Value Relevance of Environmental Capital Expenditures: New Evidence from the EU/EES Electric Utilities Sector

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Bachelor Thesis within Accounting and Financial Management at the Stockholm School of Economics

Abstract:

The electric utilities sector is one of the sector that exerts the greatest environmental impact globally, and environmental performance metrics and data are often used by investors to assess opportunities and risks among electric utility companies. In this paper, we examine whether environmental capital expenditures (ECE) are value relevant for the EU electric utilities sector. We run tests in a sample of publicly listed electric utilities firms during year 2011 to year 2015, and subsequently found that investors assign a negative value for ECE to firms that are low-polluters and a positive value for ECE for firms that are high-polluters. These findings support the notion ECE is value relevant within the European context, however the direction of ECE (conditional of polluter category) is in the opposite against previous findings based on U.S. data.

Key Words: ESG, Environmental Performance, Environmental Capital Expenditure, Value Relevance, Electric Utility, Sustainability Research

Acknowledgement

First, we express our gratitude towards our thesis supervisor Dr. Katerina Hellström, for her helpful comments and constructive criticisms on our initial manuscript as well as addressing various issues in the research process during the thesis seminars.

We would also like to thank Robert Westerdahl and Material Economics, for providing us with this opportunity to conduct this research for their firm, as well as offering various insights on statistics and industry trends within the power utilities sector.

We thank Daniel, Cecilia, Victoria as well as Philip, for the discussions during the research process.

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1. Introduction

Capital expenditures have always been an important topic within capital markets research as it accounts for one of the most significant activity in most of the firms' financial statements (Litt, 2013). It is commonly known that committing a firm's resources for long-term investments is both crucial for the survival and growth in any competitive landscape, thus value-relevance research into how various capital investment decisions ought to affect shareholder's value have been numerous over the years.

One particular area of heightened interest within capital markets research during the recent time is how environmental disclosures and performances affect firm values. The global trend of more stringent environmental regulations, Green investment initiatives as well as general consumer needs have made the managers, investors and academics alike to recognize environmental metrics as one of the most important non-financial performance indicators to firm performance. (Aggarwal and Dow, 2011)

Considering the vast amount of attention that capital expenditures as well as environmental disclosures have received, it comes as a surprise that the amount of literature within Environmental Capital Expenditures' value relevance (hereafter ECE) is so limited. Clarkson, Li & Richardson (2004) (Hereafter referred to as CLR) were the first to examine the issue and they found ECE to be value relevant using U.S. data from the Paper & Pulp industry during 1989-2000, subsequent studies showed similar results, when replicated on the electric utilities sector and on data from later years (E.g. Gao, 2011; Solheim, 2012). However previous research has primarily been based on U.S. data, and to our best knowledge, similar research remains non-existent within the European context

With this study, we aim to provide important contribution to existing literature within this area, by expanding the previous studies into the European context where environmental regulations, accounting rules and capital markets condition all differ from the U.S.

The sector that will be of particular interest is the electric utilities sector. First of all, environmental metrics are not of interest in just any given sector, electric utilities sector is well-known to be a high-polluting industry and exposures to environmental risks/opportunities are very high (Woolf, 1993), making research into environmental metrics valuable. Secondly, in comparison to other high-polluting industries, the sector has especially faced severe regulatory scrutiny recently due to recent environmental focus on Green House Gas emission (GHG) and fossil fuel, as well as the industry's significant role in GHG emission (Sims et al, 2003). Lastly, being one of the most capital-intensive industry (Sims et al, 2003), research into capital expenditures should receive heightened attention within the electric utilities industry.

As such, this paper aims to address the following research question:

"Do investors value environmental capital expenditures within the EU/EES electric utilities sector?"

Our studies found that within the EU utilities sector, ECE is positively valued by investors for firms that currently have inferior environmental performance (High-polluters) while ECE is negatively valued by investors for firms that have superior environmental performance (Low-polluters). These results are not consistent with previous findings in similar research. Although it does support the notion that ECE is value relevant, the results turned to be in the opposite direction (based on polluter category) against our initial hypothesis. We argue that industry differences, choice of statistical variables as well as the choice of time period may have influenced the outcome.

1.1 Purpose and Contribution

This study's purpose is to investigate whether ECE are value relevant to equity investors, focusing on a specific high polluting, highly regulated and highly capital intensive industry (EU/EES electric utilities sector). We are primarily drawing inspirations from Clarkson, Li & Richardson (2004) and other studies based on U.S. data, which found that the ECE are value-positive for low-polluting firms and value-negative for high-polluting firms.

The traditional attitudes among business leaders within the electric utility sector is dominated by viewing environmental spending as a financial burden. However, this notion has been challenged in recent times, some leading corporations have argued being environmentally proactive is crucial for reducing carbon risks and gaining superior environmental performance is directly related to long-term profitability (Cho et al, 2012). Through this study, we offer insights about this issue to investors, corporate executives and the academic community concerned.

Our study is expected to contribute to the existing body of literature in various ways. First, while the debate of the value relevance of environmental performances has been popular among the academic community, empirical studies focusing on ECE remain scant, especially within the European context. By using firm-level hand-collected data, we will make important contribution to this area by being the first to bring this issue into the European context, where regulatory environment as well as business environment significantly differs from the U.S. context. Secondly, previous research has had a strong focus on sectors with significant local environmental impact with little regards to global environmental issues, they tend to use pollution abatement spending as a proxy for ECE and Toxic Release Inventory (TRI) as a proxy for environmental performance. Although we do recognize the importance of local environmental issues, it is still undeniable that global environmental challenges such as the reduction of GHG emissions are also significant in magnitude. By focusing on a sector that is a major impactor on climate changes, we highlight ECE in the context of global environmental issues rather than local environmental issues

The rest of this thesis is organized as follows. In the next part we will make key definitions and delimitations that will sharpen the scope of this thesis. Then we shall present and discuss existing theories and previous research within this area (Section 2). Particularly, we focus on describing and presenting the regulatory environment including key environmental regulatory shifts that would impact the sector. We will also focus on discussing and evaluate existing literatures within environmental economics and accounting theories related to our study. Subsequently, we will present our empirical methodology including hypothesis development (Section 3). We then shall present our data and results (Section 4), and we move on with detailed discussion of these results in Section 5. Evaluations and conclusion, as well as suggestion for future research will then be presented in the subsequent section

1.2 Delimitation

This study focuses on environmental capital expenditures in listed electric utilities companies within the EU/EES region from year 2011 to year 2015, companies were selected according to the Global Industry Classification Standard (GICS). Moreover, downstream-focused electricity companies such as Transmission system operators are excluded from the selection, due to they often have non-material emission impacts. (Sundqvist & Söderholm, 2003).

