3	TE	0.1022	0.1002	0.1006	0.0986	0.0989	0.0730	0.0805	0.0671	0.1038	0.1031	0.1043	0.1071	0.1036	0.0899	0.0659	0.0813	0.0932	0.1052
	TE Down	0.1024	0.0996	0.1007	0.1010	0.0984	0.0757	0.0830	0.0796	0.1107	0.1087	0.1057	0.1108	0.1034	0.0829	0.0718	0.0958	0.0968	0.1066
C11	TE	0.0326	0.0325	0.0316	0.0321	0.0268	0.0335	0.0398	0.0335	0.0394	0.0330	0.0376	0.0419	0.0348	0.0358	0.0361	0.0456	0.0387	0.0308
	TE Down	0.0366	0.0373	0.0354	0.0356	0.0252	0.0370	0.0442	0.0399	0.0480	0.0399	0.0414	0.0457	0.0412	0.0418	0.0404	0.0572	0.0406	0.0302
C14	TE	0.0608	0.0587	0.0574	0.0574	0.0510	0.0628	0.0673	0.0635	0.0699	0.0609	0.0652	0.0707	0.0615	0.0644	0.0680	0.0699	0.0752	0.0571
	TE Down	0.0664	0.0641	0.0644	0.0623	0.0523	0.0694	0.0740	0.0808	0.0769	0.0679	0.0730	0.0818	0.0651	0.0735	0.0727	0.0829	0.0844	0.0569
Panel D: Asia																			
C9	TE	0.0903	0.0896	0.0891	0.0899	0.0788	0.0937	0.0921	0.0930	0.0989	0.0924	0.0929	0.0940	0.0909	0.0937	0.0939	0.0940	0.0831	0.0869
	TE Down	0.0916	0.0917	0.0910	0.0937	0.0876	0.1042	0.0958	0.1035	0.1050	0.0979	0.0965	0.0949	0.0943	0.1079	0.1010	0.1028	0.0748	0.1015

Notes: This table reports monthly pair-wise tracking errors and downside tracking errors between my sample of fourteen renewable energy and eighteen conventional energy indexes from the first observation of each renewable energy index until February 2013. I compute pair-wise tracking errors from equations 10 and 11 in two stages. First, we regress excess renewable energy returns on excess conventional energy index returns. Second, I save the regression residual and compute the standard deviation for each of the 252 pairs. I obtain downside tracking errors by repeating the beforementioned procedure. Instead of computing standard deviations of regression residuals, I compute semi-standard deviations of regression residuals. I estimate linear OLS regressions with standard errors robust to autocorrelation and heteroskedasticity (Newey and West, 1987). Renewable and conventional energy indexes are grouped according to geographic regions. Boxed and shaded areas indicate energy indexes belonging to the same geographic investment region. All returns are denominated in US dollars.

6.5.3 Robustness Checks

In this chapter, I investigate whether my findings are sensitive to my previous research design choices. I conduct three robustness tests. First, I test alternative absolute risk measures such as downside risks. Second, I use an alternative all-industry benchmark such as MSCI world and re-compute tracking errors for both, renewable and conventional energy index returns to investigate any deviations from my main results. Finally, I investigate economic and statistical differences between tracking and downside tracking errors in different variations.

6.5.3.1 Absolute Downside Risk

My previous analyses proxy absolute total risk with the standard deviation of returns. From the perspective of a risk-averse investor, downside risk measures are more appropriate because of their ability to explain asymmetrical risk behaviour, i.e. more weight on losses rather than gains. In Panel A of Table 16, I compare the annualised semi-standard deviations, lower partial moments and minimum returns of global renewable and conventional energy indexes. I find 6 out of 8 renewable energy indexes to have semi-standard deviations of 44 percent or higher. The AGAE Solar Index has the highest semi-deviation of approximately 65 percent. Annualised lower partial moments and minimum returns show the same pattern. Interestingly, two renewable energy indexes, Daxglobal Alternative and S&P Global Alternative, have somewhat lower downside return volatilities of 33 and 34 percent respectively. In contrast, annualised semi-standard deviations for the majority of global conventional energy indexes range between 15 and 28 percent. Two conventional indexes, Daxglobal Coal and MSCI World Metals and Mining, clearly exceed this range of downside variation with 34 and 41 percent respectively. Comparing my downside risk findings across global renewable and conventional energy samples, I can conclude that the majority of renewable energy indexes experiences much higher downside volatilities compared to conventional energy indexes. These findings are in line with my previous findings and with the literature. Although I find many global renewable energy indexes to be much riskier, the two renewables with lowest downside risk perform better than two conventionals with highest downside risk.

Panel B and Panel D of Table 16 report downside risks for European and Asian energy equity indexes, respectively. Again, I find renewable energy indexes to report downside risks of about twice the size of conventional energy indexes. In Panel C, I compare downside risks of North American energy equity indexes. Unlike the other regions, North American and more specifically US renewable energy indexes have an extremely positive downside protection. Nasdaq Clean Edge US, a highly specialised index, is by far the best renewable energy index in my sample with an annualised semi-deviation of 22 percent, lower partial moments of 19 percent and minimum returns of -22 percent. These results suggest that renewable energy indexes from North America are competitive with conventional energy indexes.

6.5.3.2 Relative Risk - MSCI World

I conduct my previous analyses with renewable energy index returns in excess of conventional energy index returns and then compute the relative residual volatilities of these two competing forms of energy equity indexes. The advantage from this approach is that I directly compare the risk variation between renewable and conventional energy equity indexes. One might argue, however, that residual return volatilities of renewable energy equity indexes are also related to all industries that I overlook and that may be important in explaining investment risks. To investigate whether renewable energy risk is similarly related to non-energy equity indexes, I repeat my previous analyses comparing both forms of energy indexes, renewable and conventional, with the all-industry benchmark MSCI World. In Table 16, I report tracking errors and downside tracking errors between all renewable and conventional energy indexes versus MSCI's global equity market index. I sort indexes according to geographic region into Global, Europe, North America and Asia.

Panel A of Table 16 shows that among Global renewable energy indexes, S&P Global Alternative Energy and Daxglobal Alternative have the lowest and almost identical tracking errors. Panel C reports the lowest tracking errors for two North American renewable energy indexes (Nasdaq Clean Edge and Wilderhill New Energy). These findings are in line with previous estimations. The same four renewable energy indexes experience low relative investment risks. In Panel A, I also compare conventional energy equity indexes' relative risk across my four investment regions. I find European and Global traditional energy indexes to show the lowest risk compared to MSCI's equity index, on average. I find North American and Asian energy equity indexes to experience comparably higher risks.

6.5.3.3 Tracking Error and Downside Tracking Error

In Table 16, I report how strong tracking error and downside tracking error estimates deviate from each other. I compute the deviation as the difference between each traditional and downside tracking error estimate and test whether the difference is statistically significant, using Wilcoxon nonparametric rank-sum test. Differences in regression estimates confirm that about 80 percent (11 out of 14) of renewable energy indexes have higher downside volatilities, i.e. downside tracking error volatilities are larger than traditional tracking error volatilities. This means that the majority of renewable energy indexes have had periods of relatively poor risk management. Furthermore, the difference between traditional tracking errors and downside tracking errors can be large in magnitude. I find monthly differences between the two measures of up to 1.03 percent. Although, the difference can be large in individual cases, tests on the statistical significance of the deviation show that none of the differences is significantly different. Meaning that both relative risk measures, tracking error and downside tracking error, should deliver identical results. One explanation for why the two measures perform very similar is the fact that I investigate passive index investments. In other words, I would expect to find larger differences in the two risk measures when observing actively managed mutual funds as they change their investment styles more dynamically and may specifically try to reduce downside variation compared to a passive index investment with a less dynamic tracking strategy.

Rather than only examine deviations between tracking error and downside tracking error estimates overall, I can rank energy indexes according to their risk performance relative to MSCI's all-industry equity index. I rank each energy index risk performance in two steps. First, I identify the energy index with the lowest tracking error within each geographic region and type of energy index (renewable or conventional). Second, I compute the difference between the lowest index relative to its peers. For example, I separately look at the magnitude of the difference between the lowest global renewable energy index with the highest global renewable energy index. Subsequently, I compute the statistical significance of the difference, using Wilcoxon nonparametric rank-sum test. In Panel A of Table 16, I identify S&P Global Alternative Energy to have the lowest tracking error among renewable energy indexes with global investment objectives. The monthly differences for my sample of global renewable and conventional energy indexes can be large (ranging from 1.22 to 6.88 percent and 0.8 to 5.72 percent, respectively). These findings suggest that my samples of global energy indexes vary substantially, which I formally confirm with Wilcoxon's nonparametric significance test.

Panel B of Table 16 shows that both, renewable and conventional energy indexes' relative risks are identical, as I cannot reject Wilcoxon's null hypothesis that the two series come from the same population. In Panel C, I report energy indexes investing in North

American energy firms. In line with previous observations, I find renewable Nasdaq Clean Edge index to have the lowest tracking error across the North American sample of energy indexes and except for one globally oriented index to almost have the lowest relative risks across the entire sample of renewable and conventional energy indexes relative to MSCI world. Panel D shows that across my Asian sample of energy indexes, conventional DJGL Asia Oil & Gas has the best risk protection, very closely followed by another conventional energy index, Daxglobal Asia Oil & Gas.

Overall, the robustness checks suggest that my conclusions from previous analyses hold irrespective of whether a) I use absolute downside risk measures such as semi-standard deviation, lower partial moments and worst losses, or use total absolute risk measures such as standard deviation of returns b) I use an all industry benchmark such as MSCI world, or directly compare relative investment risks between renewable and conventional energy indexes, and c) I use traditional tracking errors to compute relative investment risks or use my modified downside tracking error to compute these risks.

Table 16: Tracking Error and Downside Tracking Error Regressions relative to MSCI World

		Absolute Risk			Relative Risk							
ID	Energy Indexes	Ann. Semi-Std. Dev.	Ann. LPM	Min.	TE	TE Down	TE - TE Down	Wilcoxon	TE - TE lowest	Wilcoxon	TE Down - TE Down lowest	Wilcoxon
Panel A: Global												
C1	AGAE Composite	0.441	0.374	-0.490	0.068	0.061	0.007	0.195	0.030	4.04***	0.023	3.04***
C2	AGAE Extra Liquid	0.452	0.386	-0.512	0.066	0.063	0.003	0.328	0.028	3.90***	0.025	2.74***
C5	AGAE Solar	0.651	0.530	-0.548	0.106	0.102	0.004	0.090	0.069	7.26***	0.065	5.47***
C6	Daxglobal Alternative	0.329	0.265	-0.313	0.050	0.047	0.003	0.484	0.012	2.94***	0.009	2.51**
C7	World Renewable Energy	0.455	0.373	-0.477	0.083	0.083	0.000	0.369	0.045	7.11***	0.045	4.91***
C8	S&P Global Alternative Energy	0.336	0.296	-0.360	0.037	0.038	0.000	0.093	Lowest		Lowest	
C10	HFRX Alternative Energy	0.469	0.410	-0.510	0.056	0.059	-0.002	0.431	0.019	2.55**	0.021	1.40
C12	S&P Global Clean Energy	0.445	0.364	-0.392	0.051	0.048	0.002	0.464	0.013	2.42**	0.011	1.25
D1	MSCI World Oil & Gas	0.215	0.171	-0.158	0.039	0.041	-0.002	0.424	0.010	3.75***	0.011	2.85***
D2	FTSE World Oil & Gas	0.217	0.173	-0.175	0.039	0.041	-0.002	0.682	0.010	3.80***	0.011	3.29***
D3	TR Global Oil & Gas	0.214	0.170	-0.176	0.036	0.038	-0.001	0.652	0.008	3.16***	0.008	2.72***
D4	DJ Titans Oil & Gas 30	0.227	0.181	-0.191	0.039	0.041	-0.002	0.403	0.010	3.98***	0.011	3.13***
D5	MSCI World Metals & Mining	0.339	0.299	-0.387	0.052	0.058	-0.006	1.019	0.023	5.67***	0.028	4.54***
D12	Daxglobal Coal	0.410	0.350	-0.440	0.086	0.087	-0.001	0.236	0.057	7.79***	0.057	5.27***
D13	Daxglobal Nuclear	0.282	0.221	-0.226	0.064	0.058	0.006	0.694	0.035	5.41***	0.028	3.54***
D17	HFRX EH: Energy	0.156	0.138	-0.177	0.029	0.030	-0.001	0.038	Lowest		Lowest	
Panel B: Europe												
C4	AGAE Europe	0.494	0.417	-0.519	0.068	0.062	0.006	0.609	Lowest		Lowest	
C13	European Renewable Energy	0.496	0.430	-0.525	0.075	0.077	-0.002	0.650	0.007	0.67	0.015	1.56
D10	EURO STOXX Oil & Gas	0.201	0.159	-0.162	0.041	0.041	0.000	0.424	0.000	0.24	-0.001	0.02
D11	DJ Europe Oil & Gas	0.240	0.192	-0.212	0.041	0.042	-0.001	0.169	Lowest		Lowest	
Panel C: North America												
C3	AGAE North America	0.436	0.363	-0.396	0.080	0.070	0.010	0.194	0.048	5.72***	0.040	4.15***
C11	NASDAQ Clean Edge US Liq.	0.218	0.191	-0.219	0.032	0.030	0.001	0.141	Lowest		Lowest	
C14	Wilderhill New Energy Global Inn.	0.363	0.313	-0.431	0.041	0.041	0.000	0.191	0.009	3.15***	0.011	1.96*
D6	S&P 500 Oil & Gas	0.210	0.168	-0.159	0.042	0.043	-0.001	0.146	Lowest		Lowest	
D7	DJ US Int. Oil & Gas	0.188	0.149	-0.135	0.042	0.043	-0.001	0.246	0.001	0.11	0.000	0.23
D8	NYSE Arca Oil	0.233	0.184	-0.189	0.044	0.046	-0.002	0.266	0.003	0.65	0.003	0.57
D9	DJ US Coal	0.533	0.433	-0.466	0.113	0.116	-0.003	0.399	0.071	8.66***	0.073	6.15***
D18	NASDAQ/SIG Oil	0.368	0.297	-0.296	0.070	0.074	-0.005	0.277	0.028	3.35***	0.031	2.42**
Panel D: Asia												
C9	S&P Asia Alternative Energy	0.407	0.329	-0.295	0.082	0.083	-0.001	0.698	NA		NA	
D14	Daxglobal Asia Oil & Gas	0.252	0.212	-0.251	0.067	0.054	0.013	0.715	0.006	0.29	Lowest	
D15	DJGL Asia Int. Oil & Gas	0.335	0.261	-0.287	0.087	0.080	0.007	0.693	0.026	3.41***	0.026	2.68***
D16	DJGL Asia Oil & Gas	0.315	0.270	-0.367	0.061	0.061	0.000	0.865	Lowest		0.007	0.06

Notes: In this table, I report absolute and relative risk measures between my combined sample of 32 energy indexes relative to MSCI World all-industry equity index. In particular, I compute three absolute risk measures, annualised semi-standard deviations, lower partial moments and minimum returns. Relative risk measures include tracking error and downside tracking error volatilities. Columns 3 to 5 list absolute risk measures. Columns 6 to 8 report relative risk measures including the exact difference between tracking error and downside tracking error estimates relative to MSCI world index. I compute tracking errors and downside tracking errors according to equations 10 to 12. Using Wilcoxon nonparametric rank-sum test, I compute statistical significances for the difference in medians between tracking error and downside tracking error estimates in column 9. Column 10 reports the difference between the lowest tracking error estimate and energy indexes that are from the same region and energy type. For example, Panel A lists global energy indexes of which 8 are renewable energy indexes. After identifying the global renewable energy index with the lowest tracking error in that group, I compute the difference between the lowest tracking error with the 7 others belonging to the same group. Column 9 reports Wilcoxon nonparametric rank-sum test for statistical differences between the lowest tracking errors and reported tracking errors. I repeat this process for downside tracking errors and report the difference between the lowest downside tracking errors and their significance in the last two columns of this table.

6.6 Conclusion

This study investigates absolute and relative risk relations between renewable and non-renewable energy equity indexes. Using return data on fourteen international renewable energy indexes from 2000 to 2013 and eighteen conventional energy indexes over the same time period, I find strong positive correlations between their returns, indicating similarities in their underlying return generating processes. Despite strong associations between the returns of renewable and traditional energy equity indexes such as fossil-fuel generated companies, I find return volatilities to be substantially higher for 70 percent of my sampled renewable energy indexes relative to my benchmarked conventional energy indexes.

By introducing a novel approach to assess relative downside return volatilities that account for investors' asymmetric risk appetites (i.e. risk-averse investors), namely the downside tracking error, I capture the real risk exposure that matters to risk-averse investors. Using the modified tracking error for downside residual return volatilities, my empirical analysis suggests that the majority of renewable energy indexes experience higher downside tracking errors relative to their conventional energy benchmarks.

My empirical analysis leads to the conclusion that major international renewable energy indexes carry higher absolute, downside and relative investment risks compared to a large sample of conventional fossil-fuelled energy indexes. This conclusion turns out to be robust, since it holds across different risk specifications and alternative non-energy industry benchmarks. My conclusion is generally consistent with findings from the renewable energy literature that return volatilities of renewable energy indexes tend to be high (Henriques and Sadorsky, 2008; Kumar et al., 2012; Sadorsky, 2012a, b). The high return volatilities are a result of high uncertainties regarding the nature of renewable technology businesses and future prospects of the renewable energy industry in several respects. First, renewable tech companies tend to be small and technology-oriented businesses with a selected focus on few projects. Private sector investors perceive companies with only a few projects, whose outcome is unknown, as risky. Second, the renewable energy sector is very capital intensive. Due to the capital intensity of renewable energy projects, the government has substantially supported the sector by policy investments in the past, which was especially the case in the solar industry. One of the major risks of policy investing is the duration of financial support, which if discontinued (for example due to a recession) can produce devastating effects to a sector, as seen by the recent wave of bankruptcies in the German solar industry (Bohl et al., 2013). Furthermore, the weak carbon price does not contribute to the growth of the renewable energy sector. My empirical findings also show that several more specialised or "concentrated" renewable energy indexes have substantially lower tracking error volatilities. These indexes are specialised in specific sub-segments of renewable energy technologies such as biofuels or advanced batteries. Further, direct comparisons between more traditional measures of relative risk and my alternative approach indicate that the former are well suited to explain the risk behaviour of renewable energy equity indexes as the results obtained from tracking error are generally in line with results from the downside tracking error. A formal non-parametric significance test between these two risk measures shows that the difference is tiny and not statistically significant. As the difference between the traditional tracking error and the downside tracking error is not significantly significant, the two risk proxies lead to the same result. Meaning that the traditional tracking errors sufficiently explain the risk relationship between renewable and conventional energy equity indexes.

My results may be useful to policymakers and investors as they seek to understand differences in the assessment and perception of risk in international renewable energy equity indexes. This is increasingly relevant as renewables make up larger and larger parts of total energy and power capacity. For policymakers, an investigation of these risks can help to shape future financial support in RD&D activities. In order to increase the participation of private sector investors, understanding perceived risks in renewable energy investments is of great importance. Particularly, to reduce investment risks in renewable energy to cater for more risk-averse private sector investors such as large institutional funds. Innovative products such as fixed-income renewable energy funds or green bonds have the potential to achieve this goal. I hope my findings will be useful for future research to increase the understanding of risk in renewable energy equity indexes.

My findings are, however, limited due to the following restrictions. First, my risk findings apply to equity investments in renewable energy and in particular to equity indexes only. More recently, the renewable energy sector has seen growing demand for green bonds and fixed income products, which could substantially reduce uncertainties and risks in the sector. Second, my results largely apply to renewable energy equity indexes in developed countries only. Renewable energy equity and bond markets in emerging economies are growing at enormous speeds. So far, data limitations on individual firms or indexes have made comparisons rather difficult. Further research should look at the drivers of risk in renewable energy equity indexes in relation to traditional energy equity indexes. Also, to advance the development of more appropriate risk measures to evaluate renewable energy investments.

7 The Effects of Environmental, Social, and Governance (ESG) Disclosure Quality on the Cost of Capital

The Effects of Environmental, Social, and Governance (ESG) Disclosure Quality on the Cost of Capital

Abstract

This chapter empirically investigates the effects of Environmental, Social, and Governance (ESG) disclosure quality on the expected cost of equity as well as the cost of debt. To investigate these effects, my analysis is based on a large sample of US S&P 500 companies over the sample period from 2004 to 2014. Using several alternative approaches to compute the expected cost of equity and debt (based on Graham and Harvey's expected market premium and inferred from several asset pricing models), my results show a negative and statistically significant association between ESG disclosure quality and my expected cost of equity and debt variables, while also controlling for company- and debt-specific characteristics. My results suggest that companies with high ESG disclosure quality have lower expected cost of equities and debt, everything else equal. Accordingly, my findings of the relation between ESG disclosure quality and the expected cost of equity and debt imply that the market prices a company's ESG disclosure quality along with other factors. My results are robust over time and alternative regression specifications.

7.1 Introduction

This chapter empirically investigates the effects of Environmental, Social, and Governance (ESG) disclosure quality on the cost of equity and debt capital on a large sample of US S&P 500 companies from 2004 to 2014. Over the last decade, corporate disclosures of environmental, social, and governance activities have substantially increased. According to KPMG's annual survey on corporate disclosures of ESG activities of the world's largest companies, the rate of disclosure has risen from 64 percent in 2005 to 93 percent in 2013 (KPMG, 2005; 2013)[92]. Since then many North American companies have committed to make ESG disclosures, and have now overtaken leading European companies in this type of disclosure (KPMG, 2013).

The rapid increase of corporate ESG disclosures raises the question: What are the motives behind companies' ESG disclosure?

The reasons for companies to disclose on their ESG activities vary, but the following three motives could potentially answer the question. First, corporations are under constant scrutiny now more than ever due to a series of recent corporate scandals that have adversely impacted society and the economy's stability. Companies who are trying to re-build that trust and to increase their reputation could have the incentive to increase disclosure on environmental, social, and governance issues. Some scholars (see e.g. Brammer and Pavelin, 2006; Lii and Lee, 2012) have argued that poorly managed ESG risks have shown to impact a company's reputation and sales. For instance, British Petroleum (BP) has been struggling for several years and have invested more than 90 billion US dollars in environmental liabilities to strengthen its reputation after the 2010 Deepwater Horizon oil spill in the Gulf of Mexico (Chazan and Crooks, 2013; Gordon, 2013). Second, the rise in ESG disclosure could also be driven by large institutional investors such as pension and investment funds who have called on companies to provide more transparency with regard to their environmental, social, and governance activities to be able to incorporate such information into their investment decision-making processes (PRI, 2014). Finally, the rapid growth of socially responsible investments in the US and globally could have triggered increased corporate disclosure on ESG activities. According to the US Social Investment Forum (USSIF, 2014), from 1995 to 2014, assets under management using socially responsible investment strategies in the US have grown from $639 billion to $6,570 billion.

[92] The rate of disclosure is defined as the quality of CR (Corporate Responsibility) Reporting measured against seven key criteria, which are based on current reporting guidelines including: 1) Strategy, risk and opportunity, 2) Materiality, 3) Targets and indicators, 4) Suppliers and the value chain, 5) Stakeholder engagement, 6) Governance of CR (Corporate Responsibility), and 7) Transparency and balance (See KPMG, 2005; 2013).

Thus, in this chapter, I empirically investigate whether a reduction in companies' cost of capital explains the rise in ESG disclosure quality. I focus on the cost of equity and cost of debt because they represent the two main sources of a company's financing as well as play a pivotal role in a company's financing decision making. In addition, corporate executives feel that voluntarily increasing information to investors can reduce their companie's cost of capital (Armitage and Marston, 2008). Also, there is a long-established interest in the academic community in the relation between ESG disclosure and the cost of capital (Clarkson et al., 2013; Dhaliwal et al., 2011; Plumlee, 2008; 2010).

Based on Heinkel et al.'s (2001) and Merton's (1987) theoretical framework, and consistent with the Efficient Market Theory (which I discuss in Chapter 2 'Theory: The Efficient Market Theory'), I hypothesise that companies with high Environmental, Social, and Governance (ESG) disclosure quality have lower expected cost of equity and debt, everything else being equal. The theoretical mechanisms through which ESG disclosure quality could affect the expected cost of equity and debt are the depth's of a companies investor base, reductions in companies' beta or systematic risk, and future litigation and reputational risks (Lambert et al., 2007; Merton, 1987). I will explain the three mechanisms in more detail in Chapter 7.2.1. 'ESG Disclosure and the cost of capital', as well as why ESG disclosure quality could be "priced" in the cost of capital (See Chapter 7.2.1.4. 'ESG Disclosure and Diversification').

To empirically test whether ESG disclosure quality is related to a company's expected cost of equity and debt capital, I use a large sample of US companies based on the historical constituents of the S&P 500 index. My empirical analysis shows that ESG disclosure quality is negatively associated with all of my expected cost of equity and cost of debt variables, controlling for company-and bond-specific characteristics. My results are generally statistically significant at the 1 and 5 percent significance level and consistent across alternative proxies for the expected cost of equity (based on Graham and Harvey's, 2015 expected market premium and inferred from three different asset pricing models including CAPM, Fama/French, and Carhart using daily, weekly, and monthly data frequencies) and different regression specifications. My results are consistent with Hypothesis 1 and 2, which predict that companies with high ESG disclosure quality have lower expected cost of equities and cost of debt, everything else equal. Additional robustness tests for temporal consistency and stepwise regressions support my prior findings. On the cost of equity side, my findings are in line with Dhaliwal et al. (2011), El Ghoul et al. (2011) and Sharfman and Fernando (2008). They all report that some form of ESG activities such as the initiation of standalone

ESG disclosures, environmental management, or human rights reduce a company's cost of equity. On the cost of debt side, my findings tend to be generally in line with Bauer and Hann (2010) and Oikonomou et al. (2014), who find several ESG dimensions such as corporate environmental management, community strengths, and product safety and quality strengths to reduce the cost of debt.

To the best of my knowledge, my chapter is the first to investigate both, the effects of the cost of equity and debt capital on a novel ESG disclosure quality variable. I contribute to the existing literature by extending the research on voluntary ESG disclosure. To date, no study has investigated the effects of ESG disclosure quality on the cost of debt. Further, the literature on ESG disclosure focuses predominantly on self-constructed ESG disclosure variables that indicate whether or not companies disclose standalone ESG reports. In contrast, my ESG disclosure variable is a novel indicator that measures the extent (or the *quality*) to which companies report on specific ESG information. Furthermore, I contribute to the existing literature by using alternative approaches to compute the cost of equity as well as the cost of debt capital. The existing literature on ESG disclosure focuses primarily on the implied cost of equity. In contrast, my expected cost of equity is based on Graham and Harvey's survey data of the expected market premium (Graham and Harvey, 2015). My chapter aims to increase the reliability and validity of previous studies investigating the relevance of ESG disclosure for equity and debt investors.

My chapter is closely related, but differs from the studies of Sharfman and Fernando (2008), Dhaliwal et al. (2011), El Ghoul et al. (2011), Bauer and Hann (2010), and Oikonomou et al. (2014). Sharfman and Fernando (2008) and Bauer and Hann (2010) investigate the impact of environmental risk management on the realised cost of equity capital and cost of debt capital, respectively. My chapter investigates a different concept of ESG, which is concerned with corporate disclosures of ESG activities.

My chapter also differs from Dhaliwal et al. (2011), who examine the impact of self-constructed standalone ESG disclosures on the implied cost of equity. In my chapter, I use a ESG disclosure variable that is different from Dhaliwal's et al. (2011) self-constructed ESG disclosure variable. I use a proxy that measures the accuracy (or quality) to which companies disclose environmental, social, and governance information, while Dhaliwal et al. (2011) use a dichotomous variable that indicates whether or not companies publish ESG reports.

My chapter also differs from El Ghoul et al. (2011), who examine the impacts of several dimensions of ESG activities on the implied cost of equity. My chapter investigates the effects of ESG disclosure on both, the cost of equity and cost of debt financing separately.