2. Theoretical Framework and Literature Review

In this section, we will discuss the theoretical framework related to the value relevance of ECE. It is divided into three sub-sections: 2.1) Regulatory environment where we discuss the environmental regulatory developments within the electricity utilities sector; 2) Environmental economics literatures where we address how ECE ought to affect firm performance and valuations. 3) Accounting literatures where we discuss various theories that address how the capital market values Economics literatures where we address how ECE ought to affect firm performance and valuations.

2.1 Regulatory Environment

Combating climate change became a specific goal of the European Union charter as a result of the Treaty of Lisbon (2009). For the period following that, the electricity utilities within the EU area has faced large regulatory overhauls and pressure due to its large climate impact. In a reference study, CLR (2004) argued that a "prominent feature of environmental regulations in the U.S. pulp and paper industry is that regulations are established based on the Best Available Technology (BAT)", so the firms that have superior environmental performance can effectively set the industry standard and thus the development of the regulations. This feature (The use of BAT as regulatory standard) has been effectively introduced into the EU/EES area when the 2010/75/EU Industrial Emissions Directive (IED) was introduced.

The IED aims to "ensure a reduction in harmful industrial emissions across Europe through the application of BAT". Member states are required to prepare so-called BAT References (BREF) where they carry out analysis on the BAT within various sectors and report them to the EU Commission. The EU Commission will then update the so called BAT Conclusion (BATC) which the member states have to mandatorily follow when setting their Emission Limitation Values (ELV) to various electricity production facilities. New installations will have to fulfil the BATC requirements before their commencement, while existing installations will have four years to upgrade their facility to meet the requirement of BATC. (EC, 2011)

This regulatory shift effectively means that electricity utilities companies with the superior environmental performance (Low-polluters) can effectively affect the future ECE of their low-performing peers (High-polluters), since they will have to "catch-up" and upgrade their facilities according to the BAT within four years and they will not be able to rely on their older technologies when establishing new generation facilities. According to Clarkson et al. (2004), we can view this as a creation of latent environmental liabilities, i.e. future ECE spending to match the regulatory requirement (Regulatory ECE).

Another important regulatory overhaul that affect the electric utilities sector is the changes within the EU Emission Trading Scheme (EC, 2003). EU Emission Trading Scheme (EU-ETS) is a landmark policy that works in the following manner: regulated companies (including electric utilities companies) are allocated a fixed amount of permits by the Regulators in each Compliance Period, thus forming the maximum possible emission within each period. During this compliance period, firms that have lesser emission needs can sell their permits while the firms that have higher pollution must buy their permits. (Marin et al., 2015). Studies have found that this scheme significantly benefit firms with cleaner energy sources. This is a logical result, considering this scheme imposes high latent carbon liabilities on the high polluters and thus benefit the low polluters (Clarkson et al. 2014). Linares et al. (2006) for example found that the EU-ETS Scheme significantly redistribute the profit pool of the electricity utilities industry to the renewable and cleaner electric firms in Spain. Hindsberger et al. (2003) and Jensen and Skytte (2003) developed similar models within the Nordic context, and found similar results. Ex-post analysis of the impact of the EU-ETS Scheme still needs further data and more studies (Martin, 2015) (Laing, 2013), however the theoretical fundamentals all point towards one result: Low-polluting firms should benefit, while high-polluting firms will bear an extra cost.

Green (2008) argued that ETS and emission taxes affect electric generating companies in various ways. The risk level of high polluting firms increases with the introduction of the ETS system, since they now face both the risk of disrupted operations due to lack of certificates as well as investment risks as they will have to change their technology to reduce their marginal costs in the longer term. The profitability of firms that are high polluter will also decrease due to increased costs. More recently in 2013, EU-ETS was updated (Entry into the so-called Phase III of

Implementation) (EC, 2012). This drastically limited the free allocation of certificates to electric utilities company to 0%. Following Green (2008) and Linares et al. (2006), this regulatory change should significantly increase the risks (Due to higher risks of operational disruption) of high polluting electric companies while boosting profitability for the low polluting firms.

Phase III EU-ETS also significantly decreased the overall cap of emission immediately, and the cap is decreasing linearly from 2013 to 2020. This has significant financial implications for the high polluting firms within the power utilities sector. According to IAS Article 36, an entity's assets should not carry more than their recoverable amount (The maximum amount of its fair value less transaction costs and its value-in-use). (IASB, 2016). The value-in-use of the high-emission assets (such as fossil fuel generation assets) will decrease as a result of this regulation, since they will not be produce the expected amount of volume, and the fair value of the these assets will decrease as they become less attractive. These assets thus face large impairments, affecting the high-polluting firms' financial performance significantly. Caldecott and McDaniels (2014) showed that empirical data support the hypothesis of large impairments within the sector, they referred the assets that are no longer economic viable as "stranded assets".

2.2 Environmental Economics

There has been extensive environmental economics literature discussing the various economic impacts of environmental regulations on firms. When it comes to regulatory environmental spending, it is almost unambivalently agreed among academics that environmental regulations can impose large compliance costs to non-compliant firms in various ways. When it comes to the strategic level, Conrad and Morrison (1989) found that new environmental regulations can impose significant compliance costs for non-compliant firms by increasing their investment needs into new plants and instruments. On the operational side, Farber and Martin (1986) have identified that managers will often have to change their production process to decrease the emission, resulting in operational disruption and short-term compliance costs. Jorgenson et al. (1990) have argued that the productivity growth of non-compliant firms decrease as the regulatory burden increases, since the firms won't be able to focus on their core business anymore. Burton et al. (2011) have argued that the size of the compliance costs can be so significant that it can result in the close-down of smaller non-compliant firms.

While the literature on regulatory environmental spending has been almost uniformly arguing that these spending impose large costs on regulated firms and thus affect profit negatively, the benefits or costs of non-regulatory environmental spending has faced greater debates.

Older research such as McCain (1978) argued that firms maximize their profit and value when they only spend the minimal compliance costs prescribed by law. The paper argued that by being non-compliant, a firm faces significant legal risks that can drastically decrease a firm's profitability, however over-compliance results only in increased costs for the firm and thus is value destructive. However later research done in the 1980s and 1990s have mostly refuted this notion, per CLR (2004).

For example, if traditional microeconomic theories are followed, rising costs in a none perfectly competitively market result in exit of firms, therefore decreases competition and increases profitability of the remaining incumbent firms. Salop and Scheffman (1983) argued that market dominant firms can injure their competitors by increasing their rival costs in various ways, such as technology innovations and increased marketing spending. This result in two major benefits: 1) Exit of competitors, thus higher profit share; 2) Even without exit, competitors that have higher costs become less flexible and thus easier to compete with. Relating to our research and the EU/EES Electric utilities industry, this theory has significant implication. With the introduction of Industrial Emission Directive, firms that have high environmental performance can effectively set the BAT and thus increase their rival's costs significantly, resulting in exit and less competent competitors and thus should result in higher profitability for themselves. It is thus logical to think here that firms enjoy benefit from over-compliance, since it improves the competitive landscape and profit.

Strategy researchers have also argued that environmental over-compliance can result in innovations and thus competitive advantage for firms. Porter and van der Linde (1995) argued that well-designed environmental regulations can make companies change their production processes, in this process innovations are often detected. One example of this is when Environmental Protection Agency (EPA) introduced a voluntary regulation for U.S. firms to scrutinize their own energy consumption and report them voluntarily to the EPA, the participating firms mostly (80%) undertook highly profitable investments into changes of their energy consumption practices. Researchers found (DeCanio, 1993) that firms that didn't participate in this regulation simply missed out these profitable investments since they didn't have any incentive to innovate. This theory is also highly relevant to our research, the electric utilities industry is often slow when it comes to innovation, thus over-compliance with regulations can result in detection of inefficiencies and thus create innovations for the firms. (Delmas et al., 2007)

Another theory that suggest the benefits of overcompliance is the green goodwill theory. Bagnoli and Watts (2003), Arora (1993) and Arora and Gangopadhyay (1995) explain the firms' behaviour of environmental overcompliance by consumer preferences of greener products. Arora and Gangopadhyay (1995) argue in non-perfectly competitive environment, firms can target segments that prefer cleaner technology and achieve greater profit. Whether this theory can be applied to sectors selling non-differentiated goods (such as electricity) have been questioned by CLR (2004), empirical data however shows that this theory is relevant for the European electric utilities sector. Research into consumer behaviours have found that on average consumers are willing to pay a premium of 16% for greener electricity (Kaenzig et al. 2013) and that consumers are not very price sensitive to this price premium (Paladino and Pandit, 2012).

In a summary, it can be said that economic literature suggest that regulatory environmental spending can be costly for firms, while overcompliance environmental spending are mostly viewed as positive. The theories have all shown great relevance regarding the industry studied (Electric utilities sector).

2.3 Accounting Literature

The ground theory that has guided research into value-relevance of corporate disclosures is the information asymmetry and agency problem described by Fama and Jensen (1983). The researchers argued that a fundamental problem facing investors is that managers of firms often have superior access to information and different agendas than the investors. The only way to solve this is the disclosure of information (Healy and Palepu, 2001). Not all information is deemed to be useful although, Francis and Schipper (1999) argued that only information that "can capture or summarize information which affect share values" can be considered as value-relevance. Nilsson (2003) stated that several studies have questioned the usefulness of accounting information for equity valuation in the United States. Because of the loss of value relevance of traditional financial metrics, academics and business practitioners alike have been seeking other type of non-financial information (environmental performance for example) to help them assess the value of a firm's equity (Berndt et al., 2005).

Following neoclassical financial theories, investors value equities based on future cashflow (dividends which are affected by accounting earnings) and risks (cost of equity). (Ryan et al. 2003). Following this logic, all information that offer prediction of a firm's future earning ability and the risk level should be value-relevant, assuming the efficient market hypothesis holds. Various studies have showed that environmental information can be value-relevant. Hassel and Nilsson (2004) for example found superior environmental performance result in higher valuations due to its ability to predict future earning within the Swedish context. Hughes (2000) examined the value-relevance of pollution metrics within the electric utilities sector, and found them to be value-relevant.

3. Method

In this section, we shall first develop our hypothesis based on theories described and discussed in the previous section. Afterwards, we will introduce our regression model and make discussions surrounding the methodological concerns surrounding it.

3.1 Hypothesis Development

In this section, we will develop our key hypothesis based on the theories outlined in the previous section.

We first hypothesize that for firms that currently have good environmental performance (low polluters), investors would assign a positive value for their ECE. This is a logical conclusion of the regulatory, environmental economics and accounting literature reviewed above. Since 2010, with the implementation of the new Industrial Emission Directive (IED), firms that have top environmental performance can effectively set the regulatory standards and can thus raise their lower performing rivals' costs, this in turn should benefit themselves in the competitive environment and results in superior financial performance. The new EU-ETS also benefit the current top environmental performers, by significantly disrupting their rivals' operations. Other factors such as Green goodwill theory (Higher premium for more environmental friendly electricity) as well as the Innovation Accelerator theory (Stimulates innovation and gives competitive advantage) also suggest that ECE for low-polluters should result in superior performance. Following those factors, combined with the accounting literature that suggests that investors do use Environmental performance metrics when valuing equities, we logically arrived at our first hypothesis below.

H1: "For firms with currently superior environmental performance (Low-polluters), investors assign a positive value for Environmental Capital Expenditures (ECE)"

We then hypothesize that for firms that currently have inferior environmental performance (high polluters), investors would assign a negative value for their ECE.

Following the regulatory literature, the implementation of the new EU-ECTS should significantly disrupt the operations of the current high-polluters, resulting in worsened financial results and higher risks. The new IED also will result in great needs for the high-polluters to boost their compliance capital expenditure (Their high performing peers will set the new standards), compliance expenditures often represent a cost to investors with no incremental benefits and is usually considered to be negative economically speaking. Following these theories, as well as the accounting literature, we argue that the investors will see these ECE as pure "compliance costs" with no incremental benefits, thus we arrive at our second hypothesis below.

H2: "For firms with currently inferior environmental performance (High-polluters), investors assign a negative value for Environmental Capital Expenditures (ECE)"

3.2 Valuation Model Development

We have chosen to use a modified version of the Ohlson (1995) model developed by CLR (2004) and Gao (2011).The original Ohlson model has been widely praised in previous research and the model's prediction of firm value has showed great linkage with accounting information, as high as 70 % (R^2) (Frankel and Lee, 1996) and an R2 in excess of 80% (Hand-Landsman, 1998). Other studies (Lundholm, 1995; Benard, 1995) also propose great explanatory power of the model.

The model's approach to firm value through accounting information such as the book value plus the present expected value of abnormal earnings is in the modified version of the model by Clarkson and Lee and Richardson developed to specify future negative abnormal earnings as linked to environmental performance. According to Clarkson and Lee the proven existence of environmental liabilities in studies such as Barth and McNichols (1994); Cormier et al. (1993); Cormier and Magnan (1997); Hughes (2000) clearly indicates a negative impact on the prediction of future abnormal earnings for firms with poor environmental performance. CLR (2004) and Gao (2011) continue, and argue that investments, such as reported CAPEX today affects predicted future abnormal earnings and has formulated the model as follows:

Equation 1:

$$V = \beta + \beta\ ABV + \beta\ ECE + \beta\ ECE*EMISSH + \beta\ NECE + \beta\ AE + \beta\ EMISSH + v$$

Where;

V = market value of common equity in million dollars, measured three months after the firm's fiscal year end

ABV = adjusted book value of common equity equal to book value of common equity (BV) minus current period capital expenditure (ECE + NECE), in million dollars

ECE = current period (undepreciated) environmental capital expenditure, in million dollars

NECE = current period (undepreciated) non-environmental capital expenditure, in million dollars

AE = abnormal earnings defined as earnings to common equity less an assumed cost of capital based on the CAPM times beginning-of-period book value of common equity, in million dollars. Common equity excludes instruments such as preferred stocks that have characters for both debt and stock, and it excludes instruments that have dilution effects such as Options, Warrants and Futures.