Methodologically, my chapter differs from Sharfman and Fernando (2008), Dhaliwal et al. (2011), and El Ghoul et al. (2011) by employing an alternative method to obtain the cost of equity capital. My approach to compute the cost of equity is based on Graham and Harvey's (2015) expected market premium which is obtained by the author's quarterly survey of US Chief Financial Officers from S&P 500 companies and inferred from three alternative asset pricing models including CAPM, Fama and French, and Carhart models. My approach overcomes the well-known problem of excluding companies with negative earnings per share (EPS) forecasts in the computation of implied cost of equities that could potentially result in a substantial loss of sample size. My measure also overcomes another documented bias in the computation of the implied cost of equity, namely, the analyst forecast optimism bias (El Ghoul et al., 2011).

Finally, my chapter differs from Oikonomou et al. (2014), who test the effects of several ESG dimensions on the corporate spreads of bonds, i.e. cost of debt. In my chapter, I use a different and novel proxy for the cost of debt. My proxy uses corporate spreads of bonds adjusted for a company's credit rating, while Oikonomou et al. (2014) use the former without adjustments for a company's credit ratings.

In sum, my chapter contributes to the existing literature by complementing and extending the works of Sharfman and Fernando (2008), Dhaliwal et al. (2011), El Ghoul et al. (2011), Bauer and Hann (2010), and Oikonomou et al. (2014).

My chapter is organised as follows. Chapter 7.2. 'Literature Review and Hypotheses', provides a literature review and theoretical motivation on the potential effects of ESG criteria (more generally) and ESG disclosure (more specifically) on the cost of equity and cost of debt capital. The literature review leads to the development of my hypotheses. In Chapter 7.3. 'Research Design', I discuss my research design, including sample and methodology. Chapter 7.4. 'Empirical Results', provide empirical evidence on the effects of ESG disclosure quality on the expected cost of equity and debt. Chapter 7.5. concludes.

7.2 Literature Review and Hypotheses

To locate where my chapter fits in with the existing literature, I examine previous work on the effects of companies' ESG disclosure activities and the cost of capital. Furthermore, my aim is to discuss theoretical arguments that could motivate a negative relation between the cost of capital and ESG disclosure, all else being equal.

7.2.1 ESG Disclosure and the cost of capital

Prior research on the relation between corporate disclosures of ESG activities and the cost of capital focuses on self-constructed ESG disclosure variables and the implied cost of equity capital (See e.g. Chava, 2011; Dhaliwal et al., 2011; El Ghoul et al., 2011; Plumlee et al., 2010). The consensus appears to be a negative relationship between ESG disclosure and the cost of equity capital. Surprisingly, only very few studies investigate such effects on the cost of debt (Bauer and Hann, 2010; Oikonomou et al., 2014). However, the few studies that do, also report a negative relationship between companies' ESG activities and the cost of debt.

For example, Dhaliwal et al. (2011) empirically show that companies enjoy lower cost of equities after the initiation of increased ESG disclosure. Their findings are based on a large sample of 1,300 US companies, on average, and over the sample period from 1993 to 2007. In line with Dhaliwal et al.'s (2011) findings, El Ghoul et al. (2014) also report a negative relation between a company's environmental performance and the implied cost of equity for global manufacturing companies and high polluting sectors in the US.

Although the available evidence on the relationship between a company's ESG activities and the cost of debt is rather scarce, the empirical evidence is similar to prior findings related to the cost of equity. While Oikonomou et al. (2014) empirically establish that several dimensions of ESG concerns are negatively related to the cost of debt, Bauer and Hann (2010) corroborate these findings by focussing on one sub-dimensions of ESG, namely corporate environmental practices and its potential effects on a company's cost of debt capital. More specifically, using environmental management strengths and weaknesses, Bauer and Hann (2010) show that companies with better corporate environmental management enjoy lower cost of debt financing relative to companies with environmental concerns. Oikonomou et al. (2014) extend the analysis to a comprehensive list of several ESG dimensions and report that several fine-grained ESG themes such as sustainable community, employment, environment, and product safety and quality initiatives are negatively related to the cost of debt. In contrast, ESG controversies related to community and employment tend to increase the cost of debt (Oikonomou et al., 2014).

In the following chapter, my aim is to discuss theoretical arguments that could motivate a negative relation between the cost of capital and ESG disclosure, all else being equal. Drawing from Merton's (1987) model of market equilibrium with incomplete information, my theoretical arguments are related to the depths of a companies' investor base, reductions in companies' beta (systematic risk), and reductions in companies' future litigation and reputational risks.

7.2.1.1 Depth of Companies' investor base

According to the Efficient Market Theory, when companies immediately materialise on profitable investment strategies they rapidly eliminate market abnormalities and inefficiencies[93] (Fama, 1970; Jensen, 1968). This mechanism only works under the perfect market assumption that companies can immediately raise sufficient capital to trade on profitable investment strategies (Merton, 1987). However, as Merton (1987) and others (see e.g. Grossman and Stiglitz, 1980) highlight, "the dealer business is neither costless nor instantaneous" (Merton, 1987:485). Investment professionals have to follow regulatory capital requirements that could restrict the pursuit of every profitable investment strategy (Merton, 1987). Similarly, the assumption that any type of publicly available information will reach all investors immediately and that investors act on it instantly, may be somewhat simple (Merton, 1987:484).[94]

As a result, Merton (1987) developed a capital market equilibrium model with incomplete information by departing from the complete and instantaneous information assumptions. The key assumption in Merton's theoretical framework is that "an investor uses security k in constructing his optimal portfolio only if the investor knows about security k" (Merton, 1987:488). He argues that the information exchange between firm k and the investor only occurs after considerable "set-up" costs[95] have been incurred. If investors have to pay considerable set-up costs for any company they wish to follow, then they will likely only follow a subset of all traded companies in the market (Merton, 1987).

With respect to a company's cost of capital, this implies that according to Merton's (1987) capital market equilibrium model with incomplete information, companies have an incentive to disclose more information as this increases investors' awarness of a company's existence and expands the investor base, which will reduce the firm's cost of capital and increase the market value of the company (Merton, 1987). In other words, to increase the depth of a company's investor base (and thereby reduce the cost of capital), management is

[93] For example, through arbitrage.
[94] For example, while some information such as companies' earnings or dividend announcements could be readily analysed by investors, other information such as published empirical discoveries (including the size anomaly) could take some time to be properly assessed by investors (Merton, 1987).
[95] Set-up costs are fixed costs incurred by the investor for setting up a company's information exchange (Merton, 1987). If an investor has to pay a significant set-up cost for each company, then any investor will likely only follow a subset of all traded companies (Merton, 1987).

encouraged to disclose more information to attract new investors who are not currently shareholders to incur the set-up costs that allow for a seamless information exchange between the investor and security k [96] (Merton, 1987).

7.2.1.2 Reductions in companies' beta

Another mechanism through which corporate disclosures on ESG activities could affect the cost of capital is beta or systematic risk (Dhaliwal et al., 2011). Within a framework consitent with a traditional model of market equilibrium, i.e. capital asset pricing model (CAPM), Lambert et al. (2007) investigate how better information disclosure quality or more precise firm-specific disclosures influence the cost of capital. Lambert et al. (2007) show that not only does better disclosure lower the variance of a copmany's cash flows, it also affects the covariances with other companies, which brings a company's cost of capital closer to the risk-free rate. According to Lambert et al.'s (2007) theoretical framework, these effects are nondiversifiable (systematic): "Moreover, this effect is not diversifiable because it is present for each of the firm's covariance terms and hence does not disappear in large economies." (Lambert et al., 2007:387). Lambert et al.'s (2007) study provides theoretical guidance for empirical assessments on the relationship between corporate disclosures of financial and non-financial activities and the cost of capital.

7.2.1.3 Future Litigation and Reputational Risks

Lastly, prior work suggests that socially irresponsible companies [97] are perceived as riskier investments because of potential future litigation and reputational risks (Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Starks, 2009).[98] Brammer and Pavelin (2004) argue that ethically and socially unsound companies could face unexpected future claims based on companies' non-compliant behaviour. To give one example, if a company provides deliberately misleading information on their products and services, then this will increase the likelihood of future lawsuits against the company. Bankers Trust was involved in a controversy whereby employees of the bank had repeatedly misled customers with false valuations of their derivative contracts (Forbes, 1996). As a result, Procter and Gamble and

[96] As mentioned in the previous section, security k refers to any security that an investor could consider when constructing his optimal portfolio, only when he knows about a security (Merton, 1987).

[97] Irresponsible companies are defined as companies pursuing irresponsible activities with negative environmental and social impacts and externalities for stakeholders (Heal, 2005).

[98] Such as idiosyncratic business risks, which include risks such as lawsuits, strikes, brand and reputation loss, and consumer boycotts (Lee and Faff, 2009).

other former clients of the bank started a lawsuit against the bank, which cost the bank tens of millions of dollars in settlements (Forbes, 1996). [99]

Companies that behave irresponsibly by violating environmental, social, or governance standards will likely be subject to fines, penalties, government sanctions and other associated litigation costs (Bauer and Hann, 2010; Oikonomou et al., 2014). These negative events could then manifest itself in higher cost of capital financing. As an illustration, Oikonomou et al. (2014) point out the increase of BP's bond yield spreads and downgrade of BP's credit rating from AA to BBB, immediately after the 2010 Deepwater Horizon oil spill in the Gulf of Mexico.

Furthermore, Hong and Kacperczyk (2009) provide evidence that "sin" companies' products [100] are more likely to be associated with increased litigation risks. "For example, tobacco companies faced substantial litigation risk until their settlement with state governments in 1997" (Hong and Kacperczyk, 2009:17). Similarly, Brammer and Pavelin (2004) argue that companies in the alcohol sector face increased litigation risks because they are associated with visible social issues such as crime and health related issues.

7.2.1.4 ESG Disclosure and Diversification

One could argue that these higher risks of low ESG disclosure companies (socially irresponsible companies) could be diversified away in a broad investor portfolio and not be "priced" in the cost of capital. My following arguments will explain why ESG disclosure could be "priced" in the cost of capital. First, as mentioned in Chapter 2.5.1. 'Pricing of ESG information', socially responsible investors do not have a preference for investing in companies with low ESG disclosures due to differences in tastes for certain assets (Fama and French, 2007; Galema et al., 2008; Hamilton et al., 1993; Heinkel et al., 2001). Consistent with efficient capital markets, Heinkel et al.'s (2001) capital market equilibrium model, shows that when fewer investors are available to hold the shares of irresponsible companies, then this will reduce diversification (risk-sharing) and increase companies' cost of capital. This means, if low ESG disclosure companies have a smaller investor base due to socially

[99] My examination committee pointed out that future litigation costs could harm a company's expected cash flows and growth opportunities only when future litigation costs exceed a certain threshold. While this is the case for "direct" costs, "indirect" long-term costs due to reputational loss could also lead to substantial financial harm (Brammer and Pavelin, 2004).

[100] "Sin" companies are involved in the production of alcohol, tobacco, and gaming products (Hong and Kacperczyk, 2009).

responsible investors' tastes, then their cost of capital will be higher (Merton, 1987).[101] Second, according to Merton's (1987) equilibrium model "...expected returns seem to depend on both market risk and total variance", meaning that not just beta but also idiosyncratic risk matters for pricing (Hong and Kacperczyk, 2009). Ultimately, low ESG disclosure companies could have higher cost of capital due to higher non-diversifiable risks.[102] Based on the beforementioned arguments and discussion, I state my hypotheses as follows:

> *Hypothesis 1: Companies with high Environmental, Social, and Governance (ESG) disclosure quality have lower expected cost of equity.*
>
> *Hypothesis 2: Companies with high Environmental, Social, and Governance (ESG) disclosure quality have lower expected cost of debt.*

In the following chapter, I will continue to describe the more technical details of my chapter including my empirical models to test the above hypotheses.

7.3 Research Design

7.3.1 Sample Selection

To empirically examine the relevance of ESG disclosure quality for the cost of capital, I require a representative sample of large, liquid, and publicly traded companies that have continous access to capital markets for precise cost of capital estimates. Also, I require companies to be transparent with respect to their coverage on several dimensions of the ESG disclosure spectrum. Based on these criteria, I choose the S&P 500 (Standard and Poor's), as it represents all major, large and publicly traded companies in the United States. Samples based on the S&P 500 have been used in related studies in this field before (See e.g. Bauer and Hann, 2010; Sharfman and Fernando, 2008; Oikonomou et al., 2014).

7.3.2 ESG Disclosure

Bloomberg is the database for my ESG disclosure data. Bloomberg is originally known to provide a wide range of financial data services via its terminals. Since 2009, the company has dedicated resources to extend their data sources beyond accounting and market-based

[101] This, of course, depends on the amount of funds controlled by socially responsible investors (Heinkel et al., 2001).
[102] All in all, whether ESG disclosure quality has an effect on the expected cost of capital and is relevant for equity and debt investors is an empirical question, which my chapter aims to address.

financial information and now also offers a wide range of non-financial information such as environmental, social, and governance information (Ediger, 2013). ESG disclosure is one of the newer non-financial data sources that Bloomberg offers to its subscribers. Information on ESG disclosure is collected by Bloomberg analysts based on companies' annual reports, standalone environmental, social, and governance reports, CSR reports, sustainability reports, and corporate websites (Ediger, 2013). Companies' ESG information that contributes to ESG disclosure include companies' performance on climate risks, carbon emissions, energy efficiency and intensity, community programmes, health and safety policies, waste creation, water consumption, recycling, and many more (see Bloomberg Fundamentals ESG).

The more accurate a company discloses on any of Bloomberg's ESG data variables, the better a company's ESG disclosure quality. Bloomberg's ESG disclosure variable is updated regularly, but generally available on an annual basis at the end of each calendar year. A firm's ESG disclosure can vary from '0' to '100' percent in any given year. '0' indicates very poor ESG disclosure quality and practices, whereas '100' would indicate very strong ESG disclosure quality and practices.

The main advantage of using Bloomberg's ESG disclosure variable over self-constructed ESG disclosure variables, are that of comparability and standardisation across companies. While previous research on ESG disclosure has relied on self-constructed ESG disclosure variables (see e.g. Clarkson et al., 2013; Dhaliwal et al., 2011; Plumlee et al., 2010), I aim to overcome the shortcomings of self-constructing an ESG disclosure variable by using Bloomberg's standardised ESG disclosure variable.[103] Another advantage of using Bloomberg's ESG disclosure variable relative to self-constructed ESG disclosure variables, is to increase the reliability and validity of the relationship between ESG disclosure and the cost of capital, using an alternative proxy for ESG disclosure quality.

7.3.3 Dependent Variables

The following chapter describes my choice of key variables of the cost of capital to investigate the relevance of ESG disclosure for debt and equity investors.

7.3.3.1 Expected Cost of Equity

I use four key variables to capture the expected cost of equity to empirically test the relevance of ESG disclosure for equity investors: Bloomberg's cost of equity, cost of equity based on

[103] As there is currently no regulation on voluntary ESG disclosure, companies tend to report their data in different formats, which could introduce a bias when self-constructing ESG disclosure variables.

the capital asset pricing model, cost of equity based on Fama and French's three-factor model, and cost of equity based on Carhart's four-factor model. To compute all alternative versions of the cost of equity, I obtain data from Bloomberg, Graham and Harvey's survey data on the Equity Risk Premium[104], Kenneth French's Data Library[105], and Thomson Reuters Datastream. My first dependent variable is based on Bloomberg's cost of equity. Bloomberg's cost of equity in a given year equals the risk-free rate plus the company's beta coefficient multiplied by the expected equity market premium. Bloomberg estimates a company's beta coefficient using the capital asset pricing model (See e.g. Equation 4 in Chapter 3.6.3.2. 'Regression Analysis') based on weekly observations over the previous two years. My remaining dependent variables are based on my own computations and represent alternative versions of the expected cost of equity and differ somewhat from Bloomberg's cost of equity.

My second dependent variable is the expected cost of equity based on Graham and Harvey's annual surveys on the expected market premium. The expected cost of equity equals the risk-free rate plus a company's beta coefficient multiplied by the expected equity market premium which I obtain from Graham and Harvey's annual surveys on the expected equity risk premium based on survey data of US Chief Financial Officers from S&P 500 companies. Using survey data of expected equity risk premia is similar to using analyst earnings per share forecasts (EPS) commonly used to compute implied cost of equities (See e.g. Dhaliwal et al., 2011, 2012; El Ghoul et al., 2011; Plumlee et al., 2010). I infer a company's beta coefficient by estimating the capital asset pricing model based on daily, weekly, and monthly observations using Equation 4 in Chapter 3.6.3.2. 'Regression Analysis'). I use daily, weekly, and monthly data frequencies to increase the robustness of my estimations as well as to avoid known biases such as the trading frequency bias with short-interval data (See e.g. Dimson, 1979; Roll, 1981; Scholes and Williams, 1977).

My third dependent variable expands the second dependent variable and adds a company's size coefficient multiplied by the size premium as well as a value coefficient multiplied by the value premium. I infer the additional size and value coefficients using Fama and French's three factor model (See e.g. Equation 5 in Chapter 3.6.3.2. 'Regression Analysis').

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[104] Graham and Harvey (2015) conduct and publish quarterly surveys of US Chief Financial Officers from S&P 500 companies to obtain the expected risk premium. Graham and Harvey's (2015) survey data on the expected equity risk premium goes back to 1996 and is available online on SSRN and the following website: http://www.cfosurvey.org/past-results-2015.html).

[105] Kenneth French's Data Library is available online:
http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

My fourth dependent variable expands the third dependent variable once more and adds a company's momentum coefficient multiplied by the momentum premium. I infer the additional momentum coefficient using Carhart's four factor model (See e.g. Equation 6 in Chapter 3.6.3.2. 'Regression Analysis'). I re-estimate and calculate each of my dependent variables using daily, weekly, and monthly data frequencies. Overall, I produce nine expected cost of equities inferred from three asset pricing models including CAPM, Fama and French, and Carhart (See Equations 4 to 6 in Chapter 3.6.3.2. 'Regression Analysis').

My expected cost of equity models relative to implied cost of equity models require fewer assumptions about earnings forecasts. Even the simplest implied cost of equity model (see e.g. Easton's, 2004 implied cost of equity based on the Price-Earnings-Growth Ratio) requires at least two year ahead positive earnings forecasts (El Ghoul et al., 2011). In addition, companies require positive actual earnings per share figures. Companies with negative earnings forecasts will be either excluded from the sample or "replaced by the value implied by a 6% return on assets" (El Ghoul et al., 2011:2402). Excluding companies with negative earnings forecasts considerably reduces the sample size and representativeness of the sample. Thus, to overcome the shortcomings of the implied cost of equity model by shortening my sample size due to companies' negative earnings forecasts, I use Graham and Harvey's survey data on the expected equity risk premium to infer my expected cost of equities. This ensures that my initial sample size stays intact.

A second shortcoming of the implied cost of equity approach is a common bias called the analyst's forecast optimism bias. It is common among analysts to provide overly optimistic company earnings forecasts, which could introduce a bias in the implied cost of equity estimate (El Ghoul et al., 2011; Kothari, 2001). Controlling for this bias is not always straigthforward. Thus, my approach to compute the expected cost of equity based on Graham and Harvey's survey data on the expected equity risk premium is a more conservative approach.

7.3.3.2 Cost of Debt

I use one key variable to capture the cost of debt to test the relevance of ESG disclosure for debt investors: corporate yield spreads. The corporate yield spread of a certain bond class represents the average yield spread between corporate bonds and government bonds. Bloomberg computes a 'debt adjustment factor' which reflects a company's credit rating in the calculation of the cost of debt. I collect the cost of debt variable directly from Bloomberg.

Bloomberg's cost of debt variable is available on an annual basis at the end of each calendar year.

7.3.4 Control Variables

In my empirical analysis, I include a number of independent variables in my regression models, inspired by the existing literature related to the determinants of the cost of equity and the cost of debt (See e.g. Bradley and Chen, 2015; Dhaliwal et al., 2011; El Ghoul et al., 2011; Oikonomou et al. 2014; Harjoto and Jo, 2014; Bauer and Hann, 2010). I distinguish the included independent variables as controls for cost of equity firm characteristics and cost of debt bond characteristics.

7.3.4.1 Cost of Equity Firm Characteristics

The first set of control variables are cost of equity firm characteristics, which I obtain from Thomson Reuters Datastream.

Size measures company size and is defined as the natural logarithm of companies' total assets. As larger companies tend to have lower operating and financial risks they could enjoy reduced cost of equity valuations (Harjoto and Jo, 2014; Oikonomou et al., 2014). *Leverage* is the financial leverage of a company and is defined as the ratio of total liabilities to total assets. Companies with higher leverage and debt levels are associated with increasing risk of default. Thus, highly leveraged companies tend to have increased cost of equity capitals (Dhaliwal et al., 2011; El Ghoul et al., 2011; Fama and French, 1992). *Market-to-Book* is the ratio of a company's market value relative to its book value and is defined as the ratio of a company's total assets minus common shareholder's equity plus the company's market value divided by total assets. The Market-to-Book ratio is an additional indicator of distress (Oikonomou et al., 2014). *ROA* is the accounting return on assets and is defined as the ratio of income before extraordinary items divided by total assets. It appears that companies with a weaker profitability position are more eager to increase ESG disclosure quality (See e.g. Aerts et al., 2008). *Return Volatility* represents a company's stock return volatility and is defined as the natural logarithm of the annualised standard deviation. I compute the annualised standard deviation based on daily stock returns for company i for at least 100 daily observations per year. *Interest Coverage* represents the interest coverage ratio which is defined as the ratio of operating income before depreciation and amortization over total interest expenses. Companies that are better able to serve its debt obligations are seen as less risky and therefore tend to have lower cost of equity valuations (Bauer and Hann, 2010).

Research and Development (R&D) intensity is a company's R&D expenditure and is defined as the ratio of R&D expenses over total assets. It has been shown that companies investing in R&D could be exposed to increasing levels of risk (Oikonomou et al., 2014). *Capex* equals the capital expenditure ratio which describes a company's capital expenses on new or existing fixed assets. Capex is the ratio of capital expenditure over total assets. *Capital intensity* is computed as the ratio of property, plant, and equipment (PPE) over total assets. Both, Capex and Capital intensity are common proxies for companies' financial risks (Bauer and Hann, 2010). Meaning that companies with increased capital intensity are perceived as having greater financial risks (Bauer and Hann, 2010). *Advertising intensity* is a company's advertising expenditure and defined as the ratio of advertising expenses over total assets. Companies with increased advertising intensity (or advertising expenditures) incur higher costs and could be therefore seen as riskier (Harjoto and Jo, 2014). *Sales Growth* represents a company's one-year sales growth and is defined as the ratio of the natural logarithm of total net sales at time t divided by total net sales at time t-1. A company's improved sales growth signals its ability to better cover costs and maintain solvent (Bradley and Chen, 2015). *Free Cash Flows* represent a company's cash flows after accounting for capital expenditures and are defined as the ratio of income before extraordianry income minus depreciation over the lag of property, plant, and equipment. Cash flow can be understood as a measure of the short-term liquidity and more importantly the solvency of a company (Oikonomou et al., 2014).

7.3.4.2 Cost of Debt Bond Characteristics

The second set of control variables are bond-specific and control for cost of debt bond characteristics, which I obtain from Thomson Reuters Datastream.

Bond Liquidity represents the amount of debt originally issued. I compute the natural logarithm of the amount issued at par value to proxy for bond liquidity. *Bond Rating* represents S&P's historical bond ratings. I convert the original ratings issued by S&P into numerical time-series and groups as follows: Bond ratings with AAA are equal to bond group 7. Bond ratings <= AA+ and >= AA- are equal to bond group 6. Bond ratings <= A+ and >= A- are equal to bond group 5. Bond ratings <= BBB+ and >= BBB- are equal bond group 4. Bond ratings <= BB+ and >= BB- are equal bond group 3. Bond ratings <= B+ and >= B- are equal bond group 2. All other corporate bonds that have been rated CCC+ and below are equal to bond group 1. *Bond Maturity* represent the years to maturity of a company's bonds and are defined as the natural logarithm of the number of years the bonds have been issued. *Bond Duration* equals the modified duration of a bond in years and measures a bond's interest rate risk. It is defined as the natural logarithm of the number of years. *Bond Convexity* measures the relation between a bond's price and yield duration. It is defined as the natural logarithm of the convexity of a bond. Finally, *Subordinated Debt* is a dummy variable and equals 1 if the bonds of a company are classified as subordinated debt, and 0 otherwise.

7.3.5 Regression Models

To empirically analyse the effects of ESG disclosure quality on the expected cost of equity and cost of debt, and to test my two hypotheses, I use the following regression models (19) to (23):

$$\mathrm{C}_{\mathrm{E(Bloomberg)}_{\mathrm{i,t}}} = f\ (\mathrm{ESGdisc}_{\mathrm{i,t\text{-}1}}, \mathrm{Company\ Characteristics}_{i,t-1}) \quad (19)$$

$$\mathrm{C}_{\mathrm{E(Capm)}_{\mathrm{i,t}}} = f\ (\mathrm{ESGdisc}_{\mathrm{i,t\text{-}1}}, \mathrm{Company\ Characteristics}_{i,t-1}) \quad (20)$$

$$\mathrm{C}_{\mathrm{E(Fama\&French)}_{\mathrm{i,t}}} = f\ (\mathrm{ESGdisc}_{\mathrm{i,t\text{-}1}}, \mathrm{Company\ Characteristics}_{i,t-1}) \quad (21)$$

$$\mathrm{C}_{\mathrm{E(Carhart)}_{\mathrm{i,t}}} = f\ (\mathrm{ESGdisc}_{\mathrm{i,t\text{-}1}}, \mathrm{Company\ Characteristics}_{i,t-1}) \quad (22)$$

$$\mathrm{C}_{\mathrm{D(Bloomberg)}_{\mathrm{i,t}}} = f\ (\mathrm{ESGdisc}_{\mathrm{i,t\text{-}1}}, \mathrm{Company\ Characteristics}_{i,t-1}, \mathrm{Bond\ Characteristics}_{i,t-1}) \quad (23)$$

where, $\mathrm{C}_{\mathrm{E(Bloomberg)}_{\mathrm{i,t}}}$ is my first proxy for the expected cost of equity, which I obtain from Bloomberg. The cost of equity is associated with company i in year t. Firm characteristics are the variables described in Chapter 7.3.4.1. 'Cost of Equity Firm Characteristics', and are the same across all alternative specifications as well as for the cost of debt regression. $\mathrm{C}_{\mathrm{E(Capm)}_{\mathrm{i,t}}}$, $\mathrm{C}_{\mathrm{E(Fama\&French)}_{\mathrm{i,t}}}$, $\mathrm{C}_{\mathrm{E(Carhart)}_{\mathrm{i,t}}}$ are my additional proxies for the expected cost of equity. These are based on Graham and Harvey's annual survey on the expected market premium and inferred from three alternative asset pricing models including CAPM, Fama and French, and Carhart models using daily, weekly, and monthly data frequencies. The expected cost of equities are associated with company i in year t. My final depenent variable, $\mathrm{C}_{\mathrm{D(Bloomberg)}_{\mathrm{i,t}}}$ represents my proxy for the cost of debt, which I obtain from Bloomberg. The cost of debt is associated with company i in year t. In addition to firm characteristics, I also include bond characteristics, which are all variables described in Chapter 7.3.4.2. 'Cost of Debt Bond Characteristics'.

Consistent with previous literature on the relationship between the cost of capital and disclosure (see e.g. Clarkson et al., 2013; Dhaliwal et al., 2011; El Ghoul et al., 2011; Harjoto and Jo, 2014; Oikonomou et al., 2014) my ESG disclosure quality variable and all other independent variables are lagged in all models. This is done to overcome potential issues related to reverse causality and simultaneity (Harjoto and Jo, 2014; Oikonomou et al., 2014), as well as to ensure that the information content in my ESG disclosure variable has been fully disseminated to all investors (Clarkson et al., 2013). Thus, lagging my ESG disclosure variable helps to ensure that this information is public knowledge at time t, and has begun to be incorporated by the market in the price formation process (Godfrey et al., 2009; Oikonomou et al., 2014).