EMISSH = an indicator variable assuming the value of 1 for firms within the defined polluting interval (Top 25%, Top 50%, Bottom 50%, Bottom 25%)

v = error term

We have chosen to use the modified Ohlson model due to the high explanatory power as well as its recognition in previous research.

3.3 Regression model

We are going to use a modified version of the Ohlson model with a small adjustment from the CLR (2004) and Gao (2011) study as presented below:

Equation 2: $Market\ Value = \beta_0 + \beta_1 BookValue + \beta_2 ECE + \beta_3 ECE * EMISSH + \beta_4 NonEnvironmentalCAPEX + \beta_5 AbnormalEarnings + \beta_6 EMISSH + \varepsilon$

Hereafter we define each dependent variables and explanatory variables.

The dependent variable, Market value is here defined as the firm's market value in million Euros, measured six months after the firm's fiscal year end. Market value is defined as Common shares outstanding multiplied by the Closing price six months after the fiscal year end. Previous researches have used a three months time lag between the fiscal year's end and the market value and is due to the time it takes for the market to value newly published financial information. We argue that this assumption doesn't hold in the EU context. In the European context, ECE is usually disclosed along the additional voluntary reporting (Such as Sustainability reports) which is usually published 4-5 months after the fiscal year end, thus we choose 6 months instead of the 3 months' period used by previous research. Another reason for this relatively long time lag is that ECE is a very non-traditional financial metric, and usually the reporting of ECE is well-hidden within the financial reports (Usually not reported on the main sections), previous research done by You and Zhang (2007) have shown that investor react to these so-called "complex financial reports" in a much slower fashion, thus we choose the 6 months period. The coefficients describe the impact each variable has on Market value. β_1 for example, measures the impact on Market value from a firm's adjusted book value.

The variable *BookValue* is defined as the Book value of common equity minus current period total capital expenditure, in million Euro. Most studies points a lot of explanatory power to the the book value (from the original Ohlson model) and the β_1 is therefore expected to be positive. Usually Book value of common equity is not adjusted for capital expenditures in the Ohlson model. However since the total capital expenditures (ECE+NECE) are both included as separate variables in our model, and they are both capitalized into the book value, they will be valued twice if Book Value is not adjusted.

The variable *ECE* measures the amount of environmental capital expenditures in million of euros invested during the year. Since there is no common framework that defines ECE, we decide to adopt the framework used by Litt (2013). Litt argues that firms invest in environmental activities in five different types of initiatives: 1) Environmental Products and Services that includes the use of Greener raw material or the "replacement of fixed assets to ensure more efficient and eco-friendly processes"; 2) Recycling Initiative: Change of processes that increase the use of recycled materials; 3) Climate Change Prevention: Substantial reductions in "emissions and toxic waste and reduction of carbon footprint"; 4) Pollution Abatement: Recovery and repair of previous pollution damages; 5) Other environmental friendly activities such as commitment to management systems, environmental audit among others. Whether an investment constitute an ECE is judged by reading the financial reports of the sample firms. Please see below for some commented excerpts from Financial Statements of our sample firms for clarity purposes.

"2012 includes £180 million (2011: £5 million) of expenditure for our biomass transformation, being construction in progress for fuel delivery, storage and distribution systems" Since Biomass energy is typically considered as an environmental friendly way of electricity generation with lesser carbon footprint (Sims et al. 2003), we consider this as a Climate Change Prevention Initiative as well as an Environmental Products and Services initiative, we thus assign this firm 180 billion GBP of ECE for 2012.

"This includes expenditure of £8 million (£20 million in 2010) on our major strategic carbon abatement project, and £5 million of expenditure on new conveyors and fuel handling infrastructure in support of our biomass research and development work (2010: £nil)." Carbon abatement and biomass research are classified as "Pollution Abatement initiative" and "Environmental Products and Services", we thus assign 13 million GBP for ECE for that year and firm.

"£109.6m in energy supply and related services which includes work associated with preparation with the roll-out of smart meters and improving digital services for Customers" We assign 0 million GBP for ECE for that year and firm, since this capital expenditure's main purpose is to increase customer satisfaction and does not fall into the five activities defined by Litt (2013).

We expect the coefficient of this variable to be significantly negative when the firms are classified as a High polluter (Top 50^{th} percentile and Top 25^{th} percentile of carbon factor, discussed below). We expect the coefficient to be positive when the firms are classified as a Low Polluter (Low 50^{th} percentile and Low 25^{th} percentile of carbon factor)

The variable *EMISSH* will be defined as a binary dummy variable and only take values of either 0 or 1. The categorizing into high/low performance firms is going to be relative to the rest of the sample each year. Companies will first be ranked based on carbon emission deflated with their electricity production from the highest to the lowest performer (Kg of CO_2/KWh), this is called a "Carbon Factor" and is considered as an industry standard metric for environmental performance (PwC, 2011). The firms will then be classified into four percentile ranges: Top 50^{th} percentile, Top 25^{th} percentile (High Polluter); Low 25^{th} percentile and Low 50^{th} percentile (Low Polluter). We will run our regression model four times using each of the percentile ranges, we will assign the value of 1 for firms within the defined percentile range, and value 0 for firms beyond the defined percentile range.

NonEnvironmentalCAPEX is a measure of the total capital expenditures minus investments in environmentally friendly activities in million of euro for the year.

We have chosen to use the most common definition of *Abnormal Earnings*: Abnormal earnings in million Euro= the total earnings – Cost of Equity capital * Book Value in the beginning of the year (Donnelly, 2014). The cost of capital will be calculated from the CAPM model, all market risk premiums and risk free rates are extracted from a database provided by the University of New York (Damodaran, 2017). Beta were retrieved from Thomson Reuters Datastream.

$\beta_3 ECE * EMISSH$ is commonly referred as an conditional interactive variable (Gao, 2011), by adding this variable, the model allows us to separately examine ECE from the other variables.

To test our hypothesis, we run our regression four times. To test our first hypothesis, we run our regression twice and see whether the coefficient of ECE+Conditional interactive variable, $\beta_2 + \beta_3$ reliably exceeds zero ($\beta_2 + \beta_3 > 0$) when the value 1 is assigned for firms with superior environmental performance (Lowest 25th percentile and Lowest 50th percentile carbon factor) as the indicator value for PollutionLevel.

To test our second hypothesis, we run our regression twice and see whether the coefficient of ECE+Conditional interactive variable, $\beta_2 + \beta_3$ reliably falls below zero ($\beta_2 + \beta_3 < 0$) when the value 1 is assigned for firms with inferior environmental performance (Highest 25th percentile and Highest 50th percentile carbon factor) as the indicator value for PollutionLevel.