7.4 Empirical Results

7.4.1 Summary Statistics and Correlations

Table 17 provides summary statistics for my dependent variables including expected cost of equity and cost of debt proxies. The table reports individual summary statistics for each of the ten expected cost equity and one cost of debt capital such as mean, median (p50), standard deviation (sd), minimum, maximum, and the average annual number of companies over the full sample period for each of ICB's ten super sectors (these include 1-Oil and Gas, 1000-Basic Materials, 2000-Industrials, 3000-Consumer Goods, 4000-Health Care, 5000-Consumer Services, 6000-Telecommunications, 7000-Utilities, 8000-Financials, 9000-Technology.

Across all sectors the average expected cost of equity ranges from 5.94 percent to 11.1 percent, per annum. Bloomberg's cost of equity estimates are always highest across all sectors and also within sectors relative to my alternative versions of the cost of equity. For example, my expected cost of equity capital proxies which I infer from Graham and Harvey's (2015) expected market risk premium and estimate via traditional asset pricing models are more similar to El Ghoul et al.'s (2011) average implied cost of equity. They report an average implied cost of equity of 4.75 percent over the sample period from 1992 to 2007, per annum. While, Bloomberg's expected cost of equity is more similar to Dhaliwal et al.'s (2011) average implied cost of equity of 11.98 percent per annum.

Table 17 also reports on individual sectors' average cost of equities. Companies with higher cost of equities relative to the all sector average tend to be found in the Oil and Gas, Basic Materials, Industrials, and Technology sectors. While companies with relatively lower cost of equties are found in the Consumer Goods, Health Care, Consumer Services, Telecommunications, and Utilities sectors. These findings are consistent across all ten alternative cost of equity proxies. An exception is the Financial Sector's cost of equity, which is not consistent across different measures and displays higher or lower cost of equities relative to the all sector average depending on the method used. For example, the Financial's cost of equity tends to be higher than the all sector average when using the CAPM model rather than Fama and French or Carhart asset pricing models.

In Table 17, I also report summary statistics for my cost of debt proxy. All sectors combined have an average cost of debt capital of 2.96 percent per annum, over the full sample period. The cost of debt figure is very similar to Oikonomou et al.'s (2014) average annual yield spread of 2.9 percent over the sample period from 1992 to 2008.

To investigate individual sectors' cost of debt capital, Table 17 distinguishes between the cost of debt for ICB's ten super sectors. Individual sectors that display relatively higher cost of debt capitals include the Oil and Gas (3.07), Basic Materials (3.44), Consumer Goods (3.03), Health Care (3.02), Telecommunications (3.45), Utilities (3.03), and Financials (2.97). While, companies in sectors with relatively lower cost of debt are found in the Industrials (2.94), Consumer Services (2.86), and Technology sectors (2.62).

The following section continues with a correlation analysis between my dependent variables and summary statistics for my ESG disclosure variable.

Table 18 reports Pearson correlation coefficients between my eleven dependent variables including Bloomberg's cost of debt, Bloomberg's cost of equity, cost of equities based on Graham and Harvey's (2015) equity market premium estimated with CAPM, Fama and French, and Carhart asset pricing models using daily, weekly, and monthly data frequencies. My results show that all cost of equity estimates are positively correlated to some degree. For example, Bloomberg's cost of equity and my alternative versions of the cost of equity are very similar. The correlations between Bloomberg's cost of equity and the cost of equities based on my computations range between 54.74 percent and 75.64 percent. All correlation coefficients are statistically significant at the 1 percent significance level. Similarly, the correlations among my alternative cost of equities tend to correlate in the range of 55.02 percent and 96.79 percent. My findings indicate that all cost of equities are generally very similar over the estimated sample period. Table 18 also displays the correlations between Bloomberg's cost of debt capital and my cost of equity estimates. As expected Pearson correlation coefficients are much lower between the cost of debt and cost of equity capital. The correlations between Bloomberg's cost of debt and all cost of equity proxies ranges between 1.05 percent and 15.21 percent.

Table 17: Summary Statistics for Dependent Variables by Sector

Sector		CD Bloomberg	CE Bloomberg	Daily Data CE CAPM	Daily Data CE Fama/French	Daily Data CE Carhart	Weekly Data CE CAPM	Weekly Data CE Fama/French	Weekly Data CE Carhart	Monthly Data CE CAPM	Monthly Data CE Fama/French	Monthly Data CE Carhart
All Sectors	mean	0.0296	0.1111	0.0595	0.0599	0.0594	0.0611	0.0609	0.0605	0.0618	0.0634	0.0628
	p50	0.0294	0.1072	0.0577	0.0578	0.0576	0.0586	0.0581	0.0581	0.0572	0.0597	0.0590
	sd	0.0154	0.0287	0.0182	0.0199	0.0195	0.0220	0.0240	0.0244	0.0270	0.0283	0.0282
	min	0.0000	-0.0639	-0.0226	-0.0265	-0.0201	-0.0103	-0.0739	-0.0755	-0.0126	-0.0287	-0.0861
	max	0.1133	0.8650	0.1636	0.2039	0.1924	0.2740	0.2978	0.2818	0.4104	0.4046	0.4124
	n	6238	6236	6074	6074	6074	6074	6014	6014	5998	5998	5998
0001 Oil & Gas	mean	0.0307	0.1175	0.0657	0.0720	0.0751	0.0678	0.0708	0.0752	0.0619	0.0709	0.0767
	p51	0.0304	0.1185	0.0655	0.0749	0.0740	0.0681	0.0702	0.0703	0.0594	0.0671	0.0749
	sd	0.0126	0.0230	0.0146	0.0247	0.0252	0.0172	0.0258	0.0278	0.0190	0.0226	0.0245
	min	0.0035	0.0594	0.0240	-0.0011	0.0225	0.0144	-0.0339	-0.0287	0.0239	0.0205	0.0199
	max	0.0786	0.1855	0.1060	0.1332	0.1439	0.1186	0.1380	0.1592	0.1417	0.2048	0.1977
	n	497	497	487	487	487	485	479	479	477	477	477
1000 Basic Materials	mean	0.0344	0.1235	0.0691	0.0731	0.0745	0.0709	0.0732	0.0750	0.0716	0.0799	0.0823
	p52	0.0341	0.1180	0.0671	0.0677	0.0673	0.0688	0.0677	0.0693	0.0663	0.0718	0.0731
	sd	0.0163	0.0293	0.0206	0.0293	0.0298	0.0230	0.0307	0.0329	0.0286	0.0339	0.0370
	min	0.0000	0.0323	0.0159	0.0008	0.0101	-0.0103	-0.0293	-0.0198	0.0007	-0.0099	-0.0087
	max	0.0803	0.2116	0.1500	0.2039	0.1924	0.1401	0.2021	0.2033	0.1971	0.2049	0.2108
	n	322	322	320	320	320	320	317	317	315	315	315
2000 Industrials	mean	0.0294	0.1133	0.0610	0.0618	0.0615	0.0635	0.0636	0.0634	0.0642	0.0667	0.0657
	p53	0.0293	0.1110	0.0604	0.0606	0.0602	0.0629	0.0621	0.0620	0.0614	0.0636	0.0633
	sd	0.0146	0.0209	0.0145	0.0156	0.0155	0.0180	0.0198	0.0203	0.0225	0.0253	0.0245
	min	0.0000	0.0324	0.0129	0.0131	0.0134	0.0149	0.0036	0.0020	-0.0107	-0.0263	-0.0427
	max	0.0789	0.1976	0.1227	0.1238	0.1294	0.1454	0.1520	0.1578	0.1798	0.2517	0.2533
	n	960	960	922	922	922	926	920	920	920	920	920
3000 Consumer Goods	mean	0.0303	0.1044	0.0532	0.0544	0.0536	0.0552	0.0558	0.0552	0.0547	0.0558	0.0541
	p54	0.0304	0.0977	0.0513	0.0513	0.0518	0.0514	0.0518	0.0521	0.0506	0.0524	0.0512
	sd	0.0142	0.0273	0.0165	0.0178	0.0161	0.0219	0.0225	0.0218	0.0232	0.0243	0.0230
	min	0.0000	0.0592	-0.0226	-0.0265	-0.0201	0.0129	0.0049	0.0005	0.0036	-0.0048	-0.0054
	max	0.0813	0.2368	0.1101	0.1228	0.1265	0.1598	0.1398	0.1488	0.1476	0.1543	0.1436
	n	730	730	709	709	709	707	700	700	696	696	696
4000 Health Care	mean	0.0302	0.0978	0.0518	0.0537	0.0530	0.0520	0.0541	0.0535	0.0480	0.0498	0.0505
	p55	0.0301	0.0959	0.0506	0.0531	0.0529	0.0501	0.0527	0.0522	0.0440	0.0471	0.0480
	sd	0.0148	0.0175	0.0132	0.0140	0.0138	0.0175	0.0192	0.0194	0.0188	0.0194	0.0200
	min	0.0000	0.0582	0.0133	0.0132	0.0039	0.0055	-0.0125	-0.0169	0.0055	0.0049	-0.0111
	max	0.0806	0.2244	0.1144	0.1145	0.1134	0.1516	0.1268	0.1254	0.1479	0.1558	0.1440
	n	573	572	561	561	561	556	549	549	550	550	550
5000 Consumer Services	mean	0.0286	0.1089	0.0565	0.0577	0.0560	0.0584	0.0586	0.0569	0.0598	0.0603	0.0580
	p56	0.0286	0.1053	0.0560	0.0567	0.0560	0.0553	0.0554	0.0549	0.0571	0.0579	0.0557
	sd	0.0145	0.0242	0.0151	0.0152	0.0137	0.0206	0.0217	0.0207	0.0242	0.0251	0.0247

	min	0.0000	-0.0432	0.0167	0.0162	0.0130	-0.0001	-0.0107	-0.0016	-0.0126	-0.0132	-0.0861
	max	0.0807	0.2377	0.1067	0.1157	0.1016	0.1545	0.1738	0.1769	0.2240	0.2001	0.2012
	n	902	902	868	868	868	862	855	855	852	852	852
	mean	0.0345	0.0985	0.0478	0.0484	0.0489	0.0507	0.0503	0.0512	0.0558	0.0600	0.0580
	p57	0.0349	0.0951	0.0467	0.0469	0.0463	0.0487	0.0491	0.0520	0.0543	0.0551	0.0555
6000	sd	0.0140	0.0197	0.0139	0.0141	0.0125	0.0171	0.0152	0.0128	0.0248	0.0279	0.0268
Telecommunications	min	0.0149	0.0748	0.0251	0.0252	0.0312	0.0241	0.0125	0.0228	0.0181	0.0176	0.0174
	max	0.0741	0.1848	0.0891	0.0907	0.0876	0.1170	0.1047	0.0947	0.1549	0.1612	0.1694
	n	70	70	58	58	58	60	57	57	55	55	55
	mean	0.0303	0.0898	0.0457	0.0488	0.0507	0.0456	0.0490	0.0504	0.0419	0.0502	0.0500
	p58	0.0303	0.0889	0.0472	0.0510	0.0522	0.0463	0.0517	0.0523	0.0415	0.0485	0.0495
7000	sd	0.0123	0.0158	0.0137	0.0176	0.0184	0.0154	0.0200	0.0223	0.0177	0.0267	0.0249
Utilities	min	0.0102	0.0037	0.0115	0.0100	0.0115	-0.0011	-0.0033	-0.0089	0.0040	0.0058	0.0051
	max	0.0740	0.1551	0.0926	0.0992	0.1112	0.1002	0.1068	0.1285	0.1121	0.2455	0.2221
	n	389	389	378	378	378	378	375	375	376	376	376
	mean	0.0297	0.1190	0.0657	0.0597	0.0573	0.0661	0.0599	0.0572	0.0664	0.0609	0.0595
	p59	0.0287	0.1100	0.0609	0.0567	0.0562	0.0612	0.0566	0.0559	0.0605	0.0560	0.0559
8000	sd	0.0148	0.0367	0.0223	0.0219	0.0202	0.0262	0.0271	0.0266	0.0317	0.0329	0.0317
Financials	min	0.0000	-0.0639	0.0095	-0.0132	-0.0180	-0.0063	-0.0739	-0.0755	0.0087	-0.0287	-0.0339
	max	0.1133	0.4089	0.1636	0.1520	0.1323	0.2740	0.2978	0.2818	0.4104	0.4046	0.4124
	n	1053	1053	1065	1065	1065	1056	1046	1046	1048	1048	1048
	mean	0.0262	0.1191	0.0642	0.0639	0.0630	0.0668	0.0673	0.0664	0.0786	0.0791	0.0771
	p60	0.0258	0.1152	0.0626	0.0625	0.0617	0.0626	0.0656	0.0636	0.0735	0.0752	0.0737
9000	sd	0.0208	0.0343	0.0173	0.0168	0.0162	0.0217	0.0222	0.0219	0.0303	0.0267	0.0263
Technology	min	0.0000	0.0359	0.0033	0.0024	-0.0051	0.0121	-0.0009	0.0115	0.0160	0.0049	0.0003
	max	0.0796	0.8650	0.1214	0.1320	0.1312	0.1792	0.1668	0.1716	0.1826	0.1757	0.1659
	n	742	741	706	706	706	724	716	716	709	709	709

Notes: This table displays summary statistics for my cost of capital proxies such as Bloomberg's cost of debt, Bloomberg's cost of equity, cost of equities estimates based on CAPM, Fama and French, and Carhart models for each of ICB's ten super-sectors. Summary statistics include mean, median (p50), standard deviations, minimum, maximum, and the average number of firms in each sector over the sample period from 2004 to 2014.

In Table 19, I report summary statistics for my ESG Disclosure quality variable for each of ICB's ten super-sectors over the full sample period from 2004 to 2014. The figures are presented in percentages and show strong variation over time. Table 19 shows the total average ESG disclosure quality of all industries is 26.67 percent. Companies from four sectors including Industrials, Health Care, Consumer Services, and Financials have a disclosure quality below the all sector average, while companies from six sectors such as Oil & Gas, Basic Materials, Consumer Goods, Telecommunications, Utilities, and Technology have higher than the all sector average ESG disclosure quality. These figures are consistent with Dhaliwal et al. (2011) and Plumlee et al. (2010), which show that companies in the Utilities, Chemicals, and Food sectors tend to disclose more information, using self-constructed ESG Disclosure variables to measure ESG activities. Table 19 also reports sector medians. Sector medians are almost identical with sector averages, except for the Oil & Gas sector, which falls below the sector median of 21.90 percent. While companies in the two super-sectors Basic Materials and Industrials have the lowest ESG disclosures of 2.89 percent on average, companies in the Oil & Gas and Technologies sector disclose the most, with 78.01 percent and 77.27, respectively. Further, Table 19 displays skewness and kurtosis of my ESG disclosure quality variable. Across all sectors, my ESG disclosure variable has a skewness and kurtosis of 0.98 and 3.12, respectively. While the results on the skewness of my ESG disclosure quality variable show that it tends to be somewhat positively skewed relative to a normal (Gaussian) distribution, my results on the excess kurtosis show that my variable is identical to a normal distribution.

Table 18: Correlations between Dependent Variables

			[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
	Cost of Debt Bloomberg	[1]	1										
	Cost of Equity Bloomberg	[2]	0.0105 ***	1									
	Cost of Equity CAPM	[3]	0.1454 ***	0.7012 ***	1								
Daily	Cost of Equity Fama/French	[4]	0.0981 ***	0.6213 ***	0.9267 ***	1							
	Cost of Equity Carhart	[5]	0.0848 ***	0.5474 ***	0.8591 ***	0.9539 ***	1						
	Cost of Equity CAPM	[6]	0.1521 ***	0.7564 ***	0.8984 ***	0.8294 ***	0.7685 ***	1					
Weekly	Cost of Equity Fama/French	[7]	0.0917 ***	0.6400 ***	0.7734 ***	0.8414 ***	0.8164 ***	0.8859 ***	1				
	Cost of Equity Carhart	[8]	0.0873 ***	0.5625 ***	0.7020 ***	0.7842 ***	0.8270 ***	0.8191 ***	0.9583 ***	1			
	Cost of Equity CAPM	[9]	0.0886 ***	0.6655 ***	0.7083 ***	0.6629 ***	0.6246 ***	0.6980 ***	0.6030 ***	0.5502 ***	1		
Monthly	Cost of Equity Fama/French	[10]	0.1240 ***	0.6044 ***	0.6892 ***	0.6717 ***	0.6313 ***	0.6813 ***	0.6134 ***	0.5590 ***	0.9408 ***	1	
	Cost of Equity Carhart	[11]	0.1032 ***	0.5857 ***	0.6807 ***	0.6839 ***	0.6491 ***	0.6684 ***	0.6222 ***	0.5736 ***	0.9009 ***	0.9679 ***	1

Notes: This table displays Pearson's pair-wise correlation coefficients between my dependent variables including Bloomberg's cost of debt, Bloomberg's cost of equity, cost of equities estimated with the CAPM, Fama and French's three factor model, and Carhart's four factor model based on daily, weekly, and monthly data frequencies. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 19: Summary Statistics for my ESG Disclosure Quality variable

ESG Disclosure by Sector	mean	p50	sd	min	max	skew	exc.kurt	N
All Sectors	26.67	21.90	13.92	2.89	78.01	0.98	3.12	3976
0001 Oil & Gas	27.12	20.66	15.51	7.85	78.01	1.26	3.84	319
1000 Basic Materials	33.38	30.37	16.22	2.89	74.38	0.49	2.16	204
2000 Industrials	25.22	21.49	12.35	2.89	65.70	0.97	3.09	619
3000 Consumer Goods	30.56	28.93	14.67	5.79	70.25	0.59	2.40	476
4000 Health Care	26.56	20.66	14.58	6.61	72.31	0.84	2.48	371
5000 Consumer Services	22.46	19.01	9.80	6.20	51.24	0.91	2.87	580
6000 Telecommunications	29.14	25.51	13.55	13.99	62.96	0.58	2.39	42
7000 Utilities	32.83	31.32	13.70	11.70	67.55	0.38	2.18	255
8000 Financials	22.27	16.67	12.26	8.68	71.93	1.66	5.16	643
9000 Technology	29.18	24.38	15.00	10.74	77.27	0.70	2.53	467

Notes: This table reports summary statistics for my ESG Disclosure Quality variable including mean, median (p50), standard deviations, minimum, maximum, skewness, kurtosis, and the average number of firms in ten different sectors over the sample period from 2004 to 2014.

The next table, Table 20, displays the essential summary statistics for all of my explanatory variables including mean, median (p50), standard deviation, minimum, maximum, and mean observations over the full sample period from 2004 to 2014, all of which I will be using in my multivariate regression analysis. Table 20 includes cost of equity company-specific explanatory variables as well as cost of debt bond-specific explanatory variables.

Table 20: Summary Statistics for Independent Variables

	mean	p50	sd	min	max	N
Panel A:						
ESG Disclosure Quality	26.67	21.90	13.92	2.89	78.01	3976
Size (log $millions)	16.25	16.11	1.46	10.36	21.61	6234
Leverage (%)	0.60	0.59	0.22	-0.16	2.03	6211
Market-to-Book (%)	0.61	0.61	0.22	-0.16	1.80	6048
ROA (%)	0.06	0.05	0.08	-0.89	0.77	6212
Volatility (log $millions)	5.37	5.43	1.73	-3.57	13.82	6049
Interest Coverage	2.51	2.38	1.36	-8.44	10.22	5690
R&D Intensity (%)	0.05	0.03	0.06	0.00	0.85	2689
Capex (%)	0.05	0.03	0.05	0.00	0.47	6025
Cash Flows	0.40	0.15	2.42	-52.00	58.14	5961
Capital Intensity (%)	0.28	0.18	0.26	0.00	0.97	6138
Advertising	0.19	0.15	0.17	0.00	1.18	5735
Sales Growth	1.71	1.07	47.08	0.13	3702.47	6182
Panel B:						
Bond Liquidity (log $millions)	12.96	12.99	0.65	8.61	17.04	5330
Bond Rating	3.65	4.00	1.26	1.00	7.00	3964
Years to Maturity (years)	12.47	10.84	5.99	0.00	43.94	5332
Convexity (log years)	3.72	3.94	1.03	-0.23	5.83	3013
Duration (log years)	1.70	1.74	0.59	-2.01	4.86	4272
Subordinated	0.02	0.00	0.13	0.00	1.00	6656

Notes: This table displays summary statistics for my Independent variables including mean, median (p50), standard deviations, minimum, maximum, and the average number of firms over the sample period from 2004 to 2014.

Further, in Table 21, I report Pearson correlation coefficients between my independent regression variables to investigate any potential Multicollinearity that could bias my multivariate regression results. I find two variables, namely, Leverage and Market-to-Book ratio to be particularly highly correlated (98.95 percent), which could cause Multicollinearity issues. To avoid estimation bias through Multicollinearity, I exclude the Market-to-Book ratio from all of my multivariate regressions and always only include the Leverage variable. The second highest correlation of -54.79 percent is found between the Interest Coverage and Market-to-Book ratio. Generally, this correlation level should not be a concern for Multicollineartiy, but given that I entirely exclude the Market-to-Book ratio from my analysis, due to the initial correlation with the leverage variable, I further reduce the probability of estimation bias in my regression analysis.

Table 21: Correlations between Independent Variables

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]
[1]	ESG Disclosure Quality	1																		
[2]	Size	0.3593***	1																	
[3]	Leverage	0.0051	0.3176***	1																
[4]	Market-to-Book	0.0024	0.3379***	0.9895***	1															
[5]	ROA	0.0560***	-0.0572***	-0.0729***	-0.0771***	1														
[6]	Volatility	0.1018***	0.1056***	-0.1563***	-0.1651***	0.0093	1													
[7]	Interest Coverage	0.0347**	-0.2354***	-0.5171***	-0.5479***	0.4748***	0.1701***	1												
[8]	R&D Intensity	-0.0944***	-0.3267***	-0.1596***	-0.1792***	-0.2602***	-0.0997***	0.2043***	1											
[9]	Capex	0.0205	-0.0825***	-0.0930***	-0.0787***	0.0307***	0.0314***	0.0443***	-0.0473***	1										
[10]	Cash Flows	0.0088	0.0541***	-0.0346***	-0.0326***	0.0907***	0.0326***	0.1745***	-0.2051***	-0.0750***	1									
[11]	Capital Intensity	0.1104***	-0.0122	-0.0064	0.0078	-0.0166	-0.0112	-0.2185***	-0.2629***	0.6058***	-0.0828***	1								
[12]	Advertising	-0.0384**	-0.4118***	-0.0759***	-0.1079***	0.0376***	0.0458***	0.2449***	0.5282***	-0.0660***	-0.0091	-0.2294***	1							
[13]	Sales Growth	-0.0450***	-0.0093	-0.0052	-0.0057	-0.0086	-0.0056	0.0892***	0.0597***	0.0555***	-0.0029	0.0136	-0.0134	1						
[14]	Bond Liquidity	0.0635***	0.0806***	-0.1439***	-0.1320***	0.0294**	-0.0010	0.1806***	0.2822***	-0.0033	0.0276**	-0.0570***	-0.0226*	-0.0091	1					
[15]	Bond Rating	0.2095***	0.4365***	-0.0862***	-0.0668***	0.0632***	0.2872***	0.2180***	-0.1568***	-0.0498***	0.0658***	-0.1126***	-0.0748***	-0.0282*	0.0823***	1				
[16]	Years to Maturity	0.1119***	0.1330***	0.0028	-0.0044	0.0265**	0.0379***	0.0138	-0.1513***	0.0329**	0.0047	0.1221***	-0.0787***	-0.0020	-0.0155	0.2527***	1			
[17]	Convexity	0.0584***	0.0917***	0.0256	0.0095	-0.0392**	0.1132***	-0.0193	0.0125	0.0118	-0.0195	-0.0089	0.0300	-0.0172	-0.0543***	0.0576***	0.0903***	1		
[18]	Duration	0.1620***	0.1420***	-0.1038***	-0.0910***	0.0220	0.0099	0.0890***	-0.0426*	0.0517***	0.0287**	0.0343**	0.0110	0.0138	0.1475***	0.1773***	0.4239***	0.0372**	1	
[19]	Subord.	0.0424***	0.1582***	0.0490***	0.0563***	-0.0029	-0.0026	-0.0894***	-0.0356**	-0.0146	-0.0180	-0.0076	-0.0587***	-0.0015	-0.0276**	0.0133	-0.0328***	0.0530***	-0.0023	1

Notes: This table displays Pearson's pair-wise correlation coefficients between my independent regression variables. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

7.4.2 *Univariate Analysis*

Following my initial summary statistics and correlation analysis of all dependent and independent variables, I will now continue with a univariate comparison analysis.

Table 22 displays the results of my univariate comparison analysis between the cost of capital of "high" ESG disclosure quality (Group of companies with ESG Disclosure >= 70 percentile) and "low" ESG disclosure quality (Group of companies with ESG Disclosure <= 30 percentile) groups. My univariate analysis compares the mean cost of equity and debt differential between the two groups. The mean cost of equity for companies with "high" ESG disclosure quality tends to be significantly lower relative to companies with "low" ESG disclosure quality. For example, for 8 out of 10 cost of equity proxies the mean difference is statistically significant at the 1 or 5 percent significance level. For the remaining two cost of equity proxies (Cost of Equity Carhart estimated with daily and weekly data) the mean difference is also negative, but not statistically significant. My results suggest that the mean cost of equity for companies with "high" ESG disclosure quality is lower than for "low" ESG disclosure quality. The difference in the cost of equity can be as high as 1.51 percent per annum (Bloomberg's Cost of Equity) and as low as 0.24 percent per annum (Cost of Equity Fama/French estimated with daily data).

Table 22 also compares the mean cost of debt differential between "high" ESG disclosure quality (Group of companies with ESG Disclosure >= 70 percentile) and "low" ESG disclosure quality (Group of companies with ESG Disclosure <= 30 percentile) groups. In contrast to the cost of equity findings, my results on the mean cost of debt differential suggest that the mean cost of debt for companies with "high" ESG disclosure quality is significantly higher than for companies with "low" ESG disclosure quality. The cost of debt differential amounts to 0.83 percent, on average, and is statistically significant at the 1 percent significance level. One explanation for my cost of debt result is related to investors' computation and forecast of the cost of debt. Unlike the cost of equity, which is based on estimates derived from asset pricing models or earnings forecasts, the cost of debt can be computed more directly (Armitage and Marston, 2008). As the cost of debt is already very transparent and easy to obtain for investors, it could be that additional information in form of a company's ESG disclosure quality helps to increase the accuracy of cost of equity estimates and forecasts, but could have no additional value for debt investors.

Thus, in the next chapter, I will aim to shed more light on the effects of ESG disclosure quality on the cost of equity and cost of debt by extending the univariate comparison analysis to a multivariate regression setting that also controls for company-specific and bond-specific characteristics.