We run all four regressions by first deflating all of our variables with the Common Shares Outstanding, except Carbon Factor

3.4 Alternatives to the binary measure of Environmental performance

The variable EMISSH is expressed as binary and will take on values of either one or zero for the firms within the given emission level interval. This approach is chosen since we believe that it makes more sense than the continuous alternative for the variable. If the variable is expressed as continuous with the absolute values of Kg of CO2/KWh emission for each year one of the key assumptions in the model becomes illogical. A continuous measure of environmental performance in absolute numbers would lead to an assumption that all firms, even the firms who are considered as low polluters (superior environmental performers) would have unbooked environmental liabilities (regulatory ECE requirement), which they obviously do not have . (CLR, 2004)

3.5 Analysis Technique of Panel Data

We wish to examine the value relevance of ECE through time and cross-sectionally. Most previous studies propose a mixed approach with both cross sectional data and time-serie data, resulting in Panel Data. We chose this approach due to various reasons. Panel data improves the efficiency of the estimates, by giving more accurate inference of model parameters (Hsiao & Wang 2003). Also, in relation to this particular study, panel data provides one key advantage that is not offered by time-series data and cross-sectional data. First, when analyzing dynamic economic relationships, Hsiao & Wang (2003) have argued that panel data is strictly preferred, as it allows "inter-individual differences to reduce and eliminate" collinearity between various current and lag variables. Since the industry of electric utilities is very dynamic as previously discussed (driven by competitive and regulatory factors), we decide to adopt the panel data for this reason.

We thus decide to pool the cross-sectional observations over time to create a panel dataset. When doing so, the assumption that observations and therefore residuals are independently distributed over time no longer holds, the assumptions of the Ordinary Least Squared (OLS) technique are therefore violated. This results in inefficient estimates and sometime even misleading statistical inferences (Wooldridge, 2012). Previous research in this field has adopted the Generalized Least Squares (GLS) technique when estimating the model. This is a reasonable approach that we also adopts, the GLS techniques is efficient for estimating the unknown parameters when there is correlation between the residuals. GLS allows the existence of autocorrelation and heteroscedacity without providing inefficient/misleading parameter estimates. (Greene, 2000)

4. Data

4.1 Sample selection

Five criteria were used when defining our sample; the companies needed to be listed within the EU, have sufficient available data and be listed between 2011-2015

The initial sample was selected using GICS Industry Classification (Electric Utility Production Company) listed within the EU 2011 - 2015. This resulted in a set of 38 companies. After manual analysis of the company's annual report, 6 companies were excluded as data that were needed for the computation of Environmental Capex (ECE) were not reported. After this exclusion, 3 other companies were then excluded for the non-reporting of Carbon Energy Intensity, and 1 company was excluded for being listed after year 2011. This resulted in a remaining sample of 28 companies, and 140 observations. See Table 1 for a summary of this sample selection process.

4.2 Time period

The chosen time period was selected for three key reasons. Firstly, since the Industrial Emission Directive was firstly updated in 2010, it can be assumed that the similarity between the EU electric utility market and the US paper and pulp market arose back then (That the top environmental performers effectively set the regulatory standards). Thus, some of the theories used to construct the hypothesis would make little sense time period prior to 2010 was to be chosen. Secondly, we use 2011 as the starting date, as we assume the implementation of the directive would have a lag and the effect would first take place a year after the implementation. Thirdly, during the process of data collection, some of the firms have not yet published their annual report for 2016. These three factors resulted in the selection of the time period 2011-2015.

4.3 Data Collection

Data necessary for the computations for the control variables were collected from the Compustat database, 5% of the data points were then randomly selected for correctness control and compared to data from other sources such as total CAPEX reported in the annual reports. No systematic error were found using this method. Skogsvik (2002) also have done various checks into the databases used, and found no systematic errors between the database's number and the actual annual account's reporting. ECE and Energy Intensity data were collected manually from the annual reports, sustainability reports and investor presentations of the companies as well as an industry report from Pricewaterhousecoopers (PwC, 2011-2015).

4.4 Sample Descriptive statistics

We present the descriptive statistics for the various variables in our main regression model in Table 2. It is clearly seen that like previous studies, the distributional spread for the different variables are very large. Across the research period (2011-2015), the average ECE per year for the firms included in our sample is EUR 71.1 million, with a range of 0.1 million to EUR 319 million. The average NECE across all firms within the research period is EUR 512.0 million, ranging from EUR 3.0 million to EUR 2.1 billion. This result suggests the average ECE to total capex (NECE+ECE) is 12.2%, slightly higher than previous studies done on the U.S. paper and pulp industry, potentially suggesting a higher requirement of environmental capital expenditures in the electric utility sector.

When analyzing the firms' environmental performance, across the research period, the average carbon factor is 311Kg/KWh produced, with a large distributional spread ranging from 21Kg/KWh to 1006Kg/KWh. A lower carbon factor suggests superior environmental performance.

Abnormal earnings are both negative at the median and at the mean, we argue that this is due to the general decline of the industry's profitability during the research period. (Caldecott and McDaniels, 2014)

In Table 3, we partition the sample firms across years into two groups (Polluters and Non-polluters) using two percentile definitions, and thereafter present certain important descriptive statistics. Inferential statistics (Wilcoxon rank-sum test) is also included, this test examines the null hypothesis that it is equally likely that a value randomly selected in one sample is greater or less than a value randomly selected in another sample. (Newbold, 2009) In Panel A, firms with a below 50th percentile carbon factor were assigned as Low-polluters and vice versa. In Panel B, this definition of Low-polluters has been made more stringent, only firms with a below 25th percentile carbon factor was assigned as Low-polluters. There were no instances where firms changed group (Polluter to Non-polluters or Vice-versa) throughout the 5 years period. This is inconsistent with the original studies, where more than 3 firms changed their group during their 12 years period. We argue that this is due to the fact that our research period is much shorter (5 years) and it is difficult for polluting firms to catch up during such a short period.

In Panel A, the median carbon factor is 491Kg/KWh for firms that are high-polluters versus the average carbon factor of 84Kg/KWh for firms that are classified as low-polluters. The similar data for Panel B is 55Kg/KWh for firms that are low-polluters versus the median carbon factor of 397Kg/KWh for firms that are high-polluters.