Table 22: Univariate Tests

		ESGD >= 70 percentile "High" ESG Disclosure	ESGD <= 30 Percentile "Low" ESG Disclosure	Difference		T-Stat
		[1]	[2]	[1] - [2]		
Daily Data	Cost of Debt - Bloomberg	0.0339	0.0256	0.0083	***	11.81
	N	3386	571	2815		
	Cost of Equity - Bloomberg	0.1064	0.1215	-0.0151	***	-11.60
	N	3384	571	2813		
	Cost of Equity - CAPM	0.0591	0.0649	-0.0058	***	-7.20
	N	3273	558	2715		
	Cost of Equity - Fama & French	0.0610	0.0634	-0.0024	**	-2.56
	N	3273	558	2715		
	Cost of Equity - Carhart	0.0609	0.0620	-0.0011		-1.15
	N	3273	558	2715		
Weekly Data	Cost of Equity - CAPM	0.0610	0.0662	-0.0052	***	-5.21
	N	3274	560	2714		
	Cost of Equity - Fama & French	0.0622	0.0647	-0.0025	**	-2.27
	N	3226	553	2673		
	Cost of Equity - Carhart	0.0620	0.0633	-0.0013		-1.12
	N	3226	553	2673		
Monthly Data	Cost of Equity - CAPM	0.0601	0.0693	-0.0092	***	-7.23
	N	3210	553	2657		
	Cost of Equity - Fama & French	0.0647	0.0675	-0.0028	**	-2.05
	N	3210	553	2657		
	Cost of Equity - Carhart	0.0641	0.0677	-0.0035	***	-2.66
	N	3210	553	2657		

Notes: This table reports univariate comparison T-tests for one cost of debt and ten cost of equity estimates of "high" ESG Disclosure (ESG Disclosure >= 70 percentile) versus "low" ESG Disclosure (ESG Disclosure <= 30 percentile) groups.The 5th column reports the relative difference between these two groups. The final two columns report statistical significance levels and t-ratios. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

7.4.3 Multivariate Regression Analysis

To investigate the association between ESG disclosure quality and several proxies for the expected cost of equity and cost of debt through space and time, I use cross-sectional as well as panel regression analysis with fixed effects and robust standard errors (Huber/White heteroskedasticity-consitent standard errors) as well as robust standard errors clustered at the sector level (2 digit ICB sector codes). Related studies (see e.g. Bauer and Hann, 2010; El Ghoul et al., 2011; Oikonomou et al., 2014) use similar estimation strategies.

7.4.3.1 Cross-Sectional Regression Analysis

To examine the cost of capital effects of ESG disclosure quality, I separately regress my ten proxies for the cost of equity capital on my ESG disclosure quality variable and several company-specific control variables using OLS cross-sectional regressions with robust standard errors.[106] Further, I repeat my analysis and also regress my cost of debt variable on my ESG disclosure quality variable, company-specific, and bond-specific control variables using the same approach. Table 23 displays my main results estimated over the full sample period from 2004 to 2014. In each model, the dependent variable is the individual proxy for the cost of equity or cost of debt such as Bloomberg's cost of debt, Bloomberg's expected cost of equity, expected cost of equity based on Graham and Harvey's expected market premium and inferred from three alternative capital asset pricing models including the CAPM, Fama and French, and Carhart models, which I compute using daily, weekly, and monthly data frequencies. The independent variables include my ESG disclosure quality variable, eleven company-specific variables, and six bond-specific variables. Consistent with my previous univariate comparison analysis results on the expected cost of equity and debt, I find strong and consistent evidence of ESG disclosure quality effects on the cost of equity and debt.

Columns 3 to 12 of Table 23, report the effects of ESG disclosure quality on several alternative proxies for the expected cost of equity capital, while also controlling for company-specific characteristics. The coefficient on ESG disclosure quality is consistently negative and significant at the 1 percent significance level (t-ratios ranging from a minimum of -7.66 to -12.08). The negative association between my ESG disclosure quality variable and the expected cost of equity is consistent across alternative specifications. My results are consistent with Hypothesis 1, which posits that companies with high ESG disclosure quality have lower expected cost of equities. For example, an increase in a company's ESG

[106] All of my cross-sectional regressions are run with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors.

disclosure quality would have reduced the expected cost of equity, on average, by at least 2.76 percent up to 3.71 percent over the estimated sample period, everything else held constant. My findings are also in line with Dhaliwal et al. (2011), El Ghoul et al. (2011) and Sharfman and Fernando (2008). They all report that some form of ESG such as the initiation of standalone ESG disclosures, environmental management, or human rights reduce a company's cost of equity.

Column 2 of Table 23, displays the effects of ESG disclosure quality on the cost of debt, while also controlling for company-specific and bond-specific variables. The coefficient on ESG disclosure quality is negative and significant at the 1 percent significance level (t-ratio of -3.66). My result suggests, consistent with Hypothesis 2, that companies with high ESG disclosure quality have lower cost of debt capital. To give one example, an increase in a company's ESG disclosure quality would have reduced the company's cost of debt by 1.33 percent, on average, over the estimated sample period, all else equal. My findings are in line with Bauer and Hann (2010) and Oikonomou et al. (2014) [107]. They report that several ESG dimensions such as corporate environmental management, community strengths, and product safety and quality strengths reduce corporate yield spreads (cost of debt).

To better isolate the effect of ESG disclosure quality on the expected cost of equity and cost of debt, my regressions reported in Table 23 also display the estimated coefficients and t-ratios of all company-specific and bond-specific control variables. For example, the coefficient on size is negative and generally statistically significant at either the 1 or 5 percent significance level across different specifications. This result is plausible as larger companies tend to be less exposed to business and financial risks and are therefore expected to have lower cost of equity and debt capitals (Oikonomou et al. 2014). The negative association between size and the expected cost of equity is consistent with Sharfman and Fernando's (2008) findings, as well as Brammer & Pavelin (2008) who find that a company's environmental disclosure quality is negatively related to company size. Meaning that high quality disclosures are associated with larger firms and in sectors closely related to environmental concerns (Brammer and Pavelin, 2008). The coefficients on ROA, Interest coverage, Capex, Advertising expense, Sales growth, and R&D intensity generally have the expected sign. To be more specific, negative and statistically significant coefficients are reported for Roa, Interest coverage (in the cost of debt regression), and advertising expense.

[107] Bauer and Hann (2010) report that environmental management strengths (as measured by KLD) reduce the cost of debt by -3.87 percent, while environmental management concerns increase the cost of debt by 4.91 percent. Similarly, Oikonomou et al. (2014) also report that KLD's aggregated ESG strengths reduce the cost of debt by -6.08 percent, while KLD's aggregated ESG concerns increase the cost of debt by 65.12 percent.

While positive and statistically significant coefficients are reported for Capex, Sales growth, and R&D intensity. My findings on the coefficient exposures of the control variables are consistent with Bauer and Hann (2010), El Ghoul et al. (2011), and Harjoto and Jo (2014). One exception is the coefficient on my leverage control variable which is expected to have a positive association with the cost of capital. As Bauer and Hann (2010) and Oikonomou et al. (2014) note, companies with higher leverage are supposed to have higher default risk and this should thus be reflected in higher cost of equity and debt capital. However, my results indicate that the coefficient on leverage is generally not statistically significant and negative, across various specifications.

Overall, the results of my analysis contribute to the existing literature by complementing and extending the works of Sharfman and Fernando (2008), Dhaliwal et al. (2011), El Ghoul et al. (2011), Bauer and Hann (2010), and Oikonomou et al. (2014). More specifically, my results extend the research on voluntary ESG disclosure. My results contribute to this literature by using a novel proxy for ESG disclosure quality, which has not been studied before. The closest studies to mine are Dhaliwhal et al. (2011) and Plumlee et al. (2010), both of which use self-constructed ESG disclosure variables. For example, Dhaliwal et al. (2011) use a dichotomous variable that indicates whether or not companies publish ESG reports. In contrast, I use a proxy that indicates how accurately companies disclose on their environmental, social, and governance performance. Methodologically, my chapter differs from Sharfman and Fernando (2008), Dhaliwal et al. (2011), and El Ghoul et al. (2011) by employing an alternative method to obtain the cost of equity capital. My approach to compute the cost of equity is based on Graham and Harvey's (2015) expected market premium which is obtained by the author's quarterly survey of US Chief Financial Officers from S&P 500 companies and inferred from three alternative asset pricing models including CAPM, Fama and French, and Carhart models.[108] Furthermore, to the best of my knowledge, my chapter is the first to study the effects of ESG disclosure quality on the cost of debt.

All in all, my results provide additional evidence, in line with the existing literature, that companies with high ESG disclosure quality have lower cost of equity and debt capital, everything else held equal.

[108] My approach overcomes the well-known problem of excluding companies with negative earnings per share (EPS) forecasts in the computation of implied cost of equities that could substantiall reduce the sample size. My alternative measure also overcomes another documented bias in the computation of the implied cost of equity, namely, the analyst forecast optimism bias (El Ghoul et al., 2011). The forecast optimism bias suggests that analysts rarely provide negative outlooks of companies' earnings, which leads to an upward bias of EPS estimates (El Ghoul et al., 2011).

Table 23: Cross-Sectional Cost of Debt & Cost of Equity Regressions

			Daily Data			Weekly Data			Monthly Data		
	CD Bloomberg	CE Bloomberg	CE CAPM	CE Fama & French	CE Carhart	CE CAPM	CE Fama & French	CE Carhart	CE CAPM	CE Fama & French	CE Carhart
ESG Disclosure	-0.0133 ***	-0.0340 ***	-0.0325 ***	-0.0307 ***	-0.0276 ***	-0.0369 ***	-0.0321 ***	-0.0301 ***	-0.0371 ***	-0.0354 ***	-0.0340 ***
	-3.66	-8.07	-12.08	-10.75	-9.86	-11.10	-9.03	-8.20	-8.57	-8.19	-7.66
Size	0.0004	-0.0022 ***	-0.0010 ***	-0.0011 ***	-0.0007 **	-0.0007	-0.0010 **	-0.0005	-0.0008	-0.0010 *	-0.0014 **
	0.65	-4.07	-2.90	-3.09	-2.09	-1.59	-2.19	-1.05	-1.49	-1.93	-2.51
Leverage	-0.0025	-0.0001	-0.0036	-0.0055 **	-0.0052 **	-0.0023	-0.0059 *	-0.0048	0.0003	-0.0031	-0.0026
	-0.78	-0.03	-1.55	-2.35	-2.34	-0.79	-1.90	-1.51	0.07	-0.83	-0.69
ROA	-0.0036	-0.0639 ***	-0.0285 ***	-0.0089	-0.0052	-0.0325 ***	-0.0061	-0.0092	-0.0463 ***	-0.0308 ***	-0.0240 **
	-0.39	-5.55	-4.18	-1.25	-0.78	-3.90	-0.65	-0.91	-3.72	-2.63	-1.99
Volatility	-0.0003	0.0006 *	0.0004	0.0004 **	0.0002	0.0002	0.0002	-0.0001	-0.0006	-0.0008 **	-0.0009 **
	-0.99	1.93	1.56	2.00	1.10	0.68	0.70	-0.30	-1.61	-2.38	-2.35
Interest Coverage	-0.0023 ***	-0.0011	-0.0006	-0.0007	-0.0002	-0.0007	-0.0009	-0.0005	-0.0008	-0.0010	-0.0006
	-2.77	-1.62	-1.33	-1.54	-0.61	-1.17	-1.49	-0.86	-0.88	-1.29	-0.76
Capex	0.0341	0.1728 ***	0.0992 ***	0.1016 ***	0.0905 ***	0.1242 ***	0.1041 ***	0.1041 ***	0.1527 ***	0.2040 ***	0.2270 ***
	1.08	5.98	4.94	4.89	4.10	4.96	3.68	3.50	4.43	6.33	6.40
Cash Flows	-0.0010 **	0.0010 **	0.0003	-0.0001	0.0000	0.0001	-0.0005	0.0002	0.0003	0.0005	0.0004
	-2.16	2.46	1.18	-0.49	-0.10	0.37	-1.32	0.39	0.35	0.64	0.55
Capital Intensity	0.0009	-0.0046	0.0040	-0.0033	0.0011	-0.0006	-0.0071	-0.0034	-0.0127 *	-0.0205 ***	-0.0210 ***
	0.17	-0.65	0.86	-0.69	0.22	-0.11	-1.19	-0.53	-1.71	-2.89	-2.74
Advertising	-0.0016	-0.0385 ***	-0.0213 ***	-0.0150 ***	-0.0149 ***	-0.0241 ***	-0.0164 ***	-0.0181 ***	-0.0280 ***	-0.0359 ***	-0.0404 ***
	-0.50	-7.35	-6.95	-4.52	-4.80	-5.99	-3.81	-4.06	-5.36	-7.07	-7.61
Sales Growth	-0.0089 ***	0.0075 **	0.0064 ***	0.0103 ***	0.0127 ***	0.0035	0.0122 ***	0.0141 ***	-0.0011	0.0044	0.0061 *
	-2.92	2.36	3.24	4.87	5.28	1.33	4.37	4.24	-0.31	1.36	1.81
R&D Intensity	0.0594 ***	0.0581 ***	0.0474 ***	0.0594 ***	0.0429 ***	0.0410 ***	0.0593 ***	0.0496 ***	0.0698 ***	0.1043 ***	0.1029 ***
	5.01	3.81	4.90	5.77	4.10	3.05	4.28	3.24	3.92	5.97	5.88
Bond Liquidity	0.0006										
	0.60										
Bond Rating	-0.0003										
	-0.59										
Years to Maturity	0.0001										
	1.15										
Convexity	0.0000										

	-0.03										
Duration	-0.0013										
	-1.07										
Subordinated	0.0059 **										
	2.01										
Intercept	0.0326 ***	0.1527 ***	0.0769 ***	0.0739 ***	0.0641 ***	0.0790 ***	0.0748 ***	0.0633 ***	0.0940 ***	0.0941 ***	0.0959 ***
	2.76	15.98	12.50	11.76	10.09	10.17	9.07	7.54	9.39	9.92	9.79
N	574	1579	1580	1580	1580	1580	1580	1580	1580	1580	1580
Adj. R2	0.1632	0.1927	0.2081	0.1874	0.1654	0.1691	0.1345	0.1140	0.1256	0.1615	0.1642

Notes: This table reports cross-sectional regressions from regressing ten expected cost of equity and one cost of debt estimates on my ESG disclosure quality variable and a set of company-specific and bond-specific control variables over my full sample period from 2004 to 2014. My ten proxies for the expected cost of equity are based on Graham and Harvey's (2015) expected market premium and are inferred from three capital asset pricing models including the CAPM, Fama/French, and Carhart models using daily, weekly, and monthly data frequencies. I regress each of the dependent variables for the expected cost of equity and debt separately. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

7.4.3.2 Panel Regression Analysis (Fixed Effects)

To further examine the cost of capital effects of ESG disclosure quality through space and time, I separately regress my ten proxies for the cost of equity capital on my ESG disclosure quality variable and several company-specific control variables using Panel regressions with fixed effects and robust standard errors as well as robust standard errors clustered at the sector level (2 digit ICB sector codes).[109] Further, I repeat my analysis and also regress my cost of debt variable on my ESG disclosure quality variable, company-specific, and bond-specific control variables using panel regressions with fixed effects.

To formally determine which of my tested panel models, fixed vs. random effects, are more efficient in producing the estimators, I conduct the Hausman specification test for each of my regression specifications (Brooks, 2008).[110] My results of the Hausman specification test show that the fixed effects model is the more appropriate model for all panel regression specifications. Based on the results of the Hausman specification test, I report the results of my panel regressions with fixed effects.

Table 24 displays my main results of the panel analysis with fixed effects, which I estimate over the sample period from 2004 to 2014. Identical to my prior analysis, in each model, the dependent variable is the individual proxy for the cost of equity or cost of debt such as Bloomberg's cost of debt, Bloomberg's expected cost of equity, expected cost of equity based on Graham and Harvey's expected market premium and inferred from three alternative capital asset pricing models including the CAPM, Fama and French, and Carhart models, which I compute using daily, weekly, and monthly data frequencies. The independent variables include my ESG disclosure quality variable, eleven company-specific variables, and six bond-specific variables. Consistent with my previous cross-sectional regression results on the expected cost of equity and debt, I find strong and consistent evidence of ESG disclosure quality effects (through space and time) on the cost of equity and debt, using panel regressions.

[109] All of my panel regressions with fixed effects are run with robust standard errors, using Huber/White heteroskedasticity-consitent standard errors. In addition, I repeat my panel regression analysis with fixed effects using robust standard errors clustered at the sector level. Clustering standard errors at sector level means that my observations are independent across different sectors, however not within sectors (Bauer and Hann, 2010).

[110] I perfomed this test as follows: First, I ran the fixed effects model (without robust standard errors) and stored the estimates of the fixed effects model. Second, I ran the random effects model (without robust standard errors). Finally, I compared the estimates of the fixed effects model with those of the random effects model. For each of my eleven regression specifications, my results convincingly show that the fixed effects model is the appropriate panel regression model.

Columns 3 to 12 of Table 24, report the effects of ESG disclosure quality on several alternative proxies for the expected cost of equity capital, while also controlling for company-specific characteristics. Consistent with my previous results (cross-sectional regressions), the coefficient on ESG disclosure quality is consistently negative and significant at the 1 percent significance level (t-ratios ranging from a minimum of -4.33 to -8.88). The negative association between my ESG disclosure quality variable and the expected cost of equity is consistent across alternative specifications. My results are consistent with Hypothesis 1, which posits that companies with high ESG disclosure quality have lower expected cost of equities. For example, an increase in a company's ESG disclosure quality would have reduced the expected cost of equity, on average, by at least 2.71 percent up to 5.13 percent over the estimated sample period, everything else held constant.[111] My findings are in line with Dhaliwal et al. (2011), El Ghoul et al. (2011) and Sharfman and Fernando (2008). They all report that some form of ESG information such as the initiation of standalone ESG disclosures, environmental management, or human rights reduce a company's cost of equity.

Column 2 of Table 24, reports the effects of ESG disclosure quality on the cost of debt, while also controlling for company-specific and bond-specific variables, using panel regressions with fixed effects. In line with prior estimations, the coefficient on ESG disclosure quality is negative and significant at the 1 percent significance level (t-ratio of -5.31). My result suggests, consistent with Hypothesis 2, that companies with high ESG disclosure quality have lower cost of debt capital. To give one example, an increase in a company's ESG disclosure quality would have reduced the company's cost of debt by 3.41 percent, on average, over the estimated sample period, all else being equal. Once again, my findings are in line with Bauer and Hann (2010) and Oikonomou et al. (2014) [112]. They report that several ESG dimensions such as corporate environmental management, community strengths, and product safety and quality strengths reduce corporate yield spreads (cost of debt).

[111] My panel regression results with fixed effects and robust standard errors clustered at the sector level are in line with my panel regression results with fixed effects and Huber/White heteroskedasticity-consistent standard errors. The coefficients on the ESG Disclosure variable are all negative and statistically significant at the 1 percent significance level across all alternative panel regression specifications (-0.0340609 / -0.0270562 / -0.0441928 / -0.0418715 / -0.0404504 / -0.0490779 / -0.0465872 / -0.0471093 / -0.0512565 / -0.0466694 / -0.0452047) and t-stats (-4.09 / -3.33 / -10.62 / -5.59 / -5.01 / -8.22 / -5.18 / -4.93 / -5.39 / -5.95 / -7.14), respectively.

[112] Bauer and Hann (2010) report that environmental management strengths (as measured by KLD) reduce the cost of debt by -3.87 percent, while environmental management concerns increase the cost of debt by 4.91 percent. Similarly, Oikonomou et al. (2014) also report that KLD's aggregated ESG strengths reduce the cost of debt by -6.08 percent, while KLD's aggregated ESG concerns increase the cost of debt by 65.12 percent.

To better isolate the effect of ESG disclosure quality on the expected cost of equity and cost of debt, my regressions reported in Table 24 also display the estimated coefficients and t-ratios of all company-specific and bond-specific control variables.[113] For example, the coefficient on size is negative and statistically significant at the 1 percent significance level across alternative specifications. As explained in my previous section, my result seems intuitive as larger companies tend to be less exposed to business and financial risks and are therefore expected to have lower cost of equity and debt capitals (Oikonomou et al. 2014). The negative association between size and the expected cost of equity is consistent with Sharfman and Fernando's (2008) findings, as well as Brammer & Pavelin (2008) who find that a company's environmental disclosure quality is negatively related to company size. Meaning that high quality disclosures are associated with larger firms and in sectors closely related to environmental concerns (Brammer and Pavelin, 2008). The coefficients on Volatility, Cash Flows, and Sales Growth generally have the expected sign. More specifically, negative and statistically significant coefficients are reported for Cash Flows, while positive and statistically significant coefficients are reported for Volatility and Sales Growth. My findings on the coefficient exposures of the control variables are consistent with Bauer and Hann (2010), Bradley and Chen (2015), and Harjoto and Jo (2014). One exception is the coefficient on ROA, which is expected to be negatively associated with the cost of capital. As Oikonomou et al. (2014) note, ROA is related to a company's efficient use of its assets to generate profits. Meaning that an increase in a company's ROA should lead to a decrease in its cost of capital because the company stands a better chance of serving its debt and equity obligations (Bauer and Hann, 2010; Oikonomou et al., 2014). However, my results show that the coefficient on ROA is positive and statistically significant, across alternative specifications.[114]

To conclude, my main regression results using cross-sectional and panel regressions with fixed effects and robust standard errors as well as robust standard errors clustered at the sector level, support both hypotheses. Hypothesis 1 predicts that companies with high ESG disclosure quality have lower expected cost of equities. My regression results show a negative association between ESG disclosure quality and the expected cost of equity,

[113] Please note that my panel regressions with fixed effects for the cost of debt variable exclude four bond-specific characteristics (including Bond Liquidity, Years to Maturity, Convexity, and Subordinate Dummy) because these four variables do not have a time component, they stay constant across the full sample period and are therefore automatically excluded.

[114] One reason for this deviation could be related to the way Oikonomou et al. (2014) compute ROA, which differs from my computation. Oikonomou et al. (2014) use EBIT over Total Assets, whereas my chapter uses Net Income before Extraordinary Items over Total Assets (in line with Bauer and Hann, 2010).

controlling for company-specific characteristics. My finding is consistent across various specifications. Hypothesis 2 predicts that companies with high ESG disclosure quality have lower cost of debt. Again, my results show a significantly negative relationship between ESG disclosure quality and the cost of debt, while also controlling for company- and debt-specific characteristics. As a result, my findings of the relation between ESG disclosure quality and the expected cost of equity and debt imply that the market prices a company's ESG disclosure quality along with other factors. Thus, my results contribute to the existing literature by complementing and extending the works of Sharfman and Fernando (2008), Dhaliwal et al. (2011), El Ghoul et al. (2011), Bauer and Hann (2010), and Oikonomou et al. (2014), which also report that companies with high ESG are associated with lower cost of equity and debt capital, using alternative proxies for ESG, the expected cost of equity, and cost of debt.

7.4.4 Robustness Tests

7.4.4.1 Cross-Sectional Year-by-Year Analysis (Temporal consistency)

To test whether my observed negative association between ESG disclosure quality and the cost of capital changes over time, I repeat my main analysis for each year of my sample period and for each of my expected cost of equity and debt proxies, separately. Overall, the expected cost of equity results from my robustness tests are strongly consistent and in-line with my previous results. However, the cost of debt results from my robustness tests for temporal consistency deviate from my main analysis. I will discuss the findings of my robustness analysis in the following paragraph. All additional tables of my robustness tests for temporal stability can be found in Chapter 7.6. 'Chapter Appendix'.

Tables 25 to 34 display the effects of ESG disclosure quality on several alternative proxies for the expected cost of equity capital for each year of my overall sample period, while controlling for company-specific characteristics. Overall, the coefficient on ESG disclosure quality is consistently negative and generally statistically significant across all individual years and ten different specifications. The negative association between ESG disclosure quality and the expected cost of equity tends to be strongest for Bloomberg's expected cost of equiy and those inferred from asset pricing models with daily data frequencies. Furthermore, the observed relationship is strongest for expected cost of equities from Bloomberg and inferred from the CAPM and Fama and French asset pricing models.

Thus, the results of my first robustness test for temporal stability provide additional support to prior results, consistent with Hypothesis 1, confirming that companies with high

ESG disclosure quality have lower expected cost of equities. Accordingly, my additional findings of the relation between ESG disclosure quality and the expected cost of equity imply that the market prices a company's ESG disclosure quality along with other factors over the full sample period as well as multiple individual years.

Table 24 reports the effects of ESG disclosure on my cost of debt proxy for each year of my overall sample period, while controlling for company- and bond-specific characteristics. In contrast to prior results, the coefficient on ESG disclosure quality is not consistently negative and also not statistically significant in any of the individual years. While this result contradicts my previous finding of a negative and statistically significant association between ESG disclosure quality and the cost of debt, the results in Table 24 should be interpreted with some caution due to the small number of observations in each annual regression. For example, the regressions of my robustness test have a minimum of 24 and a maximum of 81 observations.

Table 24: Panel Fixed Effects Cost of Debt & Cost of Equity Regressions

			Daily Data			Weekly Data			Monthly Data		
	CD Bloomberg	CE Bloomberg	CE CAPM	CE Fama & French	CE Carhart	CE CAPM	CE Fama & French	CE Carhart	CE CAPM	CE Fama & French	CE Carhart
ESG Disclosure	-0.0341 ***	-0.0271 ***	-0.0442 ***	-0.0419 ***	-0.0405 ***	-0.0491 ***	-0.0466 ***	-0.0471 ***	-0.0513 ***	-0.0467 ***	-0.0452 ***
	-5.31	-4.33	-8.88	-7.04	-7.01	-8.38	-6.84	-6.74	-6.88	-6.27	-6.34
Size	-0.0092 ***	-0.0056 **	-0.0122 ***	-0.0126 ***	-0.0133 ***	-0.0108 ***	-0.0106 ***	-0.0112 ***	-0.0161 ***	-0.0107 ***	-0.0109 ***
	-3.92	-2.16	-5.80	-4.73	-5.21	-4.62	-3.18	-3.13	-5.50	-4.01	-3.83
Leverage	0.0137 *	-0.0019	-0.0071	-0.0073	-0.0081	-0.0059	-0.0047	-0.0033	-0.0147	-0.0169 *	-0.0129
	1.87	-0.31	-1.14	-1.04	-1.27	-0.93	-0.71	-0.53	-1.39	-1.83	-1.45
ROA	0.0081	-0.0103	0.0069	0.0230 **	0.0238 **	0.0138 *	0.0450 ***	0.0390 ***	0.0231 **	0.0282 ***	0.0350 ***
	0.88	-1.06	0.86	2.10	2.24	1.82	3.75	3.27	2.15	2.63	3.13
Volatility	0.0010	0.0045 ***	0.0030 ***	0.0043 ***	0.0020 ***	0.0019 **	0.0036 ***	0.0020 **	0.0008	0.0018 **	0.0021 **
	1.05	5.17	4.98	6.38	3.21	2.26	3.86	2.05	1.02	2.03	2.43
Interest Coverage	-0.0002	-0.0004	-0.0006	-0.0011	-0.0010	-0.0003	-0.0014	-0.0013	0.0012	-0.0003	0.0001
	-0.21	-0.40	-1.09	-1.58	-1.46	-0.50	-1.64	-1.51	1.15	-0.39	0.09
Capex	0.0542	-0.0749 ***	-0.0279	0.0120	0.0014	0.0151	0.0364	0.0233	0.0117	0.0142	0.0493
	1.44	-2.62	-1.06	0.41	0.05	0.34	0.82	0.53	0.36	0.44	1.49
Cash Flows	-0.0024 ***	-0.0001	-0.0004	-0.0008 **	-0.0007	-0.0010 ***	-0.0020 ***	-0.0014	-0.0014 **	-0.0011 **	-0.0013 **
	-3.64	-0.12	-1.35	-2.14	-1.60	-2.71	-2.89	-1.55	-2.40	-2.04	-2.39
Capital Intensity	0.0255 **	0.0085	-0.0149	-0.0425	-0.0409	-0.0174	-0.0498	-0.0419	-0.0309	-0.0279	-0.0641
	2.11	0.44	-1.16	-2.02	-2.18	-0.94	-1.84	-1.59	-1.76	-1.44	-2.93
Advertising	-0.0025	0.0122	0.0059	0.0225	0.0173	-0.0082	0.0068	-0.0026	0.0253	0.0484 **	0.0585 ***
	-0.16	0.64	0.41	1.25	1.04	-0.49	0.33	-0.11	1.13	2.43	3.08
Sales Growth	-0.0055 *	0.0131 ***	0.0068 ***	0.0084 ***	0.0107 ***	0.0066 ***	0.0131 ***	0.0142 ***	0.0072 ***	0.0082 ***	0.0106 ***
	-1.87	4.62	3.53	3.67	4.16	2.71	3.96	4.10	3.02	3.20	4.25
R&D Intensity	-0.0356	-0.0146	-0.0627 *	-0.0637 *	-0.0324	0.0020	0.0290	0.0676	-0.1499 *	-0.1008 *	-0.0842
	-0.63	-0.24	-1.78	-1.72	-0.87	0.04	0.56	1.09	-1.90	-1.93	-1.40
Bond Liquidity											
Bond Rating	0.0018										

	1.48																					
Years to Maturity																						
Convexity																						
Duration	-0.0007																					
	-0.45																					
Subordinated																						
Intercept	0.1714	***	0.1722	***	0.2558	***	0.2551	***	0.2751	***	0.2390	***	0.2203	***	0.2366	***	0.3372	***	0.2397	***	0.2360	***
	4.67		3.95		7.35		5.52		6.26		6.08		3.79		3.79		6.89		5.39		4.98	
N	574		1579		1580		1580		1580		1580		1580		1580		1580		1580		1580	
Adj. R2	0.1913		0.0936		0.2401		0.2077		0.2168		0.1666		0.1439		0.1355		0.2520		0.1933		0.2058	

Notes: This table reports panel regressions with fixed effects from regressing ten expected cost of equity and one cost of debt estimates on my ESG disclosure quality variable and a set of company-specific and bond-specific control variables over my full sample period from 2004 to 2014. My ten proxies for the expected cost of equity are based on Graham and Harvey's (2015) expected market premium and are inferred from three capital asset pricing models including the CAPM, Fama/French, and Carhart models using daily, weekly, and monthly data frequencies. I regress each of the dependent variables for the expected cost of equity and debt separately. My panel regressions with fixed effects are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. My cost of debt regressions exclude four bond-specific characteristics including Bond Liquidity, Years to Maturity, Convexity, and Subordinated Dummy, because these variables do not have a time component their values are constant across time. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

7.4.4.2 Cross-Sectional Stepwise Regression Analysis

To test whether my observed negative association between ESG disclosure quality and the cost of capital is influenced by the inclusion and/or exclusion of certain company-specific or bond-specific characteristics, I repeat my analysis, using a stepwise regression approach, whereby I re-run my original regression model by consecutively adding one control variable at a time. For example, in my first stepwise regression model, I regress my dependent variable on the ESG disclosure quality variable excluding all company- and bond-specific characteristics, such as size, leverage, ROA, Volatility, Interest Coverage, Capex, Cash Flows, Capital Intensity, Advertising, Sales Growth, R&D Intensity, Bond Liquidity, Bond Rating, Years to Maturity, Convexity, Duration, and a dummy for Subordinate Debt. In my second stepwise regression model, I regress my dependent variable on the ESG disclosure quality variable and the size variable. I continue with the stepwise regression approach until I include all company- and bond-specific characteristic.