When the definition in Panel A is used, the median ECE for low-polluting firms (Scaled by cost of goods sold, COGS) is lower than firms that are high-polluters' ECE (Scaled by COGS). It is also seen that this difference is statistically insignificant (See

Wilcoxon stat, $p<0.10$). When the definition in Panel B is used, the median ECE for low-polluting firms scaled by COGS is significant lower than firms that are high-polluters' ECE scale by COGS (Wilcoxon stat, $p<0.10$). When the definition in Panel A is applied, the median ECE/COGS increased by a CAGR of 17.1% throughout the research period for polluters, while the median ECE/COGS only increased by a CAGR of 5% through the research period for low-polluters. However, when the definition in Panel B is applied, the median ECE/COGS increased by a CAGR of 31% for high-polluters while the median ECE/COGS decreased by a CAGR of 9% for low-polluters through the research period. This result is consistent with the Raising Rival Cost argument presented by Salop and Scheffman (1987), previous research argues that this pattern means that Non-polluters forces up the ECE for their Polluter peers, by setting regulatory standards. Panel A difference in ECE/COGS is statistically insignificant, and the Panel B difference is significant, this can potentially be explained by the fact that Industrial Emission Directive (IED) dictates that only the Best-available-technology (BAT) should be used, and thus the regulatory setters within the industry is not simply actors that have a carbon factor below the 50th percentile, but rather more "industry leading" companies with a carbon factor level below the 25th percentile.

Examining the profitability, the median abnormal earning per share is significantly higher for non-polluters in comparison to their polluter peers, without regards which definition (Panel A or Panel B) is used. It can be argued that the environmental economics theories presented in Section 2 are demonstrated by these statistics. Non-polluters have lower costs, higher revenue (green goodwill) and less risk (reflected potentially in the Cost of Equity), thus they should have higher abnormal earning per share.

Other two interesting factors presented here are two factors that are not included in the regression model: Liquidity and Leverage. Liquidity is significantly higher for non-polluters, this is consistent throughout Panel A and B. Research suggests that liquidity is usually used as a proxy for operational risk (Johansson and Runsten, 2005), lower liquidity usually indicates higher operational risks and vice versa. This result is consistent with certain theories presented before, Farber and Martin (1966) for example identified operational disruption as one of the key risks for low environmental performing firms.

Leverage is higher for low polluting firms across Panel A and Panel B, these differences are however not statistically significant. We argue this indifference can depend on two reasons. Firstly, empirical evidence and capital structure research (Modugu, 2013) has suggested that firms that have lower operational risks and higher profitability have the ability to borrow more (gain higher financial leverage), if this theory is followed, then the non-polluters (higher profitability and lower operational risk firms) should have higher leverage. But secondly, there are also documented large asset impairment for the non-environmental friendly generation assets within the electric utility sector (Caldecott and McDaniels, 2014). The definition of Leverage used here is Interest Bearing Debt/Book Value of Shareholder's Equity, the large impairments should have reduced the Book Value of Equity. If this theory is followed, then the polluters should have higher leverage. We argue that these two factors can have self-cancellation effects, resulting in indifferent leverage. Our results differs in comparison to previous studies done in the U.S., where the Non-polluters had significantly lower leverage. We argue that the reason behind this is that there has been no major waves of asset impairments documented within the Paper and Pulp industry during the previous research period.

Table 1 Selection of Sample

Criteria	Number of Firms	Observations
Electric Production (EU Listed, 2011-2015)	38	190
Missing ECE Reporting	6	30
Missing Carbon Reporting	3	15
Listed after 2011	1	5
Total	28	140

TABLE 2
Sample Descriptive Statistics: EU Electric Utilities Firms from the Period 2011-2015

Measure	Minimum	Mean	Median	Maximum	Standard Deviation
Market Value (EUR MM)	691	17913	12491	210199	22931
Adjusted Book Value (EUR MM)	(74)	9314	9071	155491	7643
Environmental Capex (EUR MM)	0.1	71.1	64	319	59
Non-Environmental Capex (EUR MM)	3	512	417	2100	712
Abnormal Earning (EUR MM)	(614)	(19)	(17)	2049	297
Carbon Factor (Kg of CO2 / MWh)	21	311	397	1006	459
ECE/Total Capex (%)	3%	12%	13%	13%	5%

Table 3 Median Measures for Sample Firms Partitioned Based on Pollution Level

Panel A: Low-Polluting Firms Defined as <50th Percentile Carbon Factor

Measure	Low-Polluting Firms	High-Polluting Firms	Wilcoxon Statistics P-value
Market Value in EUR MM	15702	9741	0.0892*
Carbon Factor	84	491	0.0000***
ECE EUR MM	70	62	0.3724
ECE/COGS (Ratio)	0.03	0.04	0.2917
Non ECE Capex EUR MM	392	441	0.4072
Abnormal Earning EUR MM	49	-72	0.0000***
Leverage (Interest-bearing Debt / Book Equity)	1.21	1.05	0.3497
Liquidity (Operational Cashflow/Revenue)	0.214	0.131	0.0641**

Panel B: Low-Polluting Firms Defined as <25th Percentile Carbon Factor

Measure	Low-Polluting Firms	High-Polluting Firms	Wilcoxon Statistics P-value
Market Value in EUR MM	21072	14739	0.1124
Carbon Factor	55	397	0.0000***
ECE EUR MM	21	17	0.3917
ECE/COGS (Ratio)	0.02	0.05	0.0462**
Non ECE Capex EUR MM	491	520	0.4816
Abnormal Earning EUR MM	327	9	0.0097***
Leverage (Interest-bearing Debt / Book Equity)	0.97	0.94	0.4162
Liquidity (Operational Cashflow/Revenue)	0.245	0.151	0.0632**

*,**,*** denotes to 10%, 5%, 1% statistical significance respectively

4.5 Pearson Correlation

We presented our regression model in section 4.3. We test the Pearson's correlation coefficient for our explanatory and control variables against our dependent variable (Market Valuation).

In Table 4, we present our result of this Pearson Correlation analysis. All explanatory and control variables correlate strongly ($p<0.01$) with our dependent variable. Adjusted book value, a control variable correlates with the dependent variable significantly, however only at a 10% significance level.

Some of the control variables correlate with each other. Not surprisingly, NECE and ECE showed significant correlations with each other. This suggests the potential problem of multicollinearity, while this doesn't affect the predictive power and the reliability of the regression model in its entirety, the issue of multicollinearity is still problematic when discussing the results of the individual predictor variables (Explanatory and control variables) (Wooldrige, 2012). This issue will be further analysed in later sections where we perform sensitivity and robustness controls.

5. Results

We present the test results of our main hypothesis here; the analysis and discussion will take place in subsequent section.

5.1 Value Relevance of Environmental Capital Expenditures among Low-polluting firms

The first hypothesis tests if a high level of environmental capex increases the market value of a low polluting firm. The results are presented in Table 5, model 1 and 2. In Model 3, where all firms with a carbon factor below the 50th percentile were defined as firms with superior environmental performance and thus received the value "one" for EMISSH (Pollution), the coefficient of $\beta_2 + \beta_3$ (-10.806) was negative and statistically significant. In Model 2, where the definition of "superior environmental performance" was made more stringent (Only firms with a carbon factor below the 25th percentile received the value "one" for EMISSH (Pollution), the coefficient of $\beta_2 + \beta_3$ (-1.309) was negative and statistically significant. With the support of these results, we reject our hypothesis and retain the null hypothesis: that ECE is value negative for firms with superior environmental performance. The explanatory power of our model (R^2) is 0.493 in Model 1 and 0.691 in Model 2. As for control variables, most of the control variables showed significance in our first test. Non Environmental

Capex (NECE) coefficient were both positive and significant at a 1% level, abnormal earning (AE) showed significantly positive coefficient however only at a 10% significance level. Adjusted Book Value (ABV) did not exhibit any significant coefficient at all.