Overall, the results from my additional stepwise regression analyses in Tables 35 to 45 are highly consistent with prior results of my primary regression analysis.

Tables 36 to 45 display the effects of ESG disclosure quality on ten alternative proxies for the expected cost of equity using the stepwise regression analysis approach over my full sample period. My results show that the coefficient on ESG disclosure quality is consistently negative and statistically significant at the 1 percent significance level across all alternative stepwise regression specifications. Generally, my findings tend to be strongest for Bloomberg's expected cost of equity estimate and expected cost of equities inferred from the CAPM model. For example, t-ratios for the coefficient on ESG disclosure quality across all stepwise regressions range between -5.96 and -15.97. The results of my second robustness test provide additional support to my previous main findings, because the coefficient on ESG disclosure quality is also consistently negative, statistically significant, and similar in magnitude. Thus, consistent with Hypothesis 1, I can confirm that companies with high ESG disclosure quality have lower expected cost of equities.

Further, Table 35 displays the effects of ESG disclosure quality on my cost of debt variable using the stepwise regression analysis approach. The coefficient on ESG disclosure quality is also consistently negative and statistically significant at the 1 percent significance level across all specifications. Therefore, my additional regression results provide additional support to prior results, consistent with Hypothesis 2, that companies with high ESG disclosure quality have lower cost of debt.

7.5 Conclusion

My chapter empirically investigates whether Environmental, Social, and Governance (ESG) disclosure quality affects a company's expected cost of equity and debt capital. I hypothesise that companies with high ESG disclosure quality have lower expected cost of equity and debt, due to low ESG disclosure quality companies' smaller-sized investor base (Merton, 1987), higher systematic risk (Lambert et al., 2007), and higher company-specific risks such as future litigation and reputational risks (Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Starks, 2009). Investigating a large sample of S&P 500 US companies from 2004 to 2014, and controlling for company- and bond-specific characteristics as well as temporal consistency and stepwise regression analysis tests, I find ESG disclosure quality to have a negative and statistically significant impact on both, cost of equity and debt financing. In other words, companies with high ESG disclosure quality have lower expected cost of equities and cost of debt. The empirical results are consistent with both of my hypotheses. My chapter adds to the existing literature on the effects of ESG criteria, more generally, and ESG disclosure, more specifically, on the cost of equity and cost of debt, by showing that a company's ESG disclosure quality can increase company value by reducing a company's expected cost of equity and debt.

Future research could investigate the effects of ESG disclosure quality on the expected cost of equity and debt globally. It could be that in other geographical contexts a different association between ESG disclosure quality and the expected cost of equity and debt exists. Also, future research could investigate this relationship beyond the constituents of the S&P 500 index. Methodologically, future research could use alternative proxies of the cost of equity and cost of debt. For example, releated studies (see e.g. Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Oikonomou et al., 2014) use implied cost of equities or corporate bond yield spread. Future research could then empirically re-examine the relation between ESG disclosure quality and these alternative proxies. This would increase the reliability and validity of empirical studies' findings researching the relevance of ESG disclosure quality for equity and debt investors.

7.6 Chapter Appendix

Table 25: Cost of Debt Bloomberg - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	0.0112	0.73	-0.0013	-0.11	0.0105	1.00	0.0037	0.33	0.0084	0.86	0.0022	0.35	-0.0017	-0.40	0.0072	1.13	-0.0022	-0.59
Size	-0.0039 *	-1.75	0.0015	1.04	0.0006	0.44	-0.0002	-0.10	0.0009	0.75	-0.0010 *	-1.66	-0.0007	-1.29	-0.0010	-1.50	0.0000	0.04
Leverage	0.0125	0.37	-0.0252 *	-1.74	-0.0148 **	-2.28	-0.0130 *	-1.71	0.0021	0.24	-0.0054	-1.38	-0.0034	-0.79	0.0013	0.24	-0.0077 **	-2.22
ROA	-0.2062	-0.74	0.0683	1.41	0.0212	0.72	0.0465 *	1.76	-0.0037	-0.24	0.0230	1.32	0.0011	0.09	-0.0051	-0.39	0.0102	0.82
Volatility	0.0032 *	1.81	0.0020	1.59	0.0006	0.58	0.0008	0.59	-0.0008	-0.90	0.0003	0.87	-0.0006	-1.48	-0.0019 ***	-4.58	-0.0002	-0.73
Interest Coverage	0.0047	1.02	-0.0084 **	-2.30	-0.0010	-1.23	-0.0034	-1.38	-0.0023	-1.43	-0.0034 ***	-2.94	-0.0017 **	-2.31	-0.0017	-1.19	-0.0036 ***	-3.61
Capex	0.1966	1.26	0.1145	1.37	-0.0125	-0.18	-0.0744	-0.75	-0.0952	-1.11	0.0108	0.29	0.0432	1.46	-0.0029	-0.08	0.0268	1.08
Cash Flows	-0.0144	-0.30	-0.0057 ***	-2.86	-0.0061	-1.02	-0.0106 ***	-2.70	-0.0015	-0.43	0.0002	0.20	0.0001	0.20	-0.0002	-0.39	-0.0006 ***	-3.76
Capital Intensity	0.0204	0.52	-0.0274 **	-2.03	-0.0022	-0.17	-0.0004	-0.02	0.0043	0.45	-0.0013	-0.22	-0.0068	-1.29	-0.0017	-0.20	-0.0095	-1.60
Advertising	0.1323 *	1.86	-0.0214	-1.12	0.0080	0.75	-0.0056	-0.67	-0.0073	-1.27	-0.0059	-1.35	-0.0030	-0.50	-0.0069 **	-2.18	-0.0018	-0.47
Sales Growth	0.0021	0.05	0.0084	1.08	-0.0103	-0.95	-0.0166	-1.37	-0.0106	-1.64	-0.0057 *	-1.78	0.0097 *	1.67	-0.0005	-0.08	0.0031	1.01
R&D Intensity	-0.2550	-1.26	0.1555 ***	3.53	0.0386	1.16	0.0432	1.53	0.0418	1.32	0.0214	1.57	0.0336 **	2.26	0.0439 ***	3.00	0.0273 *	1.95
Bond Liquidity	-0.0002	-0.07	-0.0061	-1.56	-0.0014	-0.66	0.0015	0.58	-0.0018	-0.66	0.0005	0.47	0.0021 **	2.14	0.0023 **	2.32	0.0008	0.81
Bond Rating	0.0037	1.19	-0.0013	-0.85	-0.0022	-1.64	-0.0025 **	-2.13	0.0003	0.21	-0.0005	-0.99	-0.0010 **	-2.36	-0.0022 ***	-3.81	-0.0012 ***	-2.77
Years to Maturity	0.0009	1.51	-0.0004	-1.30	0.0001	0.54	0.0002	0.91	0.0004	1.57	-0.0002	-1.36	0.0000	0.30	0.0002	1.55	-0.0001	-0.92
Convexity	0.0032	0.79	-0.0014	-0.94	-0.0001	-0.07	0.0007	0.60	0.0018	1.16	0.0008	1.44	-0.0009	-1.42	0.0017 **	2.21	-0.0005	-1.10
Duration	-0.0048	-0.60	-0.0007	-0.29	-0.0009	-0.40	-0.0005	-0.33	-0.0058	-1.22	0.0036	1.45	0.0017	0.95	-0.0009	-0.42	0.0023	0.90
Subordinated	0.0011	0.07	-0.0022	-0.34	-0.0039	-0.63	-0.0013	-0.27	-0.0018	-0.35	0.0077 ***	2.62	0.0032	1.07	0.0080 ***	5.15	0.0069 ***	3.14
Intercept	0.0258	0.51	0.1217 ***	3.21	0.0525 *	1.91	0.0532 *	1.76	0.0551 *	1.83	0.0366 ***	2.86	0.0042	0.33	0.0285 **	2.03	0.0260 ***	2.72
N	21		39		64		69		69		73		78		81		80	
Adj. R2	0.5393		0.5397		0.0066		0.1376		0.1243		0.3827		0.3292		0.4960		0.3996	

Notes: This table reports cross-sectional regressions from regressing Bloomberg's cost of debt estimate on my ESG disclosure quality variable and a set of company-specific and bond-specific characteristics over each year of my sample period separately. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 26: Cost of Equity Bloomberg - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0363 **	-2.07	-0.0104	-0.64	-0.0220	-1.52	-0.0269 ***	-2.82	-0.0583 ***	-4.74	-0.0401 ***	-2.90	-0.0248 **	-2.14	-0.0186 **	-2.15	-0.0270 ***	-3.34
Size	-0.0040 ***	-2.64	-0.0038 **	-2.21	-0.0026	-1.40	-0.0017	-1.35	0.0006	0.29	-0.0027	-1.55	-0.0016	-1.10	-0.0023 **	-2.28	-0.0006	-0.51
Leverage	0.0335 **	2.09	0.0203 *	1.71	0.0136	1.11	0.0094	1.26	-0.0017	-0.19	-0.0002	-0.02	-0.0167 *	-1.83	-0.0030	-0.49	-0.0089	-1.19
ROA	-0.0884	-1.39	-0.0112	-0.33	-0.0364	-1.10	-0.0690 ***	-3.60	-0.0619 **	-2.39	-0.0977	-1.43	-0.0851 ***	-3.28	-0.0789 ***	-3.28	-0.0064	-0.17
Volatility	0.0001	0.04	0.0001	0.14	0.0013	1.27	0.0013 *	1.74	0.0015	1.35	0.0000	0.03	0.0002	0.14	-0.0011 *	-1.71	0.0001	0.07
Interest Coverage	0.0086 ***	3.19	0.0022	1.32	0.0001	0.03	-0.0019	-1.45	-0.0040 *	-1.92	-0.0031 *	-1.76	-0.0020	-1.10	0.0008	0.56	-0.0013	-0.80
Capex	0.0299	0.34	0.0485	0.74	0.2548 ***	3.43	0.3392 ***	5.96	0.0377	0.43	0.3138 ***	3.29	0.2960 ***	3.20	0.1534 **	2.17	0.1422 **	2.40
Cash Flows	-0.0021	-0.45	0.0006	0.35	0.0006	0.95	0.0015	1.13	-0.0003	-0.09	0.0005	0.11	0.0025	1.58	0.0001	0.08	-0.0015 ***	-2.78
Capital Intensity	0.0093	0.43	0.0035	0.24	-0.0331	-1.64	-0.0486 ***	-3.20	0.0292	1.47	-0.0054	-0.27	-0.0272	-1.14	-0.0144	-0.82	-0.0260 *	-1.76
Advertising	-0.0639 ***	-3.36	-0.0537 ***	-2.93	-0.0450 ***	-3.29	-0.0262 ***	-2.63	-0.0306 *	-1.94	-0.0604 ***	-3.27	-0.0463 ***	-3.10	-0.0224 *	-1.69	-0.0279 ***	-2.62
Sales Growth	-0.0019	-0.12	-0.0059	-0.70	-0.0015	-0.14	-0.0380 ***	-4.67	0.0244 ***	3.73	0.0306 ***	3.60	-0.0006	-0.05	-0.0111	-0.94	0.0033	0.44
R&D Intensity	0.0893 **	2.01	0.1126 ***	2.71	0.0183	0.40	-0.0038	-0.14	-0.0117	-0.31	0.1407 ***	3.17	0.0851	1.45	0.0437	1.06	0.0532 **	2.07
Intercept	0.1476 ***	4.09	0.1659 ***	6.42	0.1609 ***	5.30	0.1784 ***	8.29	0.1050 ***	3.21	0.1498 ***	5.61	0.1657 ***	5.99	0.1688 ***	8.34	0.1257 ***	5.62
N	62		124		203		211		202		197		194		194		186	
Adj. R2	0.3437		0.1270		0.0970		0.3998		0.3050		0.2711		0.1878		0.2020		0.1400	