The coefficient $\beta_2 + \beta_3$ means that one euro of ECE value decreases the market value by 10.806 euro for firms within the top 50% cohort, while it decreases the market value by 1.309 for firms within the top 25% cohort.

5.2 Value Relevance of Environmental Capital Expenditures among High-polluting firms

The second hypothesis tests whether market assigns a negative value to ECE for firms with low environmental performances (High-polluting firms) and this has been rejected.

The coefficient for $\beta_2 + \beta_3$ (9.205) in Model 3 (Where firms with a carbon factor above the 50th percentile were defined as a High Polluter) were significantly positive. When this definition of High Polluter is being made more relaxed to only include firms with a carbon factor above the 75th percentile, this coefficient becomes 9.85. The explanatory power of the models is 0.493 for model 3 and 0.631 for model 4. All control variables showed similar signs and significance level like model 1 and model 2. The coefficient $\beta_2 + \beta_3$ means that one euro of ECE value increases the market value by 9.205 euro for firms within the bottom 50% cohort, while it increases the market value by 9.85 for firms within the bottom 25% cohort.

Table 4: Pearson Correlation Coefficient Matrix, Scaled by Shares Outstanding, except Carbon/Pollution Level

	Market Value	Book Value	Non ECE Capex	Abnormal Earning	ECE	Carbon Factor
Market Value EUR MM	1					
Adjusted Book Value EUR MM	0.416***	1				
Non ECE Capex EUR MM	0.539***	0.437***	1			
Abnormal Earning EUR MM	0.357***	0.126*	0.206**	1		
ECE EUR MM	0.325***	0.277***	0.399***	0.097	1	
Carbon Factor Kg CO2/KWh	-0.271***	-0.197**	-0.092	-0.120*	-0.027	1
EMISSH (<50th percentile)	0.479***	0.328***	0.184*	0.176*	0.023	-0.911***
EMISSH (<25th percentile)	0.702***	0.449***	0.297***	0.147*	0.129*	-0.862***
EMISSH (>50th percentile)	-0.479***	-0.328***	-0.184*	-0.176*	-0.023	0.911***
EMISSH (>75th percentile)	-0.467***	-0.317***	-0.216**	-0.072	0.09	0.818***

,**, denotes to 10%, 5% and 1% significance respectively**

Table 5 Time Pooled Cross-sectional GLS Regression (Scaled by Shares Outstanding)

Parameter	Variable Name	Model I (1 for <50% Carbon Factor)		Model II (1 for <25% Carbon Factor)		Model III (1 for >50% Carbon Factor)		Model IV (1 for >75% Carbon Factor)	
		Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-	21.792	0.000***	27.991	0.000***	41.295	0.000***	32.017	0.000***
Adjusted BV	ABV	0.091	0.493	0.175	0.392	0.091	0.493	-0.079	0.497
Abn. Earning	AE	3.972	0.082*	4.017	0.074*	3.972	0.082*	3.641	0.094*
ECE	ECE	5.121	0.075*	5.393	0.046**	-6.722	0.192	-7.591	0.060*
Non ECE Capex	NECE	3.263	0.000***	2.909	0.007***	3.263	0.000***	4.917	0.000***
Pollution	EMISSH	24.192	0.008***	39.235	0.000***	-24.192	0.008***	-26.140	0.000***
ECE * Pollution	ECE*EMISSH	-15.927	0.057*	-4.218	0.289	15.927	0.057*	17.441	0.036**
Other Statistics									
R^2		49.3%		69.1%		49.3%		63.1%	
Sample Size (N)		140		140		140		140	

Dependent Variable in this Model is the Stock Price (6 months post FY end). Adjusted BV is the Book value – Capex. Abnormal Earning is Earning – (Cost of Equity*Book Value) Environmental Capex is the Environmental Capital Spending. Carbon Factor is defined as Kg of CO2 emission per Kilowatt, which is an industry standard measurement for pollution level. The Pollution variable (Dummy) assigns the value 1 for firms within the defined interval of Carbon Factor. The model is scaled by Shares Outstanding. *** Indicates significance at 1% alpha, ** indicates significance at 5% alpha while * indicates significance at 10% alpha

6. Analysis of the Results

We discuss and analyze the results from our main regression model here in this section. Further evaluations of our results such as sensitivity tests, robustness controls and methodology evaluation will be done in the next section.

6.1 Analysis of the Explanatory Variables

The variable of our primary research interest is the ECE variable, a research dummy was added in the model to define whether a firm is a high-polluter or a low-polluter based on their carbon factor. To test our first hypothesis, we used two definitions of "Low-polluters", assigning the dummy value of 1 (low-polluter) to the firms below 50th percentile carbon factor (Model 1) and 25th percentile carbon factor (Model 2). The research variable $\beta_2 + \beta_3$ showed significantly negative coefficient in both models, however Model 2 showed a coefficient that was significant higher compared to Model 1 (-1.309 vs. -10.806). This suggest that ECE is value relevant but negatively for the low-polluters while it is not as negatively valued for the best environmental performers (Bottom 25th percentile emission level, in Model 2)

To test our second hypothesis, we used two definitions of "High-polluters", assigning the dummy value of 1 (High-polluter) to the firms above 50th percentile carbon factor (Model 3) and 75th percentile carbon factor (Model 4). We found that that the research coefficients $\beta_2 + \beta_3$ were positive in both models. (Coefficients were 9.205 and 9.805 in respecitve models.

These results are completely against our initial hypothesis and previous research. This suggests a need for significant revision of the theories that this research was based on, criticisms of the research method as well as other ways to seek some alternative explanations. Previous research into the value relevance of ECE in the electric utilities sector argued that ECE is positively valued by investors for low-polluters and vice versa, according to Gao (2011). However, we have noticed that this conclusion was reached due to an interpretation error in Gao (2011)'s regression analysis.

In her research, where the exact regression model was used (same as Equation 2), the coefficients of ECE was interpreted on its own, instead of adding the coefficients ECE and ECE*PollutionLevel together before interpretation. After adjusting for this, we have noticed that the correct conclusion would be that ECE is positively valued by investors for high-polluters and negatively valued for low-polluters. This conclusion is in the complete opposite direction compared to the Paper and Pulp industry, and is in line with our study.