Notes: This table reports cross-sectional regressions from regressing Bloomberg's expected cost of equity estimate on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 27: Cost of Equity CAPM (Daily) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0211 *	-1.79	-0.0032	-0.28	-0.0264 ***	-3.35	-0.0132 *	-1.81	-0.0192 ***	-4.19	-0.0207 ***	-2.73	-0.0221 ***	-3.25	-0.0133 ***	-3.33	-0.0165 ***	-2.79
Size	-0.0039 ***	-3.28	-0.0015	-1.53	-0.0003	-0.39	-0.0022 ***	-2.62	-0.0011 *	-1.67	-0.0020 **	-2.17	-0.0010	-1.09	-0.0010 **	-2.09	-0.0016 *	-1.92
Leverage	0.0189 *	1.80	0.0110	1.44	0.0034	0.62	0.0092 *	1.71	0.0020	0.61	-0.0052	-0.93	-0.0130 **	-2.14	-0.0039	-1.46	-0.0080	-1.56
ROA	-0.1028 **	-2.54	-0.0178	-0.84	-0.0021	-0.13	-0.0488 ***	-3.38	-0.0366 ***	-3.73	-0.0552	-1.30	-0.0308	-1.19	-0.0228 **	-2.28	-0.0502 **	-2.11
Volatility	0.0010	0.92	0.0001	0.15	0.0007	1.43	0.0008	1.57	0.0006	1.42	-0.0006	-0.98	-0.0001	-0.24	-0.0003	-0.87	0.0000	-0.06
Interest Coverage	0.0048 ***	2.59	0.0022 **	2.19	0.0001	0.19	-0.0002	-0.26	-0.0012 *	-1.75	-0.0024 **	-2.29	-0.0016	-1.34	-0.0016 **	-2.56	-0.0006	-0.49
Capex	0.1623 ***	2.65	0.0122	0.32	0.1386 ***	3.68	0.1672 ***	4.75	0.0750 **	2.17	0.1291 **	2.46	0.1394 ***	2.73	0.0402	1.21	0.1680 ***	3.73
Cash Flows	0.0012	0.35	0.0008	0.67	-0.0002	-0.58	0.0005	0.51	0.0006	0.49	-0.0001	-0.05	0.0001	0.09	0.0004	1.20	0.0001	0.22
Capital Intensity	-0.0032	-0.22	0.0092	0.90	-0.0053	-0.48	-0.0233 **	-2.12	0.0003	0.04	-0.0010	-0.10	-0.0073	-0.53	-0.0017	-0.21	-0.0265 **	-2.43
Advertising	-0.0432 ***	-3.34	-0.0332 ***	-3.55	-0.0307 ***	-4.37	-0.0228 ***	-3.28	-0.0189 ***	-3.09	-0.0307 ***	-3.57	-0.0279 ***	-2.58	-0.0080	-1.32	-0.0200 ***	-3.68
Sales Growth	0.0091	0.83	0.0014	0.25	0.0024	0.59	-0.0377 ***	-5.79	0.0135 ***	4.34	0.0162 ***	3.31	0.0040	0.59	0.0039	0.76	0.0214 **	2.57
R&D Intensity	0.1383 ***	3.94	0.0334	1.27	0.0111	0.50	-0.0160	-0.95	0.0279 *	1.85	0.0652 ***	2.63	0.0944 **	2.43	0.0382 ***	3.12	0.0535 ***	3.16
Intercept	0.0967 ***	4.21	0.0788 ***	5.02	0.0736 ***	5.32	0.1297 ***	9.42	0.0633 ***	5.62	0.1015 ***	7.17	0.0870 ***	5.06	0.0640 ***	6.68	0.0675 ***	3.88
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.5503		0.0931		0.2214		0.4473		0.4014		0.2860		0.2278		0.2319		0.3155	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 28: Cost of Equity Fama/French (Daily) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0207	-1.18	-0.0055	-0.46	-0.0288 ***	-3.28	-0.0113 *	-1.68	-0.0054	-1.46	-0.0242 ***	-2.97	-0.0235 ***	-3.52	-0.0088 *	-1.88	-0.0121 *	-1.95
Size	-0.0033 **	-2.10	-0.0023 **	-2.21	-0.0018 **	-2.00	-0.0011	-1.55	-0.0004	-1.03	-0.0013	-1.37	-0.0010	-1.17	-0.0008	-1.49	-0.0011	-1.23
Leverage	0.0112	0.82	0.0081	1.05	0.0042	0.67	0.0020	0.47	-0.0014	-0.46	-0.0078	-1.30	-0.0140 **	-2.31	-0.0034	-1.07	-0.0040	-0.71
ROA	-0.0585	-0.92	-0.0070	-0.34	-0.0017	-0.09	-0.0126	-0.91	-0.0446 ***	-4.62	-0.0507	-1.19	-0.0095	-0.35	0.0027	0.20	-0.0435	-1.63
Volatility	0.0004	0.29	0.0001	0.08	0.0009	1.58	0.0006	1.51	0.0002	0.54	-0.0005	-0.88	-0.0002	-0.33	0.0001	0.34	0.0000	-0.06
Interest Coverage	0.0027	1.10	0.0012	1.16	0.0002	0.29	0.0002	0.27	-0.0004	-0.99	-0.0018	-1.53	-0.0008	-0.71	-0.0021 **	-2.46	0.0000	-0.01
Capex	0.2099 **	2.01	-0.0256	-0.61	0.1661 ***	3.95	0.1533 ***	6.11	0.0582 **	2.46	0.1779 ***	3.08	0.1216 ***	2.61	0.0390	1.19	0.0958 *	1.81
Cash Flows	0.0007	0.15	0.0006	0.56	-0.0002	-0.53	0.0005	0.51	0.0026 ***	2.59	0.0010	0.34	-0.0006	-0.51	0.0001	0.20	-0.0002	-0.52
Capital Intensity	0.0043	0.17	0.0252 **	2.28	-0.0108	-0.88	-0.0174 *	-1.94	-0.0121 **	-2.37	-0.0096	-0.82	-0.0099	-0.77	-0.0188 **	-2.41	-0.0261 **	-2.18
Advertising	-0.0743 ***	-3.64	-0.0356 ***	-3.66	-0.0346 ***	-4.79	-0.0125 **	-2.08	-0.0075	-1.47	-0.0195 **	-2.08	-0.0206 **	-2.01	0.0014	0.22	-0.0111 **	-2.30
Sales Growth	0.0167	0.77	-0.0044	-0.74	0.0008	0.17	-0.0126 **	-2.22	0.0058 **	2.04	0.0218 ***	3.99	0.0087	1.34	0.0226 ***	3.38	0.0379 ***	3.54
R&D Intensity	0.0928 **	2.36	0.0147	0.55	0.0193	0.79	0.0273	1.53	0.0456 ***	3.49	0.0983 ***	3.74	0.0930 **	2.22	0.0657 ***	3.26	0.0924 ***	4.13
Intercept	0.0919 **	2.52	0.0999 ***	6.09	0.1022 ***	6.71	0.0886 ***	7.08	0.0608 ***	7.91	0.0829 ***	5.62	0.0804 ***	4.82	0.0392 ***	3.42	0.0341 *	1.76
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.3729		0.1519		0.2411		0.2349		0.2740		0.2687		0.2296		0.3076		0.4000	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 29: Cost of Equity Carhart (Daily) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0218	-1.30	0.0004	0.02	-0.0265 ***	-2.96	-0.0092	-1.63	-0.0036	-0.97	-0.0200 **	-2.34	-0.0230 ***	-3.89	-0.0053	-1.32	-0.0128 **	-2.02
Size	-0.0031 **	-2.02	-0.0032 **	-2.45	-0.0008	-0.84	-0.0005	-0.73	0.0000	-0.05	-0.0015	-1.56	-0.0006	-0.82	-0.0007	-1.27	-0.0005	-0.51
Leverage	0.0120	0.91	0.0129	1.34	0.0009	0.13	-0.0012	-0.34	-0.0027	-0.89	-0.0096	-1.49	-0.0119 **	-2.20	-0.0037	-1.32	-0.0046	-0.82
ROA	-0.0627	-1.04	0.0122	0.47	0.0300	1.59	-0.0018	-0.16	-0.0475 ***	-4.14	-0.0552	-1.40	-0.0017	-0.07	-0.0068	-0.61	-0.0412	-1.59
Volatility	0.0005	0.32	0.0001	0.15	0.0004	0.71	0.0005	1.48	0.0003	0.79	-0.0006	-1.00	-0.0001	-0.22	0.0001	0.30	-0.0005	-1.08
Interest Coverage	0.0026	1.14	0.0020	1.49	0.0006	1.03	0.0003	0.46	-0.0005	-1.29	-0.0019	-1.63	-0.0009	-0.91	-0.0013	-1.58	-0.0001	-0.09
Capex	0.2008 **	2.02	-0.0207	-0.45	0.1098 *	1.81	0.0924 ***	3.74	0.0478 **	2.16	0.1846 ***	3.21	0.0800 *	1.91	0.0765 ***	2.63	0.1900 ***	3.55
Cash Flows	0.0013	0.27	-0.0004	-0.31	-0.0007	-1.59	0.0001	0.13	0.0033 ***	2.66	0.0012	0.44	-0.0006	-0.62	0.0003	0.53	0.0001	0.17
Capital Intensity	0.0059	0.24	0.0229 *	1.90	0.0108	0.71	-0.0078	-0.99	-0.0109 **	-2.24	-0.0139	-1.12	-0.0036	-0.32	-0.0205 ***	-2.85	-0.0290 **	-2.40
Advertising	-0.0676 ***	-3.49	-0.0515 ***	-4.53	-0.0376 ***	-4.55	-0.0053	-1.13	-0.0059	-1.22	-0.0217 **	-2.35	-0.0140	-1.60	-0.0006	-0.14	-0.0153 ***	-2.71
Sales Growth	0.0143	0.70	-0.0014	-0.19	0.0202 ***	3.70	-0.0047	-0.97	0.0033	1.30	0.0210 ***	3.99	0.0110 *	1.92	0.0112 **	2.01	0.0186 **	2.22
R&D Intensity	0.0955 **	2.47	0.0107	0.34	-0.0056	-0.20	0.0282 *	1.77	0.0409 ***	3.10	0.1072 ***	3.75	0.0829 **	2.26	0.0345 **	2.39	0.0459 **	2.11
Intercept	0.0884 **	2.55	0.1096 ***	5.66	0.0627 ***	3.63	0.0693 ***	6.06	0.0561 ***	8.02	0.0892 ***	5.79	0.0675 ***	4.55	0.0469 ***	4.13	0.0475 ***	2.63
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.3587		0.1738		0.2855		0.1330		0.2390		0.2600		0.2124		0.1787		0.2227	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 30: Cost of Equity CAPM (Weekly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0391 **	-2.35	-0.0026	-0.17	-0.0284 ***	-2.62	-0.0191 **	-2.30	-0.0262 ***	-4.85	-0.0210 **	-2.22	-0.0249 ***	-3.20	-0.0091	0.01	-0.0263 ***	-2.93
Size	-0.0047 ***	-2.92	-0.0014	-0.85	-0.0007	-0.48	-0.0011	-1.02	-0.0003	-0.40	-0.0023 **	-2.00	-0.0007	-0.65	-0.0017	0.00	-0.0007	-0.52
Leverage	0.0305 *	1.78	0.0154	1.57	0.0103	1.27	0.0074	1.16	0.0034	0.83	-0.0028	-0.40	-0.0143 **	-2.14	0.0033	0.00	-0.0150 *	-1.80
ROA	-0.1590 **	-2.19	-0.0114	-0.36	-0.0401 *	-1.85	-0.0496 ***	-3.03	-0.0283 **	-2.17	-0.0798	-1.43	-0.0343	-1.35	-0.0424	0.02	-0.0106	-0.26
Volatility	0.0011	0.64	-0.0006	-0.76	0.0008	1.18	0.0005	0.77	0.0011 **	2.30	-0.0006	-0.79	-0.0005	-0.76	-0.0005	0.00	-0.0001	-0.15
Interest Coverage	0.0091 ***	3.56	0.0016	1.19	-0.0003	-0.30	-0.0008	-0.72	-0.0013	-1.61	-0.0020	-1.49	-0.0028 **	-2.08	0.0013	0.00	-0.0019	-1.12
Capex	0.0598	0.82	0.0156	0.25	0.2538 ***	4.86	0.1598 ***	3.63	0.0775 *	1.82	0.2448 ***	3.31	0.1457 **	2.30	0.0743	0.05	0.1781 ***	2.64
Cash Flows	-0.0017	-0.34	-0.0001	-0.05	0.0006	1.42	-0.0002	-0.18	-0.0008	-0.54	0.0013	0.37	0.0012	0.91	-0.0010	0.00	-0.0004	-0.54
Capital Intensity	0.0048	0.21	0.0096	0.75	-0.0300 *	-1.95	-0.0240 **	-1.99	0.0014	0.16	-0.0102	-0.71	-0.0066	-0.40	-0.0137	0.01	-0.0258	-1.50
Advertising	-0.0466 ***	-2.67	-0.0229	-1.48	-0.0347 ***	-3.79	-0.0194 **	-2.27	-0.0217 ***	-3.10	-0.0399 ***	-3.44	-0.0279 **	-1.96	-0.0086	0.01	-0.0371 ***	-4.72
Sales Growth	-0.0080	-0.49	-0.0045	-0.61	-0.0055	-0.74	-0.0376 ***	-6.16	0.0139 ***	3.75	0.0236 ***	4.06	-0.0025	-0.29	0.0009	0.01	-0.0062	-0.63
R&D Intensity	0.1449 ***	3.09	0.0086	0.26	0.0240	0.74	-0.0337	-1.55	0.0072	0.42	0.0967 ***	3.16	0.0959 **	2.01	0.0292	0.03	0.0369	0.99
Intercept	0.1237 ***	3.67	0.0859 ***	3.64	0.0923 ***	4.19	0.1190 ***	6.62	0.0502 ***	3.61	0.0964 ***	5.23	0.0935 ***	4.73	0.0708	0.02	0.0932 ***	3.73
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.4588		0.0868		0.1710		0.3644		0.3392		0.2717		0.1925		0.1298		0.1246	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 31: Cost of Equity Fama/French (Weekly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0287	-1.16	-0.0070	-0.42	-0.0250 **	-2.35	-0.0118	-1.47	-0.0120 **	-2.22	-0.0198 **	-1.96	-0.0247 ***	-3.20	-0.0028	-0.38	-0.0145	-1.61
Size	-0.0049 **	-2.48	-0.0020	-1.20	-0.0022 *	-1.68	-0.0007	-0.66	0.0002	0.23	-0.0023 *	-1.78	-0.0003	-0.27	-0.0022 **	-2.40	-0.0016	-1.16
Leverage	0.0170	0.78	0.0123	1.16	0.0147 *	1.68	-0.0076	-1.13	0.0008	0.17	-0.0076	-0.98	-0.0167 **	-2.34	0.0039	0.66	-0.0096	-1.05
ROA	-0.0993	-0.91	0.0177	0.48	-0.0516 **	-2.40	0.0111	0.70	-0.0326 **	-2.16	-0.0745	-1.21	0.0073	0.20	-0.0284	-1.05	-0.0164	-0.39
Volatility	-0.0007	-0.32	-0.0004	-0.43	0.0016 **	2.11	0.0009	1.44	0.0000	-0.06	-0.0004	-0.49	-0.0007	-1.15	-0.0009	-1.48	-0.0001	-0.09
Interest Coverage	0.0064 *	1.91	0.0003	0.19	0.0006	0.51	0.0006	0.40	-0.0005	-0.63	-0.0021	-1.36	-0.0029 *	-1.90	0.0009	0.71	-0.0008	-0.46
Capex	0.0961	0.79	-0.0812	-1.24	0.2761 ***	5.41	0.1264 ***	2.66	0.0082	0.19	0.3148 ***	3.50	0.1076 *	1.76	0.0831 *	1.75	0.0609	0.87
Cash Flows	-0.0018	-0.25	-0.0009	-0.52	0.0008	1.63	-0.0013	-0.85	0.0010	0.60	0.0017	0.41	0.0012	0.81	-0.0007	-0.69	-0.0007	-0.85
Capital Intensity	0.0173	0.43	0.0327 **	2.00	-0.0344 **	-2.12	-0.0203	-1.51	-0.0001	-0.01	-0.0260	-1.64	-0.0098	-0.65	-0.0206 *	-1.91	-0.0350 **	-2.11
Advertising	-0.0855 ***	-3.34	-0.0252 *	-1.65	-0.0433 ***	-4.07	-0.0106	-1.15	-0.0163 *	-1.88	-0.0241 **	-1.97	-0.0152	-1.13	0.0031	0.48	-0.0174 *	-1.90
Sales Growth	-0.0037	-0.12	-0.0110	-1.34	-0.0060	-0.83	-0.0063	-1.08	0.0057	1.36	0.0266 ***	4.13	0.0089	1.04	0.0219 ***	2.99	0.0281 *	1.86
R&D Intensity	0.1081 **	2.01	-0.0093	-0.24	0.0270	0.78	0.0013	0.05	0.0729 ***	3.08	0.0899 ***	2.99	0.0737	1.34	0.0751 **	2.33	0.1166 ***	3.42
Intercept	0.1437 ***	3.14	0.1032 ***	4.44	0.1130 ***	5.19	0.0797 ***	4.18	0.0535 ***	4.13	0.0937 ***	4.44	0.0746 ***	3.65	0.0549 ***	2.91	0.0617 **	2.01
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.2650		0.0758		0.1869		0.0683		0.1498		0.2400		0.1366		0.2258		0.2449	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 32: Cost of Equity Carhart (Weekly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0310	-1.33	-0.0003	-0.01	-0.0264 **	-2.37	-0.0114	-1.44	-0.0107 **	-1.98	-0.0145	-1.41	-0.0252 ***	-3.60	0.0017	0.20	-0.0143	-1.33
Size	-0.0046 **	-2.47	-0.0023	-1.20	-0.0004	-0.32	-0.0007	-0.66	0.0009	1.21	-0.0021 *	-1.66	0.0004	0.44	-0.0026 **	-2.35	-0.0005	-0.30
Leverage	0.0219	1.04	0.0160	1.29	0.0105	1.12	-0.0075	-1.12	-0.0003	-0.06	-0.0074	-0.93	-0.0138 **	-2.11	0.0090	1.21	-0.0098	-0.94
ROA	-0.1037	-0.99	0.0374	0.87	-0.0173	-0.77	0.0124	0.79	-0.0399 **	-2.43	-0.0873	-1.41	0.0255	0.71	-0.0360	-0.96	-0.0515	-1.11
Volatility	-0.0010	-0.50	-0.0008	-0.77	0.0006	0.77	0.0009	1.51	0.0001	0.26	-0.0007	-0.83	-0.0008	-1.29	-0.0009	-1.39	-0.0010	-1.10
Interest Coverage	0.0066 **	2.03	0.0017	0.85	0.0005	0.42	0.0007	0.54	-0.0007	-0.87	-0.0022	-1.43	-0.0029 **	-2.02	0.0024	1.48	-0.0005	-0.24
Capex	0.0958	0.87	-0.0657	-0.86	0.2004 ***	2.75	0.1146 **	2.44	0.0082	0.20	0.3389 ***	3.79	0.0175	0.27	0.0976 *	1.83	0.1856 **	1.99
Cash Flows	-0.0017	-0.24	-0.0016	-0.79	0.0007	1.52	-0.0013	-0.82	0.0020	1.11	0.0028	0.66	0.0014	0.78	-0.0012	-0.99	0.0015 **	2.04
Capital Intensity	0.0169	0.45	0.0319 *	1.71	-0.0157	-0.81	-0.0182	-1.37	0.0009	0.09	-0.0302 *	-1.87	0.0058	0.42	-0.0266 **	-2.13	-0.0379 *	-1.81
Advertising	-0.0756 ***	-3.15	-0.0419 **	-2.31	-0.0389 ***	-3.91	-0.0098	-1.09	-0.0139	-1.57	-0.0273 **	-2.30	-0.0087	-0.71	-0.0076	-1.17	-0.0318 ***	-3.08
Sales Growth	-0.0082	-0.30	-0.0083	-0.93	0.0229 ***	2.83	-0.0049	-0.86	0.0030	0.80	0.0275 ***	4.12	0.0123	1.47	0.0187 **	2.23	0.0085	0.61
R&D Intensity	0.1193 **	2.33	-0.0307	-0.65	-0.0029	-0.08	0.0046	0.19	0.0698 ***	2.85	0.1054 ***	3.28	0.0698 *	1.69	0.0655	1.29	0.0992 ***	3.02
Intercept	0.1397 ***	3.41	0.1047 ***	3.98	0.0576 **	2.50	0.0769 ***	4.06	0.0441 ***	3.61	0.0902 ***	4.21	0.0539 ***	2.81	0.0590 ***	2.94	0.0709 **	2.23
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.2585		0.0981		0.1601		0.0644		0.1335		0.2448		0.1118		0.1685		0.1031	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 33: Cost of Equity CAPM (Monthly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0410 *	-1.83	-0.0155	-0.88	-0.0329 **	-2.02	-0.0112	-1.21	-0.0197 ***	-2.86	-0.0221 **	-2.00	-0.0139	-1.42	-0.0089	-1.00	-0.0127	-1.25
Size	0.0005	0.21	-0.0024	-1.22	-0.0036 **	-2.07	-0.0017	-1.49	0.0000	0.05	-0.0013	-0.90	-0.0003	-0.19	0.0001	0.11	-0.0013	-0.84
Leverage	0.0240	1.03	0.0099	0.65	0.0115	0.99	0.0153 **	2.06	0.0062	1.11	0.0060	0.64	-0.0108	-1.28	-0.0012	-0.17	-0.0140 *	-1.70
ROA	-0.1532	-1.30	-0.0906	-1.45	-0.0273	-0.68	-0.0620 ***	-3.09	-0.0541 ***	-3.73	-0.0586	-0.92	-0.0318	-1.03	-0.0563 **	-2.04	-0.0397	-0.92
Volatility	-0.0022	-0.83	-0.0003	-0.23	-0.0004	-0.36	0.0001	0.16	0.0007	1.22	-0.0008	-0.93	-0.0004	-0.46	-0.0014 **	-2.01	-0.0012	-1.47
Interest Coverage	0.0125 ***	4.58	0.0014	0.55	0.0003	0.18	-0.0005	-0.36	-0.0026 **	-2.22	-0.0047 ***	-2.92	-0.0053 ***	-3.01	-0.0029 *	-1.85	-0.0027	-1.58
Capex	-0.1821 *	-1.70	0.2518 *	1.91	0.2963 ***	2.66	0.1818 ***	2.88	0.0447	0.81	0.1247	1.37	0.1956 **	2.46	0.1038	1.55	0.1776 **	2.02
Cash Flows	-0.0104	-1.18	0.0047 **	2.05	-0.0002	-0.29	0.0016	0.96	0.0009	0.43	-0.0017	-0.38	0.0004	0.22	0.0005	0.59	-0.0003	-0.45
Capital Intensity	0.0067	0.24	-0.0487 **	-2.33	-0.0556 **	-2.40	-0.0371 **	-2.31	-0.0004	-0.03	-0.0040	-0.23	-0.0272	-1.35	-0.0171	-0.99	-0.0356 *	-1.69
Advertising	-0.0238	-0.97	-0.0747 ***	-4.00	-0.0537 ***	-3.39	-0.0204 **	-2.37	-0.0094	-1.08	-0.0380 **	-2.27	-0.0298 **	-1.99	-0.0235 *	-1.87	-0.0365 **	-2.12
Sales Growth	0.0187	0.79	-0.0121	-0.87	-0.0128	-1.17	-0.0403 ***	-5.00	0.0082 *	1.70	0.0092	1.25	-0.0038	-0.36	-0.0054	-0.57	-0.0149	-1.62
R&D Intensity	0.2220 ***	3.40	0.2434 ***	4.57	0.0915 **	1.96	0.0128	0.57	0.0335	1.62	0.1226 ***	3.30	0.0535	0.99	0.0161	0.46	0.0322	0.91
Intercept	0.0189	0.40	0.1311 ***	3.46	0.1657 ***	5.68	0.1308 ***	6.98	0.0536 ***	3.34	0.1037 ***	4.30	0.0967 ***	3.47	0.0693 ***	2.83	0.1203 ***	4.65
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.4009		0.3005		0.1433		0.2993		0.2672		0.1788		0.0983		0.1078		0.0959	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 34: Cost of Equity Fama/French (Monthly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0327	-1.10	-0.0154	-0.84	-0.0325 **	-2.06	-0.0117	-1.02	-0.0220 ***	-2.79	-0.0234 *	-1.91	-0.0129	-1.23	-0.0127	-1.28	0.0004	0.04
Size	-0.0039	-1.43	-0.0006	-0.27	-0.0029 *	-1.72	-0.0027 *	-1.91	-0.0010	-0.93	-0.0014	-0.95	-0.0003	-0.28	-0.0002	-0.20	-0.0003	-0.18
Leverage	0.0425	1.53	0.0142	1.00	0.0110	1.02	0.0114	1.28	0.0009	0.13	-0.0043	-0.46	-0.0163 **	-2.23	-0.0073	-1.08	-0.0040	-0.48
ROA	-0.0836	-0.58	-0.0569	-1.04	-0.0193	-0.52	-0.0477 *	-1.82	-0.0394 **	-2.52	-0.0414	-0.64	-0.0178	-0.77	-0.0475	-1.41	-0.0386	-0.92
Volatility	-0.0018	-0.67	-0.0005	-0.39	-0.0007	-0.66	0.0004	0.57	0.0001	0.18	-0.0012	-1.35	-0.0006	-0.75	-0.0019 ***	-2.61	-0.0023 ***	-2.94
Interest Coverage	0.0130 ***	4.44	0.0002	0.09	-0.0002	-0.11	0.0000	0.00	-0.0018	-1.57	-0.0037 **	-2.26	-0.0042 ***	-2.59	-0.0009	-0.51	-0.0017	-1.10
Capex	-0.1646	-1.23	0.0762	0.66	0.2804 ***	2.66	0.2971 ***	4.23	0.1685 **	2.46	0.3388 ***	3.98	0.3071 ***	3.81	0.2197 ***	3.43	0.1466 *	1.71
Cash Flows	-0.0180 *	-1.92	0.0046 **	2.08	-0.0002	-0.35	0.0030	1.44	-0.0003	-0.14	0.0000	0.01	0.0018	1.30	0.0006	0.74	0.0012 **	2.06
Capital Intensity	-0.0007	-0.02	-0.0078	-0.41	-0.0516 **	-2.31	-0.0537 ***	-3.01	-0.0168	-1.19	-0.0231	-1.34	-0.0377 **	-2.07	-0.0338 **	-2.09	-0.0468 **	-2.37
Advertising	-0.0625 **	-2.37	-0.0659 ***	-3.58	-0.0511 ***	-3.30	-0.0380 ***	-4.08	-0.0261 ***	-2.60	-0.0579 ***	-3.42	-0.0371 ***	-2.72	-0.0285 **	-2.29	-0.0242 *	-1.81
Sales Growth	0.0273	1.13	-0.0118	-0.86	-0.0151	-1.41	-0.0275 ***	-2.79	0.0142 **	2.05	0.0226 **	2.49	0.0070	0.62	0.0005	0.05	0.0098	0.91
R&D Intensity	0.1755 **	2.32	0.2085 ***	4.63	0.0788 *	1.78	0.0703 **	2.33	0.0716 **	2.56	0.1504 ***	3.57	0.0790	1.30	0.0923 *	1.93	0.0966 ***	2.87
Intercept	0.0760	1.48	0.0954 ***	2.61	0.1585 ***	5.51	0.1336 ***	5.47	0.0709 ***	3.81	0.0944 ***	3.86	0.0839 ***	3.31	0.0695 ***	3.37	0.0681 **	2.55
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.2835		0.1502		0.1269		0.2418		0.2379		0.2241		0.1684		0.1966		0.1393	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 35: Cost of Equity Carhart (Monthly) - Annual Regressions

	2006		2007		2008		2009		2010		2011		2012		2013		2014	
ESG Disclosure	-0.0298	-0.90	-0.0136	-0.56	-0.0387 **	-2.15	-0.0108	-0.95	-0.0213 ***	-2.72	-0.0240 *	-1.95	-0.0126	-1.20	-0.0119	-1.19	-0.0006	-0.06
Size	-0.0038	-1.64	-0.0020	-0.75	-0.0030	-1.59	-0.0027 **	-1.97	-0.0010	-0.96	-0.0014	-0.92	-0.0004	-0.33	-0.0004	-0.30	-0.0003	-0.22
Leverage	0.0359	1.51	0.0191	1.29	0.0131	1.00	0.0100	1.15	0.0003	0.04	-0.0046	-0.48	-0.0168 **	-2.34	-0.0079	-1.13	-0.0036	-0.43
ROA	-0.0534	-0.50	-0.0229	-0.36	0.0067	0.15	-0.0353	-1.39	-0.0382 **	-2.43	-0.0396	-0.60	-0.0163	-0.72	-0.0499	-1.45	-0.0421	-1.00
Volatility	-0.0017	-0.63	-0.0003	-0.21	-0.0016	-1.30	0.0005	0.63	0.0001	0.17	-0.0013	-1.37	-0.0005	-0.64	-0.0017 **	-2.33	-0.0025 ***	-2.88
Interest Coverage	0.0101 ***	2.58	0.0012	0.45	0.0010	0.46	0.0006	0.32	-0.0017	-1.45	-0.0038 **	-2.30	-0.0041 ***	-2.59	-0.0008	-0.47	-0.0016	-1.04
Capex	0.1144	0.71	0.1001	0.71	0.3445 ***	2.61	0.2814 ***	4.00	0.1686 **	2.46	0.3383 ***	3.94	0.3000 ***	3.73	0.2156 ***	3.34	0.1428	1.64
Cash Flows	-0.0132	-1.57	0.0041	1.39	-0.0007	-0.80	0.0029	1.54	-0.0002	-0.09	-0.0001	-0.02	0.0019	1.40	0.0006	0.72	0.0011 *	1.87
Capital Intensity	-0.0301	-0.98	-0.0006	-0.02	-0.0483 *	-1.82	-0.0484 ***	-2.73	-0.0166	-1.18	-0.0233	-1.35	-0.0361 **	-2.00	-0.0338 **	-2.08	-0.0466 **	-2.33
Advertising	-0.0675 ***	-2.64	-0.0809 ***	-3.49	-0.0719 ***	-3.99	-0.0404 ***	-4.25	-0.0265 ***	-2.64	-0.0583 ***	-3.42	-0.0364 ***	-2.70	-0.0280 **	-2.24	-0.0240 *	-1.81
Sales Growth	0.0155	0.78	-0.0061	-0.46	-0.0076	-0.63	-0.0260 ***	-2.71	0.0141 **	2.03	0.0222 **	2.44	0.0068	0.61	-0.0003	-0.04	0.0104	0.96
R&D Intensity	0.1318 *	1.72	0.2171 ***	4.64	0.0804	1.53	0.0785 ***	2.60	0.0718 **	2.57	0.1511 ***	3.56	0.0774	1.30	0.0872 *	1.80	0.0978 ***	2.84
Intercept	0.0892 *	1.80	0.1030 ***	2.75	0.1538 ***	4.69	0.1294 ***	5.37	0.0708 ***	3.86	0.0952 ***	3.87	0.0839 ***	3.37	0.0718 ***	3.44	0.0695 ***	2.59
N	62		124		203		211		202		198		194		194		186	
Adj. R2	0.2010		0.1502		0.1591		0.2396		0.2313		0.2236		0.1664		0.1819		0.1385	

Notes: This table reports cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific characteristics over each year of my sample period separately. My proxy for the expected cost of equity is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported next to each coefficient's statistical significance. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 36: Cost of Debt Bloomberg - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
ESG Disclosure	-0.0054***	-0.0067***	-0.0053***	-0.0040***	-0.0039***	-0.0043***	-0.0042***	-0.0042***	-0.0037***	-0.0035**	-0.0040***	-0.0124***	-0.0143***	-0.0159***	-0.0159***	-0.0160***	-0.0136***	-0.0133***
	-4.25	-5.06	-4.03	-3.00	-2.97	-3.35	-3.26	-3.20	-2.80	-2.52	-2.91	-5.89	-6.44	-6.84	-6.85	-4.52	-3.78	-3.66
Size		0.0005 ***	-0.0002	-0.0005***	-0.0005***	-0.0008***	-0.0007***	-0.0007***	-0.0007***	-0.0005**	-0.0006***	0.0002	0.0001	0.0002	0.0002	0.0002	0.0006	0.0004
		3.01	-1.17	-3.01	-3.04	-5.31	-4.26	-4.09	-4.04	-2.54	-2.94	0.58	0.36	0.41	0.40	0.28	0.92	0.65
Leverage			0.0089 ***	0.0072 ***	0.0067 ***	-0.0005	0.0001	0.0000	-0.0004	0.0003	-0.0006	0.0006	0.0009	-0.0021	-0.0021	-0.0027	-0.0036	-0.0025
			8.79	7.44	6.72	-0.47	0.05	0.03	-0.39	0.23	-0.56	0.36	0.45	-0.86	-0.86	-0.89	-1.12	-0.78
ROA				-0.0255***	-0.0266***	-0.0122***	-0.0118***	-0.0102***	-0.0099***	-0.0100**	-0.0099**	-0.0146***	-0.0184***	-0.0139**	-0.0139**	-0.0104	-0.0021	-0.0036
				-8.13	-8.87	-3.47	-3.37	-2.70	-2.60	-2.57	-2.56	-2.67	-3.22	-2.15	-2.14	-1.14	-0.22	-0.39
Volatility					-0.0001	-0.0001	0.0000	-0.0001	-0.0001	0.0000	-0.0001	-0.0001	-0.0003	-0.0002	-0.0002	-0.0003	-0.0005	-0.0003
					-1.29	-1.12	-0.43	-0.55	-0.55	-0.33	-0.65	-0.56	-1.43	-0.80	-0.80	-1.07	-1.42	-0.99
Interest Coverage						-0.0015***	-0.0014***	-0.0015***	-0.0017***	-0.0017***	-0.0017***	-0.0018***	-0.0012***	-0.0022***	-0.0022***	-0.0014**	-0.0024***	-0.0023***
						-6.45	-6.24	-6.31	-6.72	-6.12	-6.12	-4.42	-2.79	-3.95	-3.92	-2.13	-2.82	-2.77
Capex							0.0190 ***	0.0185 ***	0.0306 ***	0.0315 ***	0.0325 ***	0.0270	0.0271	0.0036	0.0036	0.0156	0.0286	0.0341
							4.42	4.21	4.65	4.71	5.16	1.64	1.55	0.18	0.18	0.52	0.92	1.08
Cash Flows								-0.0001	-0.0001	-0.0002	-0.0001	0.0004	0.0003	-0.0001	-0.0001	-0.0002	-0.0009**	-0.0010**
								-0.96	-1.06	-1.13	-1.00	1.48	0.74	-0.29	-0.29	-0.38	-2.19	-2.16
Capital Intensity									-0.0033***	-0.0048***	-0.0048***	0.0049	0.0063 *	0.0091 **	0.0091 **	0.0063	0.0021	0.0009
									-2.87	-3.91	-4.07	1.46	1.81	2.44	2.44	1.18	0.40	0.17
Advertising										-0.0020	-0.0025**	-0.0033	-0.0061***	-0.0045*	-0.0045*	-0.0022	-0.0003	-0.0016
										-1.56	-1.98	-1.45	-2.62	-1.85	-1.84	-0.66	-0.09	-0.50
Sales Growth											-0.0078***	-0.0055***	-0.0061***	-0.0083***	-0.0083***	-0.0096***	-0.0090***	-0.0089***
											-5.71	-2.90	-3.03	-3.72	-3.72	-3.09	-2.95	-2.92
R&D Intensity												0.0353 ***	0.0398 ***	0.0554 ***	0.0554 ***	0.0586 ***	0.0582 ***	0.0594 ***
												4.29	4.76	6.66	6.62	4.93	4.86	5.01
Bond Liquidity													-0.0007	-0.0003	-0.0003	0.0008	0.0005	0.0006
													-1.27	-0.41	-0.40	0.71	0.47	0.60
Bond Rating														-0.0001	-0.0001	-0.0006	-0.0005	-0.0003
														-0.45	-0.45	-1.35	-1.05	-0.59
Years to Maturity															0.0000	0.0000	0.0001	0.0001
															-0.02	-0.10	1.15	1.15
Convexity																-0.0003	0.0001	0.0000
																-0.60	0.30	-0.03
Duration																	-0.0016	-0.0013
																	-1.31	-1.07
Subordinated																		0.0059 **
																		2.01
Intercept	0.0255 ***	0.0183 ***	0.0231 ***	0.0302 ***	0.0315 ***	0.0451 ***	0.0412 ***	0.0410 ***	0.0420 ***	0.0392 ***	0.0498 ***	0.0361 ***	0.0477 ***	0.0477 ***	0.0477 ***	0.0363 ***	0.0341 ***	0.0326 ***
	59.02	7.46	9.71	11.85	12.23	17.01	14.27	14.04	14.26	12.04	13.21	6.70	6.35	5.71	5.63	3.18	2.86	2.76
N	3955	3906	3890	3890	3855	3605	3508	3495	3492	3282	3281	1579	1423	1170	1170	618	574	574
Adj. R2	0.0036	0.0055	0.0266	0.0512	0.0519	0.0486	0.0527	0.0532	0.0555	0.0562	0.0716	0.0809	0.0872	0.1281	0.1274	0.1069	0.1303	0.1360

Notes: This table reports stepwise cross-sectional regressions from regressing my cost of debt estimate on my ESG disclosure quality variable and a set of company-specific and bond-specific control variables over my full sample period from 2004 to 2014. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 37: Cost of Equity Bloomberg - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0389 ***	-0.0471 ***	-0.0463 ***	-0.0426 ***	-0.0433 ***	-0.0409 ***	-0.0373 ***	-0.0373 ***	-0.0353 ***	-0.0304 ***	-0.0301 ***	-0.0340 ***
	-11.57	-12.41	-12.36	-11.50	-11.60	-11.00	-10.50	-10.38	-9.58	-7.82	-7.69	-8.07
Size		0.0023 ***	0.0020 ***	0.0012 ***	0.0011 ***	0.0006	-0.0004	-0.0007 *	-0.0007 *	-0.0032 ***	-0.0031 ***	-0.0022 ***
		5.25	4.47	2.69	2.58	1.26	-0.99	-1.67	-1.67	-6.86	-6.84	-4.07
Leverage			0.0048 **	0.0005	0.0008	-0.0070 ***	-0.0079 ***	-0.0078 ***	-0.0097 ***	-0.0074 ***	-0.0071 ***	-0.0001
			2.18	0.23	0.36	-2.91	-3.41	-3.39	-4.07	-3.07	-2.90	-0.03
ROA				-0.0677 ***	-0.0685 ***	-0.0544 ***	-0.0542 ***	-0.0623 ***	-0.0610 ***	-0.0645 ***	-0.0646 ***	-0.0639 ***
				-10.14	-9.86	-6.48	-6.64	-7.27	-7.11	-7.30	-7.32	-5.55
Volatility					0.0002	0.0003	0.0003	0.0004	0.0004	0.0002	0.0002	0.0006 *
					0.91	1.03	1.29	1.45	1.48	0.75	0.87	1.93
Interest Coverage						-0.0026 ***	-0.0024 ***	-0.0022 ***	-0.0031 ***	-0.0013 **	-0.0013 **	-0.0011
						-4.14	-4.17	-3.91	-5.45	-2.27	-2.25	-1.62
Capex							0.0396 ***	0.0437 ***	0.0915 ***	0.0791 ***	0.0785 ***	0.1728 ***
							4.74	5.10	6.11	5.26	5.22	5.98
Cash Flows								0.0005 **	0.0005 **	0.0005 **	0.0005 **	0.0010 **
								2.45	2.06	2.06	1.98	2.46
Capital Intensity									-0.0131 ***	-0.0098 ***	-0.0097 ***	-0.0046
									-3.92	-2.89	-2.85	-0.65
Advertising										-0.0211 ***	-0.0208 ***	-0.0385 ***
										-6.81	-6.75	-7.35
Sales Growth											0.0037	0.0075 **
											1.37	2.36
R&D Intensity												0.0581 ***
												3.81
Intercept	0.1242 ***	0.0884 ***	0.0910 ***	0.1098 ***	0.1093 ***	0.1278 ***	0.1405 ***	0.1447 ***	0.1488 ***	0.1856 ***	0.1807 ***	0.1527 ***
	116.62	13.13	13.61	15.88	15.45	18.19	19.99	20.77	21.74	25.17	23.08	15.98
N	3955	3906	3890	3890	3855	3605	3508	3495	3492	3282	3281	1579
Adj. R2	0.0359	0.0475	0.0482	0.0791	0.0804	0.0827	0.0839	0.0875	0.0943	0.1122	0.1125	0.1865

Notes: This table reports stepwise cross-sectional regressions from regressing Bloomberg's expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 38: Cost of Equity CAPM (Daily) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0326 ***	-0.0373 ***	-0.0374 ***	-0.0355 ***	-0.0359 ***	-0.0353 ***	-0.0336 ***	-0.0337 ***	-0.0319 ***	-0.0270 ***	-0.0267 ***	-0.0325 ***
	-15.24	-15.82	-15.97	-15.19	-15.35	-14.96	-14.39	-14.31	-13.57	-11.56	-11.44	-12.08
Size		0.0014 ***	0.0015 ***	0.0011 ***	0.0011 ***	0.0009 ***	0.0004	0.0002	0.0003	-0.0018 ***	-0.0018 ***	-0.0010 ***
		5.09	5.33	3.90	3.80	2.98	1.44	0.79	0.83	-5.63	-5.63	-2.90
Leverage			-0.0014	-0.0035 **	-0.0033 **	-0.0073 ***	-0.0079 ***	-0.0078 ***	-0.0095 ***	-0.0082 ***	-0.0078 ***	-0.0036
			-0.94	-2.50	-2.35	-4.37	-4.76	-4.77	-5.77	-4.92	-4.64	-1.55
ROA				-0.0328 ***	-0.0335 ***	-0.0239 ***	-0.0229 ***	-0.0263 ***	-0.0251 ***	-0.0273 ***	-0.0276 ***	-0.0285 ***
				-8.34	-8.45	-4.75	-4.56	-4.74	-4.54	-4.88	-4.96	-4.18
Volatility					0.0002	0.0002	0.0002	0.0003	0.0003	0.0001	0.0001	0.0004
					0.94	0.95	1.34	1.53	1.56	0.54	0.69	1.56
Interest Coverage						-0.0013 ***	-0.0013 ***	-0.0012 ***	-0.0020 ***	-0.0006	-0.0006 *	-0.0006
						-3.53	-3.52	-3.33	-5.27	-1.64	-1.74	-1.33
Capex							0.0329 ***	0.0348 ***	0.0788 ***	0.0681 ***	0.0669 ***	0.0992 ***
							5.11	5.32	7.61	6.64	6.52	4.94
Cash Flows								0.0002	0.0001	0.0001	0.0001	0.0003
								1.43	1.05	0.79	0.65	1.18
Capital Intensity									-0.0120 ***	-0.0086 ***	-0.0087 ***	0.0040
									-5.60	-4.03	-4.06	0.86
Advertising										-0.0155 ***	-0.0154 ***	-0.0213 ***
										-7.57	-7.53	-6.95
Sales Growth											0.0045 **	0.0064 ***
											2.25	3.24
R&D Intensity												0.0474 ***
												4.90
Intercept	0.0663 ***	0.0442 ***	0.0435 ***	0.0529 ***	0.0526 ***	0.0605 ***	0.0652 ***	0.0681 ***	0.0718 ***	0.1023 ***	0.0973 ***	0.0769 ***
	98.45	10.29	10.14	12.06	11.68	12.52	12.90	13.35	14.55	20.18	17.15	12.50
N	3901	3900	3891	3891	3866	3624	3527	3514	3511	3299	3284	1580
Adj. R2	0.0558	0.0647	0.0644	0.0798	0.0814	0.0814	0.0859	0.0887	0.1005	0.1247	0.1285	0.2020

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM model using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 39: Cost of Equity Fama/French (Daily) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0308 ***	-0.0248 ***	-0.0261 ***	-0.0259 ***	-0.0261 ***	-0.0280 ***	-0.0274 ***	-0.0275 ***	-0.0255 ***	-0.0244 ***	-0.0238 ***	-0.0307 ***
	-14.93	-10.94	-11.64	-11.45	-11.54	-12.23	-11.86	-11.79	-10.95	-10.23	-10.07	-10.75
Size		-0.0018 ***	-0.0012 ***	-0.0013 ***	-0.0013 ***	-0.0011 ***	-0.0012 ***	-0.0014 ***	-0.0014 ***	-0.0022 ***	-0.0022 ***	-0.0011 ***
		-7.05	-4.74	-4.90	-4.93	-4.13	-4.25	-4.81	-4.86	-7.35	-7.33	-3.09
Leverage			-0.0085 ***	-0.0088 ***	-0.0089 ***	-0.0098 ***	-0.0098 ***	-0.0097 ***	-0.0115 ***	-0.0102 ***	-0.0095 ***	-0.0055 **
			-6.29	-6.53	-6.45	-6.02	-6.00	-5.97	-7.14	-6.14	-5.69	-2.35
ROA				-0.0049	-0.0056	0.0001	0.0000	-0.0014	0.0000	-0.0013	-0.0017	-0.0089
				-1.24	-1.39	0.01	0.00	-0.23	0.00	-0.23	-0.29	-1.25
Volatility					0.0001	0.0002	0.0002	0.0003	0.0003	0.0002	0.0003	0.0004 **
					0.36	0.96	1.40	1.53	1.56	1.41	1.61	2.00
Interest Coverage						-0.0003	-0.0004	-0.0003	-0.0012 ***	-0.0007 *	-0.0007 **	-0.0007
						-1.01	-1.06	-0.87	-3.33	-1.89	-1.97	-1.54
Capex							0.0326 ***	0.0336 ***	0.0819 ***	0.0777 ***	0.0762 ***	0.1016 ***
							4.43	4.48	7.31	6.90	6.72	4.89
Cash Flows								0.0001	0.0000	-0.0001	-0.0001	-0.0001
								0.36	-0.14	-0.57	-0.79	-0.49
Capital Intensity									-0.0132 ***	-0.0131 ***	-0.0132 ***	-0.0033
									-6.24	-6.11	-6.13	-0.69
Advertising										-0.0084 ***	-0.0081 ***	-0.0150 ***
										-3.90	-3.78	-4.52
Sales Growth											0.0070 ***	0.0103 ***
											3.71	4.87
R&D Intensity												0.0594 ***
												5.77
Intercept	0.0647 ***	0.0928 ***	0.0890 ***	0.0904 ***	0.0905 ***	0.0887 ***	0.0881 ***	0.0906 ***	0.0947 ***	0.1079 ***	0.0996 ***	0.0739 ***
	97.76	23.47	22.55	22.18	21.79	19.72	18.58	19.09	20.41	21.89	18.65	11.76
N	3901	3900	3891	3891	3866	3624	3527	3514	3511	3299	3284	1580
Adj. R2	0.0510	0.0659	0.0738	0.0739	0.0752	0.0753	0.0844	0.0879	0.1018	0.1150	0.1212	0.1811

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 40: Cost of Equity Carhart (Daily) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0261 ***	-0.0194 ***	-0.0209 ***	-0.0209 ***	-0.0211 ***	-0.0232 ***	-0.0238 ***	-0.0239 ***	-0.0226 ***	-0.0211 ***	-0.0204 ***	-0.0276 ***
	-13.02	-8.84	-9.67	-9.60	-9.66	-10.51	-10.69	-10.61	-10.02	-9.21	-8.98	-9.86
Size		-0.0020 ***	-0.0014 ***	-0.0014 ***	-0.0014 ***	-0.0012 ***	-0.0011 ***	-0.0012 ***	-0.0012 ***	-0.0021 ***	-0.0021 ***	-0.0007 **
		-8.29	-5.46	-5.41	-5.40	-4.63	-3.94	-4.36	-4.36	-7.01	-6.90	-2.09
Leverage			-0.0099 ***	-0.0100 ***	-0.0102 ***	-0.0111 ***	-0.0105 ***	-0.0105 ***	-0.0117 ***	-0.0098 ***	-0.0086 ***	-0.0052 **
			-7.74	-7.85	-7.87	-7.26	-6.96	-6.97	-7.67	-6.26	-5.43	-2.34
ROA				-0.0005	-0.0010	0.0032	0.0037	0.0027	0.0035	0.0029	0.0025	-0.0052
				-0.13	-0.28	0.65	0.76	0.49	0.64	0.54	0.46	-0.78
Volatility					-0.0001	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002
					-0.50	0.28	0.56	0.70	0.73	0.84	1.12	1.10
Interest Coverage						-0.0003	-0.0003	-0.0003	-0.0009 ***	-0.0002	-0.0003	-0.0002
						-0.87	-1.03	-0.92	-2.60	-0.72	-0.82	-0.61
Capex							0.0561 ***	0.0569 ***	0.0887 ***	0.0845 ***	0.0824 ***	0.0905 ***
							7.09	7.07	7.37	7.03	6.95	4.10
Cash Flows								0.0001	0.0000	-0.0001	-0.0001	0.0000
								0.35	0.00	-0.79	-1.17	-0.10
Capital Intensity									-0.0087 ***	-0.0093 ***	-0.0093 ***	0.0011
									-4.14	-4.36	-4.41	0.22
Advertising										-0.0126 ***	-0.0121 ***	-0.0149 ***
										-6.04	-5.88	-4.80
Sales Growth											0.0112 ***	0.0127 ***
											5.40	5.28
R&D Intensity												0.0429 ***
												4.10
Intercept	0.0628 ***	0.0946 ***	0.0902 ***	0.0903 ***	0.0911 ***	0.0896 ***	0.0843 ***	0.0862 ***	0.0889 ***	0.1033 ***	0.0894 ***	0.0641 ***
	97.43	24.74	23.58	23.01	22.67	20.47	18.42	18.66	19.47	20.92	16.93	10.09
N	3901	3900	3891	3891	3866	3624	3527	3514	3511	3299	3284	1580
Adj. R2	0.0387	0.0590	0.0704	0.0702	0.0716	0.0711	0.0930	0.0951	0.1012	0.1158	0.1296	0.1590

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using daily data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 41: Cost of Equity CAPM (Weekly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0349 ***	-0.0402 ***	-0.0399 ***	-0.0377 ***	-0.0381 ***	-0.0372 ***	-0.0354 ***	-0.0357 ***	-0.0335 ***	-0.0289 ***	-0.0286 ***	-0.0369 ***
	-13.62	-14.18	-14.25	-13.51	-13.62	-13.23	-12.74	-12.70	-11.82	-9.96	-9.82	-11.10
Size		0.0016 ***	0.0016 ***	0.0011 ***	0.0011 ***	0.0008 **	0.0004	0.0002	0.0002	-0.0017 ***	-0.0017 ***	-0.0007
		4.92	4.73	3.34	3.27	2.48	1.18	0.56	0.58	-4.69	-4.76	-1.59
Leverage			0.0008	-0.0016	-0.0014	-0.0060 ***	-0.0061 ***	-0.0059 ***	-0.0079 ***	-0.0063 ***	-0.0061 ***	-0.0023
			0.47	-0.92	-0.78	-2.95	-3.02	-2.94	-3.86	-3.00	-2.84	-0.79
ROA				-0.0382 ***	-0.0384 ***	-0.0271 ***	-0.0271 ***	-0.0304 ***	-0.0289 ***	-0.0323 ***	-0.0330 ***	-0.0325 ***
				-7.93	-7.86	-4.43	-4.44	-4.55	-4.37	-4.74	-4.86	-3.90
Volatility					0.0001	0.0001	0.0001	0.0002	0.0002	0.0000	0.0000	0.0002
					0.44	0.39	0.59	0.75	0.79	-0.14	-0.11	0.68
Interest Coverage						-0.0015 ***	-0.0014 ***	-0.0013 ***	-0.0022 ***	-0.0008 *	-0.0008 *	-0.0007
						-3.31	-3.12	-2.84	-4.83	-1.68	-1.70	-1.17
Capex							0.0418 ***	0.0436 ***	0.0945 ***	0.0843 ***	0.0833 ***	0.1242 ***
							5.31	5.45	7.37	6.58	6.50	4.96
Cash Flows								0.0002	0.0001	0.0001	0.0001	0.0001
								1.10	0.57	0.68	0.62	0.37
Capital Intensity									-0.0139 ***	-0.0110 ***	-0.0109 ***	-0.0006
									-5.40	-4.22	-4.20	-0.11
Advertising										-0.0148 ***	-0.0147 ***	-0.0241 ***
										-5.72	-5.72	-5.99
Sales Growth											0.0030	0.0035
											1.26	1.33
R&D Intensity												0.0410 ***
												3.05
Intercept	0.0680 ***	0.0429 ***	0.0431 ***	0.0540 ***	0.0538 ***	0.0633 ***	0.0670 ***	0.0700 ***	0.0745 ***	0.1025 ***	0.0996 ***	0.0790 ***
	82.70	8.49	8.61	10.53	10.32	11.70	11.94	12.52	13.63	17.81	15.27	10.17
N	3905	3905	3896	3896	3874	3622	3525	3512	3509	3297	3284	1580
Adj. R2	0.0458	0.0541	0.0536	0.0686	0.0696	0.0696	0.0734	0.0758	0.0872	0.0995	0.1012	0.1627

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM model using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 42: Cost of Equity Fama/French (Weekly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0321 ***	-0.0260 ***	-0.0271 ***	-0.0267 ***	-0.0265 ***	-0.0286 ***	-0.0279 ***	-0.0281 ***	-0.0258 ***	-0.0253 ***	-0.0245 ***	-0.0321 ***
	-12.46	-8.98	-9.50	-9.33	-9.24	-10.00	-9.58	-9.51	-8.63	-8.18	-7.94	-9.03
Size		-0.0019 ***	-0.0014 ***	-0.0015 ***	-0.0014 ***	-0.0013 ***	-0.0015 ***	-0.0016 ***	-0.0016 ***	-0.0024 ***	-0.0023 ***	-0.0010 **
		-5.91	-4.35	-4.54	-4.47	-3.84	-4.18	-4.70	-4.75	-6.53	-6.32	-2.19
Leverage			-0.0071 ***	-0.0075 ***	-0.0077 ***	-0.0090 ***	-0.0092 ***	-0.0090 ***	-0.0111 ***	-0.0095 ***	-0.0085 ***	-0.0059 *
			-3.91	-4.13	-4.17	-4.32	-4.40	-4.31	-5.25	-4.32	-3.83	-1.90
ROA				-0.0065	-0.0062	0.0010	0.0005	-0.0013	0.0003	-0.0013	-0.0015	-0.0061
				-1.31	-1.22	0.15	0.07	-0.18	0.04	-0.19	-0.21	-0.65
Volatility					-0.0003	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
					-1.29	-0.49	-0.13	0.00	0.04	0.07	0.30	0.70
Interest Coverage						-0.0006	-0.0007	-0.0006	-0.0016 ***	-0.0011 **	-0.0011 **	-0.0009
						-1.35	-1.47	-1.24	-3.36	-2.26	-2.28	-1.49
Capex							0.0213 **	0.0227 **	0.0767 ***	0.0732 ***	0.0718 ***	0.1041 ***
							2.39	2.49	5.41	5.13	5.04	3.68
Cash Flows								0.0001	0.0000	-0.0001	-0.0001	-0.0005
								0.33	-0.15	-0.44	-0.61	-1.32
Capital Intensity									-0.0148 ***	-0.0153 ***	-0.0152 ***	-0.0071
									-5.39	-5.52	-5.51	-1.19
Advertising										-0.0088 ***	-0.0082 ***	-0.0164 ***
										-3.21	-2.98	-3.81
Sales Growth											0.0097 ***	0.0122 ***
											4.32	4.37
R&D Intensity												0.0593 ***
												4.28
Intercept	0.0658 ***	0.0948 ***	0.0916 ***	0.0934 ***	0.0946 ***	0.0932 ***	0.0950 ***	0.0976 ***	0.1023 ***	0.1147 ***	0.1019 ***	0.0748 ***
	77.51	19.63	19.07	18.83	18.67	17.49	16.82	17.28	18.37	19.25	15.48	9.07
N	3888	3888	3879	3879	3864	3613	3516	3503	3500	3288	3284	1580
Adj. R2	0.0369	0.0475	0.0509	0.0511	0.0512	0.0517	0.0554	0.0581	0.0699	0.0794	0.0850	0.1279

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 43: Cost of Equity Carhart (Weekly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0282 ***	-0.0213 ***	-0.0225 ***	-0.0224 ***	-0.0221 ***	-0.0243 ***	-0.0254 ***	-0.0251 ***	-0.0233 ***	-0.0221 ***	-0.0211 ***	-0.0301 ***
	-10.72	-7.18	-7.72	-7.62	-7.50	-8.19	-8.48	-8.25	-7.59	-6.99	-6.70	-8.20
Size		-0.0021 ***	-0.0015 ***	-0.0016 ***	-0.0015 ***	-0.0014 ***	-0.0013 ***	-0.0014 ***	-0.0014 ***	-0.0023 ***	-0.0022 ***	-0.0005
		-6.69	-4.83	-4.85	-4.76	-4.21	-3.60	-3.98	-3.99	-6.01	-5.75	-1.05
Leverage			-0.0084 ***	-0.0086 ***	-0.0089 ***	-0.0098 ***	-0.0095 ***	-0.0094 ***	-0.0110 ***	-0.0089 ***	-0.0075 ***	-0.0048
			-4.58	-4.70	-4.81	-4.59	-4.46	-4.44	-5.11	-3.98	-3.33	-1.51
ROA				-0.0026	-0.0016	0.0019	0.0030	-0.0006	0.0005	-0.0005	-0.0007	-0.0092
				-0.54	-0.34	0.29	0.45	-0.08	0.07	-0.07	-0.10	-0.91
Volatility					-0.0005 **	-0.0004 *	-0.0003	-0.0003	-0.0003	-0.0002	-0.0002	-0.0001
					-2.54	-1.72	-1.36	-1.21	-1.16	-1.04	-0.72	-0.30
Interest Coverage						-0.0003	-0.0005	-0.0004	-0.0012 ***	-0.0005	-0.0005	-0.0005
						-0.64	-1.06	-0.90	-2.58	-1.10	-1.14	-0.86
Capex							0.0502 ***	0.0522 ***	0.0939 ***	0.0903 ***	0.0884 ***	0.1041 ***
							5.17	5.28	6.09	5.84	5.83	3.50
Cash Flows								0.0002	0.0002	0.0001	0.0000	0.0002
								1.25	0.90	0.50	0.23	0.39
Capital Intensity									-0.0114 ***	-0.0125 ***	-0.0125 ***	-0.0034
									-4.00	-4.32	-4.33	-0.53
Advertising										-0.0134 ***	-0.0125 ***	-0.0181 ***
										-4.75	-4.49	-4.06
Sales Growth											0.0131 ***	0.0141 ***
											5.00	4.24
R&D Intensity												0.0496 ***
												3.24
Intercept	0.0643 ***	0.0972 ***	0.0933 ***	0.0941 ***	0.0966 ***	0.0951 ***	0.0903 ***	0.0923 ***	0.0959 ***	0.1101 ***	0.0929 ***	0.0633 ***
	74.60	20.09	19.41	18.96	19.01	17.79	16.05	16.24	16.97	17.92	13.67	7.54
N	3888	3888	3879	3879	3864	3613	3516	3503	3500	3288	3284	1580
Adj. R2	0.0274	0.0405	0.0452	0.0450	0.0463	0.0458	0.0564	0.0576	0.0641	0.0739	0.0839	0.1072

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using weekly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 44: Cost of Equity CAPM (Monthly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0348 ***	-0.0394 ***	-0.0390 ***	-0.0363 ***	-0.0357 ***	-0.0352 ***	-0.0320 ***	-0.0324 ***	-0.0305 ***	-0.0292 ***	-0.0295 ***	-0.0371 ***
	-11.55	-11.76	-11.68	-10.93	-10.79	-10.40	-9.43	-9.50	-8.87	-8.23	-8.24	-8.57
Size		0.0014 ***	0.0013 ***	0.0008 **	0.0009 **	0.0006	-0.0003	-0.0005	-0.0005	-0.0016 ***	-0.0017 ***	-0.0008
		3.56	3.31	1.96	2.22	1.44	-0.59	-1.15	-1.14	-3.19	-3.34	-1.49
Leverage			0.0012	-0.0019	-0.0029	-0.0063 ***	-0.0084 ***	-0.0083 ***	-0.0100 ***	-0.0081 ***	-0.0084 ***	0.0003
			0.59	-0.94	-1.43	-2.64	-3.53	-3.48	-4.14	-3.16	-3.25	0.07
ROA				-0.0462 ***	-0.0442 ***	-0.0385 ***	-0.0371 ***	-0.0419 ***	-0.0406 ***	-0.0433 ***	-0.0435 ***	-0.0463 ***
				-7.94	-7.58	-5.14	-4.96	-5.16	-5.00	-5.22	-5.25	-3.72
Volatility					-0.0012 ***	-0.0012 ***	-0.0010 ***	-0.0009 ***	-0.0009 ***	-0.0009 ***	-0.0009 ***	-0.0006
					-5.04	-4.76	-3.90	-3.65	-3.64	-3.59	-3.62	-1.61
Interest Coverage						-0.0017 ***	-0.0019 ***	-0.0017 ***	-0.0026 ***	-0.0018 ***	-0.0018 ***	-0.0008
						-2.96	-3.20	-2.98	-4.22	-2.71	-2.76	-0.88
Capex							-0.0009	0.0014	0.0474 ***	0.0419 ***	0.0414 ***	0.1527 ***
							-0.11	0.16	3.44	2.98	2.94	4.43
Cash Flows								0.0003	0.0002	0.0002	0.0002	0.0003
								1.19	0.83	0.91	0.91	0.35
Capital Intensity									-0.0126 ***	-0.0130 ***	-0.0130 ***	-0.0127 *
									-4.38	-4.32	-4.32	-1.71
Advertising										-0.0136 ***	-0.0138 ***	-0.0280 ***
										-4.76	-4.86	-5.36
Sales Growth											-0.0018	-0.0011
											-0.64	-0.31
R&D Intensity												0.0698 ***
												3.92
Intercept	0.0705 ***	0.0488 ***	0.0491 ***	0.0620 ***	0.0673 ***	0.0778 ***	0.0905 ***	0.0940 ***	0.0979 ***	0.1154 ***	0.1190 ***	0.0940 ***
	73.56	8.10	8.19	10.11	10.98	11.75	12.82	13.20	13.93	14.66	14.34	9.39
N	3888	3888	3879	3879	3875	3623	3526	3513	3510	3298	3283	1580
Adj. R2	0.0337	0.0381	0.0376	0.0538	0.0603	0.0676	0.0620	0.0641	0.0706	0.0804	0.0816	0.1189

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from the CAPM model using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 45: Cost of Equity Fama/French (Monthly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0315 ***	-0.0272 ***	-0.0289 ***	-0.0275 ***	-0.0268 ***	-0.0278 ***	-0.0259 ***	-0.0255 ***	-0.0232 ***	-0.0237 ***	-0.0238 ***	-0.0354 ***
	-10.33	-7.67	-8.25	-7.87	-7.66	-7.78	-7.21	-6.99	-6.36	-6.38	-6.33	-8.19
Size		-0.0013 ***	-0.0006	-0.0009 **	-0.0007 *	-0.0009 **	-0.0011 **	-0.0012 ***	-0.0012 ***	-0.0020 ***	-0.0021 ***	-0.0010 *
		-3.19	-1.48	-2.14	-1.82	-2.01	-2.40	-2.70	-2.69	-4.12	-4.23	-1.93
Leverage			-0.0104 ***	-0.0120 ***	-0.0133 ***	-0.0144 ***	-0.0146 ***	-0.0143 ***	-0.0164 ***	-0.0117 ***	-0.0117 ***	-0.0031
			-5.11	-5.87	-6.49	-5.86	-5.93	-5.87	-6.71	-4.60	-4.59	-0.83
ROA				-0.0238 ***	-0.0210 ***	-0.0181 **	-0.0184 **	-0.0234 ***	-0.0217 **	-0.0241 ***	-0.0241 ***	-0.0308 ***
				-4.03	-3.55	-2.23	-2.29	-2.70	-2.54	-2.79	-2.78	-2.63
Volatility					-0.0016 ***	-0.0016 ***	-0.0014 ***	-0.0013 ***	-0.0013 ***	-0.0012 ***	-0.0012 ***	-0.0008 **
					-6.59	-6.20	-5.47	-5.35	-5.39	-4.72	-4.74	-2.38
Interest Coverage						-0.0008	-0.0007	-0.0005	-0.0016 ***	-0.0007	-0.0008	-0.0010
						-1.29	-1.15	-0.94	-2.62	-1.18	-1.22	-1.29
Capex							0.0328 ***	0.0346 ***	0.0907 ***	0.0868 ***	0.0859 ***	0.2040 ***
							3.91	4.03	6.35	5.98	5.91	6.33
Cash Flows								0.0003	0.0002	0.0001	0.0001	0.0005
								1.34	0.93	0.42	0.38	0.64
Capital Intensity									-0.0153 ***	-0.0195 ***	-0.0194 ***	-0.0205 ***
									-5.17	-6.42	-6.40	-2.89
Advertising										-0.0211 ***	-0.0213 ***	-0.0359 ***
										-7.32	-7.40	-7.07
Sales Growth											0.0008	0.0044
											0.31	1.36
R&D Intensity												0.1043 ***
												5.97
Intercept	0.0678 ***	0.0879 ***	0.0832 ***	0.0898 ***	0.0970 ***	0.1013 ***	0.1014 ***	0.1032 ***	0.1080 ***	0.1219 ***	0.1221 ***	0.0941 ***
	69.46	14.34	13.71	14.37	15.50	15.05	14.24	14.28	15.25	15.80	15.13	9.92
N	3888	3888	3879	3879	3875	3623	3526	3513	3510	3298	3283	1580
Adj. R2	0.0267	0.0303	0.0362	0.0401	0.0507	0.0520	0.0540	0.0545	0.0638	0.0815	0.0824	0.1551

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Fama/French's asset pricing model using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

Table 46: Cost of Equity Carhart (Monthly) - Stepwise Regressions

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
ESG Disclosure	-0.0305 ***	-0.0250 ***	-0.0270 ***	-0.0260 ***	-0.0252 ***	-0.0268 ***	-0.0258 ***	-0.0254 ***	-0.0233 ***	-0.0230 ***	-0.0229 ***	-0.0340 ***
	-9.75	-6.92	-7.58	-7.30	-7.09	-7.34	-7.03	-6.81	-6.27	-6.04	-5.96	-7.66
Size		-0.0017 ***	-0.0008 **	-0.0010 **	-0.0009 **	-0.0010 **	-0.0010 **	-0.0012 **	-0.0012 **	-0.0024 ***	-0.0024 ***	-0.0014 **
		-4.13	-2.07	-2.50	-2.17	-2.21	-2.24	-2.51	-2.51	-4.60	-4.62	-2.51
Leverage			-0.0124 ***	-0.0134 ***	-0.0148 ***	-0.0157 ***	-0.0151 ***	-0.0149 ***	-0.0167 ***	-0.0111 ***	-0.0106 ***	-0.0026
			-6.01	-6.52	-7.14	-6.39	-6.16	-6.12	-6.80	-4.35	-4.12	-0.69
ROA				-0.0159 ***	-0.0130 **	-0.0096	-0.0102	-0.0149 *	-0.0135	-0.0145	-0.0146	-0.0240 **
				-2.67	-2.17	-1.15	-1.24	-1.68	-1.53	-1.63	-1.62	-1.99
Volatility					-0.0017 ***	-0.0017 ***	-0.0015 ***	-0.0015 ***	-0.0015 ***	-0.0012 ***	-0.0012 ***	-0.0009 **
					-6.69	-6.32	-5.74	-5.62	-5.64	-4.71	-4.69	-2.35
Interest Coverage						-0.0006	-0.0004	-0.0003	-0.0012 **	-0.0001	-0.0001	-0.0006
						-0.95	-0.70	-0.52	-1.97	-0.18	-0.24	-0.76
Capex							0.0595 ***	0.0613 ***	0.1102 ***	0.1058 ***	0.1045 ***	0.2270 ***
							6.41	6.47	7.19	6.86	6.77	6.40
Cash Flows								0.0003	0.0002	0.0000	0.0000	0.0004
								1.29	0.94	0.17	0.06	0.55
Capital Intensity									-0.0133 ***	-0.0183 ***	-0.0183 ***	-0.0210 ***
									-4.32	-5.82	-5.82	-2.74
Advertising										-0.0291 ***	-0.0290 ***	-0.0404 ***
										-9.84	-9.87	-7.61
Sales Growth											0.0049 *	0.0061 *
											1.66	1.81
R&D Intensity												0.1029 ***
												5.88
Intercept	0.0672 ***	0.0933 ***	0.0877 ***	0.0921 ***	0.0996 ***	0.1027 ***	0.0988 ***	0.1006 ***	0.1048 ***	0.1248 ***	0.1194 ***	0.0959 ***
	67.25	15.12	14.29	14.60	15.72	15.13	13.74	13.73	14.54	15.69	14.33	9.79
N	3888	3888	3879	3879	3875	3623	3526	3513	3510	3298	3283	1580
Adj. R2	0.0237	0.0298	0.0377	0.0392	0.0502	0.0507	0.0605	0.0608	0.0673	0.0910	0.0931	0.1578

Notes: This table reports stepwise cross-sectional regressions from regressing my expected cost of equity on my ESG disclosure quality variable and a set of company-specific control variables over my full sample period from 2004 to 2014. My expected cost of equity proxy is based on Graham and Harvey's (2015) expected market premium and is inferred from Carhart's asset pricing model using monthly data frequencies. My cross-sectional OLS regressions are estimated with robust standard errors, using Huber/White heteroscedasticity-consitent standard errors. T-ratios are reported under each coefficient. ***, **, and * indicate statistical significance at the 1, 5, and 10 percent significance levels.

8 Discussion and Conclusion

8.1 Discussion and Conclusion

Given the tremendous growth of ESG (Environmental, Social, and Governance) Investing and the increasing relevance of ESG information for institutional investors, corporate managers, and policymakers making different strategic financial decisions, the principal aim of my thesis was to empirically investigate the effects and implications of several ESG dimensions on the financial performance, idiosyncratic and systematic risk, and expected cost of capital of investment portfolios, indexes, and companies. Using asset pricing methodologies, consistent with general market equilibrium models which are based on the Efficient Market Theory, the empirical chapters of my thesis provide new insights on the effects and implications of different ESG dimensions for equity and debt investors as well as corporate managers and policymakers.

Following Jensen's (1978:96) definition of an efficient capital market (see Chapter 2.2. 'Definition of the Efficient Market Theory'), which posits that "A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t", I will summarise my main findings and subsequently outline their implications with respect to the Efficient Market Theory.

The main findings of my thesis can be summarised as follows. First, my results suggest that institutional investors such as pension funds governed by trust law and fiduciary duties shall be allowed to integrate ESG criteria into their investment decision making processes as they do no harm to the financial returns of my tested hypothetical equity pension portfolios. In other words, my findings show that no portfolio based on corporate environmental responsibility significantly over- or underperformed the respective conventional market benchmark (See Tables 3 and 4). Under ERISA, pension funds have been disallowed to consider environmental, social, and governance (ESG) criteria, or any other non-economic criteria, when such considerations damage the financial well-being of the beneficiary (Langbein and Posner, 1980, O'Brien-Hylton, 1992).

Second, my results show that ESG criteria can reduce the downside volatility of my tested hypothetical equity pension portfolios. This means that my screened hypothetical equity pension portfolios[115] are no riskier than unscreened portfolios and thus, do not carry a diversification penalty (See e.g. Kurtz, 2005; Markowitz, 1952; Rudd, 1981; Sharpe, 1964). My analysis shows that those portfolios with high corporate environmental responsibility criteria even tend to experience significantly lower idiosyncratic risks relative to portfolios

[115] Using e.g. corporate environmental sustainability criteria.

with low corporate environmental responsibility, depending on the specific risk measure and corporate environmental responsibility criteria used (See Figures 3 to 6). The difference tends to be statistically significant at the 1, 5, and 10 percent significance levels. According to Modern Portfolio Theory (see e.g. Chapter 2.6.1. 'Diversification and ESG information) some scholars may argue that screened portfolios are less diversified relative to unscreened portfolios because they represent only a sub-set of the unscreened portfolio and will therefore always be riskier and financially less attractive. However, consistent with my findings, recent empirical evidence shows that a reduced stock universe does not need to reduce diversification and increase risk (Bello, 2005; Kacperczyk et al., 2005; Schroeder, 2007).

Third, my results show that an investment trading strategy based on sub-sets of ESG information in form of passive renewable energy equity indexes[116] can be financially attractive as well as costly relative to investing in conventional equity markets, depending on the sample period under investigation. To be more specific, over the full sample period, several renewable energy equity indexes financially underperform relative to conventional benchmarks. Seven out of fourteen alpha coefficients are negative and statistically significant at the 1, 5, and 10 percent significance level (See Panel A of Table 10). This result is similar to the second phase of the EU ETS, where I find twelve renewable energy equities to significantly underperform their benchmarks (Panel C of Table 10). In contrast, over the first phase of the EU ETS, I find positive and statistically significant alphas for three renewable energy equity indexes (Panel B of Table 10). Although the two phases of the EU ETS are not necessarily related to financial asset prices, but rather institutional arrangements regarding Greenhouse Gas (GHG) Emissions, which have been predetermined in advance (See Scholtens and Van der Goot, 2015), it could be that the launch of the EU ETS has triggered some general positive investors sentiment that temporarily increased the demand for renewable energy companies and thereby pushed up the stock prices. This could explain my results over the first phase of the EU ETS. While the results of my dynamic performance analysis indicate that renewable energy indexes' financial performance collapsed abruptly over the second phase of the EU ETS, which could have been the result of the financial crisis.[117]

[116] ESG information sets can be used to generate different investment trading strategies. In Chapters 5 and 6 of my thesis, I empirically investigate investment trading strategies related to renewable energy, which represents a sub-set of ESG information.
[117] However, this would need to be established by more formal tests of crisis periods such as those employed by Bohl et al. (2013).

My findings also suggest that the financial returns of passive renewable energy equity indexes tend to be very volatile throughout. Thus, the findings of my pre-crisis period are consistent with Modern Portfolio Theory (see e.g. Chapter 2.6.1. 'Diversification and ESG information), which posits that higher risk exposures shall lead to higher expected returns. While the findings of my post-crisis sample period are contrary to Modern Portfolio Theory. Although renewable energy equity indexes' beta coefficients remain at a high level during the post-crisis period, their financial returns are significantly negative.

Fourth, the results of my thesis show that an investment trading strategy based on subsets of ESG information in form of passive renewable energy equity indexes is associated with higher investment risks relative to a trading strategy investing in fossil-fuel energy companies. My results suggest that renewable energy equity indexes are not only more volatile than conventional equity market benchmarks as well as fossil-fuel energy equity indexes, using absolute, downside, and relative investment risk measures (See Tables 13 and 15). Higher investment risks could be the result of high uncertainties regarding the nature of renewable energy technology businesses. Meaning that renewable energy companies tend to have more in common with technology-oriented businesses with a selected focus on few projects. Investors could perceive companies with few and uncertain projects as riskier investments. Also, the renewable energy sector is very capital intensive. Due to the capital intensity of renewable energy projects, governments had to substantially support the sector by policy investments in the past. However, once subsidies are discontinued or substantially reduced (e.g. as a result of a recession), those sectors can be seriously affected, as wittnessed by the surge of bankruptcies in the German solar sector (Bohl et al., 2013). Further, the weak carbon price of the EU ETS and the lack of a global carbon trading scheme does not contribute to the growth of the renewable energy sector, through market-based policies.

Thus, consistent with the findings of prior studies and Modern Portfolio Theory, I can conclude that renewable energy equity indexes can be financially beneficial, however, they are associated with higher risks (see e.g. Henriques and Sadorsky, 2008; Kumar et al., 2012; Sadorsky, 2012a, b).

Fifth, my results suggest that ESG information in form of high ESG disclosure quality lowers a company's expected cost of equity and debt capital, while also controlling for company- and bond-specific characteristics. In other words, the relation between ESG disclosure quality and the expected cost of equity and debt is consistently negative and statistically significant at the 1 percent significance level (See Table 23). My results imply that the market prices a company's ESG disclosure quality along with other factors.

Theoretical arguments that could motivate why ESG disclosure quality lowers the expected cost of capital are based on companies' investor base (Merton, 1987), reductions in companies' systematic risk (Lambert et al., 2007), and reductions in company-specific risks such as future litigation and reputational risks (Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Starks, 2009). To be more specific, according to Merton's (1987) capital market equilibrium model, companies have an incentive to disclose more information as this increases investors' awarness of a company's existence and expands the investor base, which will reduce the firm's cost of capital and increase the market value of the company (Dhaliwal et al., 2011; Merton, 1987). Further, Lambert et al. (2007) show that not only does better disclosure lower the variance of a copmany's cash flows, it also affects the covariances with other companies, which essentially reduces a companies' beta. Finally, irresponsible companies tend to be perceived as riskier investments because of potential future litigation and reputational risks (Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Starks, 2009). Companies that are ethically and socially unsound, and otherwise deliberately disclose misleading information on their products and services will increase the probability of future lawsuits against the company.

8.1.1 Implications for the Efficient Market Theory

The theoretical roots of my thesis in general, and my empirical methodologies in particular, can be found in the Efficient Market Theory. Following the vast majority of Finance research, my thesis is assessed from the "home paradigm" in Finance, which is most closely represented by Burrell and Morgan's (1979) functionalist research paradigm (See Chapter 3 'Methodological Position and Research Methodology') . As such, I will proceed to discuss the implications of my empirical results with respect to the Efficient Market Theory.

As outlined in Chapter 2 'Theory: The Efficient Market Theory', my empirical results can be interpreted from two different perspectives. Critics of the Efficient Market Theory argue that any persistent and statistically significant outperformance (e.g. as measured by the alpha coefficient), shows that capital markets are inefficient with regard to information set θ_t (or investment trading strategy). In contrast, supporters of the Efficient Market Theory will argue that markets are efficient, however, that the asset pricing models used to test information set θ_t (or investment trading strategy) are misspecified and do not fully price the respective information set. I have discussed this issue in Chapter 2.7. 'Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium'.

Thus, consistent with Jensen's (1978) definition of an efficient capital market, and as outlined previously, any statistically significant economic profit (as measured by the alpha coefficient) found in my thesis is interpreted as to whether or not the market is informationally efficient with respect to information set θ_t based on the specific markets and sample periods tested. In my thesis, the information set θ_t equals three related but independent ESG dimensions or investment trading strategies, namely corporate environmental responsibility, renewable energy, and ESG disclosure quality. Thus, in each of my chapters, I test a different information set (or investment trading strategy) related to ESG. I do not assume that my three individual ESG dimensions are the only information sets available, as there are hundreds and thousands of ESG criteria with millions of possible investment trading strategies that could be empirically analysed.

My results in Chapter 4 show that none of my hypothetical equity pension portfolios generate statistically significant economic profits (as measured by the alpha coefficient) over my tested sample period. This means that an investment trading strategy of investing in companies with high corporate environmental responsiblity does not generate statistically significant abnormal risk-adjusted returns, but neither does an investment trading strategy investing in companies with low corporate environmental responsbility.

According to Hamilton et al.'s (1993) equal performance hypothesis (as discussed in Chapter 2.5.1. 'Pricing of ESG information'), when risk-adjusted returns of high ESG portfolios relative to low ESG portfolios are equal, then ESG information may not be priced in the market. This is because "responsible investors who sell stocks find enough conventional investors ready to buy that the prices of the stocks do not drop" (Hamilton et al., 1993:63). As Heinkel et al's (2001) capital market equilibrium model (which is consistent with the Efficient Market Theory) shows, when fewer investors are available to hold the shares of certain companies, then this reduces diversification (risk-sharing) and increases a company's cost of capital. Risk-adjusted returns to investors are the cost of capital to the company (Hamilton et al., 1993). Thus, the equal performance hypothesis suggests that there are sufficient conventional investors available to hold the shares without causing an effect on a company's stock price or its cost of capital, and therefore responsible investors cannot influence high ESG companies' share prices or cost of capitals by favouring them over low ESG companies. As a result, the market seems to be informationally efficient with respect to information sets related to my first proxy of ESG information, corporate environmental responsibility, over my tested sample period.

However, concluding that capital markets are efficient with respect to information sets related to corporate environmental responsibility would be premature, as further empirical tests are necessary to establish that capital markets are consistently efficient with regard to corporate environmental responsibility in different markets as well as future sample periods. Prior literature on the effects of corporate environmental responsibility on risk-adjusted returns has shown that corporate environmental responsibility can have a significant effect on a company's risk-adjusted returns and cost of capitals (see e.g. Bauer and Hann, 2010; Hart and Ahuja, 1996; Horváthová, 2012; Klassen and McLaughlin, 1996; King and Lennox, 2001; Oikonomou et al., 2014; Orlitzky et al., 2003; Renneboog et al., 2008a).

Furthermore, the Joint Hypothesis Problem (discussed in Chapter 2.7. 'Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium') shows that all tests for market efficiency are always joint tests of market behaviour and models of asset pricing (Dimson and Mussavian, 1998). Thus, it could well be that my asset pricing model used for my regression tests is misspecified and does not sufficiently measure corporate environmental responsibility.

In contrast to the results of Chapter 4, the results of Chapter 5 suggest that an investment trading strategy based on investing in renewable energy equity indexes generates statistically signficant economic profits and losses (as measured by the alpha coefficient), depending on the sample period tested. My results are consistent with Hamilton et al.'s (1993) over- and underperformance hypotheses (which I have discussed in more detail in Chapter 2.5.1. 'Pricing of ESG information). The overperformance hypothesis states that when the risk-adjusted returns of renewable energy equity indexes are higher than the risk-adjusted returns of conventional equity indexes, then ESG information in form of renewable energy is priced (mispriced) by the market. The reason is that investors tend to underestimate the possibility that negative information will be released about conventional firms (Bauer et al., 2005; Hamilton et al., 1993; Moskowitz, 1972).[118] The overperformance hypothesis in conjunction with Heinkel et al.'s (2001) framework also suggests that conventional companies are being held by fewer investors since responsible investors have a preference for renewable energy companies, which as a result lowers the stock prices and increases the cost of capital of conventional companies. As a result, the market seems to be informationally

[118] For example, conventional investors who consistently underestimate the likelihood of chemical firms having issues with uncontrolled chemical spills, will see a drop in the stock prices of these chemical firms following the spill. While reduced stock prices will lower the returns of conventional portfolios holding chemical stocks, portfolios of socially responsible investors will be unaffected (See e.g. Hamilton, 1995).

inefficient with respect to information sets related to my second proxy of ESG information, renewable energy, over my tested sample periods, due to investor's mispricing.

Hamilton et al.'s (1993) underperformance hypothesis states that when risk-adjusted returns of renewable energy equity indexes are lower relative to the risk-adjusted returns of conventional equity indexes, then ESG information in form of renewable energy is also priced by the market. The underperformance hypothesis in conjunction with Heinkel et al.'s (2001) framework suggests that renewable energy companies are being held by fewer investors, which results in reduced diversification (risk-sharing), lower stock prices and increased cost of capital for renewable energy companies. As a result, both of my findings from Chapter 5 show that the market seems to be informationally inefficient with respect to information sets related to my second proxy of ESG information, renewable energy, over my tested sample periods.

Similarly, my empirical analysis of Chapter 7 shows that ESG disclosure quality is negatively associated with my expected cost of equity and debt variables, controlling for company- and bond-specific characteristics. My results are generally statistically significant at the 1 and 5 percent significance level and consistent across alternative proxies for the expected cost of equity[119] and different regression specifications. My results of the relation between ESG disclosure quality and the expected cost of equity and debt imply that the market prices a company's ESG disclosure quality along with other factors. In relation to the Efficient Market Theory, my results suggest that the market appears to be informationally inefficient with respect to information sets related to my third proxy of ESG information, ESG disclosure quality, over my sample period.

To sum up, althouth the market appears informationally efficient with respect to information sets related to corporate environmental responsibility over my tested sample period, further empirical tests are necessary to establish that capital markets are consistently efficient with regard to corporate environmental responsibility in different markets as well as future sample periods. Also, it could be that my asset pricing model is misspecified and does not sufficiently account for corporate environmental responsibility as prior studies have reported abnormal performances using similar proxies (See e.g. Orlitzky et al., 2003; Renneboog et al., 2008a). My empirical tests suggest that the market is informationally inefficient with respect to information sets related to renewable energy investment trading

[119] My expected cost of equity estimates are based on Graham and Harvey's (2015) expected market premium and inferred from three different asset pricing models including CAPM, Fama/French, and Carhart using daily, weekly, and monthly data frequencies.

strategies and ESG disclosure quality. However, due to the Joint Hypothesis Problem (as discussed in Chapter 2.7. 'Joint Hypothesis Problem: Simultaneous Tests of Market Efficiency and Models of Market Equilibrium'), it could well be that my asset pricing models are also misspecified.

8.1.2 Contributions

My thesis contributes to the extant literatures and related academic debates of the effects of different ESG dimensions on the investment performance and risk of equity portfolios, indexes, as well as companies' expected cost of capital financing (See e.g. Bauer and Hann, 2010; Bohl et al., 2013; Dhaliwal et al., 2011; El Ghoul et al., 2011; Henriques and Sadorsky, 2008; Kempf and Osthoff, 2007; Kumar et al., 2012; Lo and Sheu, 2007; Oikonomou et al., 2014; Ortas and Moneva, 2013; Scholtens, 2008; Scholtens and Zhou, 2008; Sharfman and Fernando, 2008). In particular, my thesis adds to the literature by empirically investigating the effects of different dimensions of ESG information (ESG-based investment trading strategies) on the financial performance, idiosyncratic and systematic risk, and expected cost of capital of portfolios, indexes, and companies. Using empirical methodologies based on general models of market equilibrium and consistent with the Efficient Market Theory, I especially contribute to the existing literatures on the relationships between different ESG dimensions and the investment performance and risk of investment portfolios and equity indexes, pension funds' fiduciary duties, and companies' expected cost of capital.

Chapter 4 of my thesis, contributes to the existing literature of the relationship between corporate environmental responsibility and the investment performance of portfolios from the perspective of hypothetical equity pension funds as well as pension funds' legal duties under trust law, i.e. fiduciary duties (Berry, 2011; Freshfields Bruckhaus Deringer, 2005; Richardson, 2006). My chapter not only contributes to empirical studies investigating the effects of ESG information on the investment performance of hypothetical investment portfolios (e.g. investment trading strategies) (See e.g. Kempf and Osthoff, 2007; Lo and Sheu, 2007; Scholtens, 2008; Scholtens and Zhou, 2008), but also on the relationship between ESG information and pension funds' legal duties under trust law (Martin, 2009; Richardson, 2009; Sandberg, 2011; Woods and Urwin, 2010).

Chapter 5 contributes to the existing literature by extending the research on ESG-themed investment trading strategies of passive renewable energy equity indexes. I investigate the relationship between an ESG-themed investment trading strategy in passive renewable energy equity companies and the static and dynamic investment performance

(Bohl et al., 2013; Kumar et al., 2012; Ortas and Moneva, 2013). My empirical study aims to increase the understanding of renewable energy equity indexes' return and risk characteristics relative to conventional equities. Building on my results from Chapter 5, in Chapter 6, I also contribute to the extant literature by extending the research on ESG-themed investment trading strategies of passive renewable energy equity indexes. My chapter studies idiosyncratic risks between an ESG-themed investment trading strategy in passive renewable energy equity indexes relative to an investment trading strategy in fossil-fuel energy equity indexes in the coal, gas, and oil sectors (Henriques and Sadorsky, 2008; Kumar et al., 2012; Sadorsky, 2012a, b). Using absolute, downside, and relative investment risk measures, my chapter aims to contrast renewable energies' idiosyncratic risks with those of more conventional energies such as fossil-fuel equity indexes.

In Chapter 7, I contribute to the existing literature by investigating the relevance of a third ESG dimension, namely ESG disclosure quality, for equity and debt investors. More specifically, I contribute to the existing literature by extending the research on voluntary ESG disclosure information (See e.g. Dhaliwal et al., 2011; Plumlee et al., 2010) as well as the effects of ESG on the expected cost of equity and debt, more generally (See e.g. Bauer and Hann, 2010; Chava, 2011; El Ghoul et al., 2011; Oikonomou et al., 2014). I believe that my study contributes to the existing studies by using a novel indicator to measure the extent (or *quality*) of companies' ESG disclosure, using alternative approaches to compute the expected cost of equity and debt capital (based on Graham and Harvey's (2015) survey data of the expected market premium), and by investigating the effects my ESG disclosure quality variable on the cost of debt.

8.1.3 Future Research Avenues

My thesis opens new research topics that could be investigated in the future. First, future research could conduct a study similar to my 4th Chapter, using fixed-income in addition to equity investment processes, as equity and fixed income represent the largest asset classes in international pension fund portfolios (OECD, 2013). Further, pension funds' fixed income processes tend to differ relative to those of equity investments. For example, the fact that pension funds' strategic fixed income investment decisions are influenced by credit rating agencies could constrain their ability to take on more risk (Bank for International Settlements, 2011). Second, future research could investgate the effects of different ESG dimensions on the financial and risk performance of hypothetical equity pension funds. In my thesis, I focus on corporate environmental responsibility criteria provided by EIRIS, future research could study ESG critiera from other data providers as well as extend the analysis to social and governance sustainability criteria. Third, future research could also investigate whether my results in Chapters 5 and 6 are consistent across different geographical contexts such as developing or emerging economies. Limited by data availability issues, I was only able to include one renewable energy index from Asia, at the time. Since then, various new regional renewable energy indexes from developing and emerging economies have been launched. Fourth, and related to my first point, future research could consider analysing renewable energy fixed income investments. Although the renewable energy bond market is still small relative to the conventional bond market[120], it is growing at considerable speed and could be especially promising for risk-averse institutional investors such as pension funds, who might have been reluctant to invest in renewable energies due to the higher associated risks of renewable energy equities (As my results suggest in Chapters 5 and 6). Fifth, future research could perform a similar study to Chapter 7 of my thesis, using an extended international sample of companies to test whether different cultural or regulatory frameworks have an impact on the negative association between ESG disclosure quality and the expected cost of equity and debt. Finally, future research could empirically investigate the relationship between a company's ESG disclosure quality and cost of debt capital. To the best of my knowledge, this relationship seems unexplored to date. In general, empirical studies of the effects of different ESG dimensions on the cost of debt are rather scarce (See e.g. Bauer and Hann, 2010; Oikonomou et al., 2014). Thus, future research could contribute to the debate on the effects of ESG disclosure on the cost of capital and increase the understanding of debt investors with respect to the importance of such disclosures.

8.1.4 Practitioner and Policy Relevance

The empirical results of my thesis could be relevant for institutional investors, corporate managers, and policymakers making different strategic financial decisions.

My empirical findings could be relevant for Institutional investors such as pension fund trustees who are governed by fiduciary duties and are required to make strategic financial decisions on behalf of the pension fund's beneficiaries. Strategic financial decisions could include the generation of investment strategies that integrate corporate environmental criteria into the pension portfolio construction process. Those strategic financial decisions could however interfere with pension trustees' legal duties under trust law, i.e. fiduciary duties to invest prudently and for proper purpose, by not providing a financial return that is

[120] Valued at around 3.5 billion USD in 2010 (Wood and Grace, 2011).

exclusively for the economic benefit of the beneficiary (Berry, 2011; Freshfields Bruckhaus Deringer, 2005; Richardson, 2006).[121] In examining the implications of such strategic financial decisions, my findings suggest that pension fund trustees should consider the integration of corporate environmental criteria into their portfolio construction process as such investment strategies do no financial harm and appear to have the potential to reduce return volatilities of their portfolios, especially pension funds with large equity allocations.

My results could also be relevant for corporate managers making strategic financial decisions. Strategic investments, such as those that companies make to increase their ESG disclosure quality carry a cost that have to be balanced against the potential benefits. In assessing the benefits of such strategic investments, my results suggest that corporate managers can include the potential for reductions in the cost of capital, especially those managers who finance predominantly with equity. Equally informative are my findings on the cost of debt, which show that a company's ESG disclosure quality also lowers the cost of debt, over my full sample period.

Further, my empirical results may be useful for policymakers making strategic financial decisions to address issues related to climate change such as meeting or exceeding greenhouse gas emission reduction targets. Strategic financial decisions could include increased investments to support renewable energy companies. In calculating the benefits or costs of such strategic investments, my findings show that the majority of renewable energy companies domiciled in developed economies financially underperformed conventional market benchmarks during most of my tested sample period. Additionaly, my results suggest that renewable energy companies are highly volatile investments relative to conventional (fossil-fuelled) energy companies as measured by different idiosyncratic and systematic risk proxies. My results could be relevant for those policymakers who seek to understand and reduce the investment risks of renewable energy companie by a clear and targeted renewable energy policy and one that provides less subsidies to conventional (fossil-fuelled) energy companies and lends more support to the development of innovative renewable energy technologies. Alternatively, policymakers could reduce renewable energies' investment risks by increasing the direct demand for renewable energy which could have a positive impact on the sales of renewable energy companies.

[121] The Employee Retirement Income Security Act of 1974 (ERISA) stipulates that any investment decision not based on economic (financial) ones is disallowed (Langbein and Posner, 1980, O'Brien-Hylton, 1992).

8.1.5 Limitations

My empirical chapters are subject to some limitations. I will address these limitations in the order of my empirical chapters, beginning with Chapter 4.

First, I do not consider the costs my hypothetical pension funds incur in acquiring ESG criteria from an ESG data provider such as EIRIS. More recently, Gil-Bazo et al. (2010) has shown that ESG integrating mutual funds tend to have similar expese ratios relative to conventional active mutual funds. This could indicate that ESG integration is about as expensive as the average active investment management strategy. Second, my findings are based on hypothetical pension portfolios constructed with an equity allocation only and do not consider bonds, cash, or other alternative asset allocations. This means that my results are directly only relevant for pension funds with a sizable equity allocation or equity investors, which is the most important asset class for pension funds next to fixed income investments (See e.g. Aglietta et al., 2012; Ferreira and Matos, 2008; OECD, 2013). It seems unlikely that considering bonds would change my results substantially as prior research suggests that ESG criteria has no detrimental financial effects on bonds (Derwall and Koedijk, 2009; Menz, 2010). Finally, my findings from Chapter 4 are directly only relevant for corporate environmental responsibility criteria produced by EIRIS.

The limitations of Chapter 5 are twofold. First, due to data availability limitations, my sample of renewable energy equity indexes is only directly representative of developed economies without considering renewable energy companies from developing or emerging economies. While developed economies used to be the forerunner in the investment and development of renewable energy technologies, more recently, developing economies have gained influence and should therefore represent an interesting avenue for future research (Bohl et al., 2013; World Economic Forum, 2011). Also, when more data on the historical performance of developing renewable energy indexes becomes available, meaningful empirical analyses can be conducted. Second, my results are applicable to any renewable energy equity index that has been defined as such. In other words, I do not distinguish between the screening intensity of renewable energy equity indexes neither the index provider's policy strictness with respect to listing or delisting renewable energy companies. While this distinction will likely not materially influence my previous findings, it could provide additional insight into the financial performance and risk characteristics of renewable energy companies.

In Chapter 6, my findings are based on renewable energy indexes with equity exposure only, while I do not consider renewable energy fixed income investments. Thus, my results are predominantly relevant for equity investors, which tend to be the most common private investors (such as public markets, project finance, venture capitalists, private equity) in the renewable energy sector besides governments (Bürer and Wüstenhagen, 2009; McCrone et al., 2015). Also, the renewable energy bond market is still in its infancy and relatively small compared to the conventional bond market having not gained as much attention by large institutional investors (Wood and Grace, 2011).

Chapter 7 has the following three limitations. First, my results are based on a sample of large S&P 500 companies and do not consider other countries. This means that my results are directly only applicable to large companies domiciled in the US. My sample is consistent with prior literature (see e.g. Bauer and Hann, 2010; Dhaliwal et al., 2011; El Ghoul et al., 2011; Oikonomou et al., 2014; Plumlee et al., 2010; Sharfman and Fernando, 2008), which also study the effects of ESG criteria on the cost of capital only in a US context. Given different cultural and regulatory frameworks in other countries, an investigation beyond the US could yield different results. Second, my results are based on expected cost of equity estimates inferred from different asset pricing models and only one cost of debt proxy. Meaning that my results are directly only relevant to equity and debt investors who compute the expected cost of equity and debt in a similar fashion. However, it seems unlikely that computing implied cost of equities (as in Dhaliwal et al., 2011; El Ghoul et al., 2011) would change my results considerably, as prior findings also suggest that companies with high ESG have lower implied cost of equities. Finally, although Bloomberg's financial and nonfinancial data is widely used in practice and academia, further research is needed to verify its validity in measuring companies' ESG disclosure quality.

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