In subsequent analysis, we discuss the possible explanations of why the results turned to be in the complete opposite direction against the original hypothesis. We have organized our explanations in three different ways: 1) Discussions on the theoretical framework's generalizability in the electric utilities sector; 2) Discussions on the choice of the valuation period and its impact on the results; and 3) Discussions on the choice of proxy variable in the regression model.

6.2 Theoretical Validity of Previous Research in the EU Electric Context

We have reasons to believe that these results are due to the original theoretical framework developed by CLR (2004) cannot be generalized into the electric utilities sector.

Firstly, one of the fundamental theory within this framework is the Rising Rival's Cost theory developed by Salop and Scheffman (1983). Following this theory, one of the reason why ECE should be valued negatively for High-polluters would be that they are often "regulatory capital expenditure" and are therefore value destructive. Low-polluters benefit in this process, by imposing their high-polluting rivals a large regulatory cost and relief pressure from the competitive landscape. However, within the European context, this effect may be neutralized by the large amount of subsidies available for high-polluters to improve their pollution level. The Renewable Energy Directive (EC, 2009) dictates that the member countries to give out public intervention subsidies to current high-polluters to improve their energy mix towards a more sustainable one. These subsidies have been large and effective, Blok (2014) for example found that the total value of public interventions electric energy amounted to 122 billion EUR in 2012. In the U.S., this effect might also be neutralized by polluter-friendly subsidies, in a bill proposed to the congress (Sanders, 2015), it was calculated that through 2003 to 2009, federal fossil-fuel subsidies amounted to 720 billion USD, benefiting the high-polluters. To our best knowledge, such legislation doesn't exist for the Paper and Pulp industry, so the high-polluters would bear the whole regulatory costs alone, rather than being subsidized for their upgrades. It seems that governments and other regulators wish to have a smooth sustainable transition for the high-polluters, which decreases their regulatory burdens in the process. Although these analyses give reasons on why ECE is valued positively for high-polluters in this particular industry, further explanations on why ECE is valued negatively for low-polluters are needed.

One building block of the theoretical framework is the Green goodwill theory by Arora and Gangopadhyay (1995). However, per Kaenzig et al. (2013), Customer Paid Green Premium (18% for Europe) for electricity is not simply a linear relationship, but rather a binary one (Green vs. Non-green). In this case, the current low-polluters do not receive marginal benefit if they invest in overly environmentally friendly assets, but these assets rather would impose a cost for the investors. Also, other empirical studies into marketing shows that customer perception of whether an electric company is “Green” or “Non-green” is often based on branding strategy, rather than actual environmental performance (Wiser et al., 2000). If that logic is followed, then Green goodwill would only marginally increase by actual environmental performance improvement, and if the Green Premium is low, then the improvement in environmental performance would most likely to impose a cost to investors. Also, Wiser et al. (2000) research would partially explain why Top 25% performers have a higher coefficient (although still negative) in comparison to their top 50% peers. According to Chan and Lau (2000), green marketing often only benefit those with a “distinct” green profile, and those firms that are “stuck-in-the-middle” receive little or no benefit from green products. This may suggest that the lowest-polluters (Top 25% performers)’ negative coefficient of ECE is rather caused by other factors, rather than overspending on Green goodwill creation.

With these discussions, we suggest that it is possible that the existing theoretical framework used by CLR (2004) should be revised significantly when applied to the electric utilities sector. The rising rival’s cost theory as well as the Green goodwill theory’s relevance have been challenged by these results.

6.3 Issues with Research Time Period

In the previous discussion, we put criticism to the theories applied by us and previous research. However, it can also be the case that the validity of these theories hold in the long-run, but it is rather short research period (2011-2015) that has affected these results. The Rising rival cost theory which is central in the framework has two main prerequisites. First, the model developed by Salop and Scheffman (1983) is based on multi-period oligopoly game, which means that the model isn't valid when it comes to other market structures. This criterion is satisfied in most of the EU countries where a certain degree of competition exists, although often characterized by a duopolistic or oligopolistic market structure. However, the second prerequisite of such a model: that the market is in equilibrium, doesn't always hold in the short-run. The exit of competitors is a process that takes time, and our research period 2011-2015 might be too short to fully reflect these changes. Also, another assumption of Salop and Scheffman (1983) is that the firms can exit the market without barrier, which is certainly true for the paper and pulp industry. However, electric utilities firms are often seen as "firms that offer critical infrastructure" (Westerdahl, 2017), these firms often cannot exit the market freely due to regulatory issues, and thus their exits take even longer time than other firms. We recognize this limitation of our study, and suggest a longer period can be used for future studies in this field.

Also, during an interview with an industry expert (Westerdahl, 2017), it was told that prior to 2011, the high-polluters have lost a significant amount of their share value, due to the fact that they were too "ignorant of the environmental challenges in the period prior to 2011, and the market actors are increasingly showing awareness to such problems". Due to the bottom-low valuations that these companies had in the beginning of the period due to their poor environmental performance, any environmental investment (ECE) and thus environmental improvement may significantly recover their firm value. This gives another explanation on why ECE was valued positively for high-polluters, at least in the short-run. The positive valuation was driven by previous loss of value due to lack of ECE investments.

6.4 Proxy Variables: Problems and Possible Solutions

Even though there are limitations in the theories as well the adapted research period, we still choose not to eliminate the possibility that there are intrinsic problems with the choice of proxy variables in our regression model. It is known that in Social science, wrongful operationalization of proxy variables can often decrease the validity or completely invalidate the results (Stahlecker and Götz, 1993). We believe two explanatory variables in our model need to be discussed futher: PollutionLevel and ECE.

In the paper and pulp industry, CLR (2004) adopted Toxic Release Inventory (TRI) and Biological Oxygen Demand (BOD) as two proxies for environmental performance. These are excellent proxies since a lower TRI strictly implies better environmental performance. TRI is a mixed metric created specifically by the Environmental Protection Agency (EPA) to measure the environmental performance of industrial plants.

However, the proxy used in the electric utilities sector (Carbon factor) is simply an indication of the level of green house gas emission for an electric utility company, and does not address other environmental concerns at all and can even be confounded by other factors. An example of this is companies which have a high proportion of nuclear energy in their fuel mix. EDF France, one of the lowest polluter in our dataset for example, have more than 60% of its generation source from nuclear energies. Albeit nuclear energy has one of the lowest emission rate (Sovacool, 2008), yet it has other environmental problems such as releasing of health-damaging radionuclides, possibility of disasters and accidents and permanent land pollution (U.S. Nuclear Regulatory Commission, 2017). In this case, the use of carbon factor does not reflect, or even wrongly reflect these environmental risks associated with these nuclear-intensive companies. A firm with high nuclear fuel mix has superficially high environmental performance while its other environmental risks are significantly boosted.

In future research, a mixture of environmental factors can be used to assign PollutionLevel for the firms. One good example would be the Global Reporting Initiative (GRI)'s multi-aspect model, which addresses Emission, Biodiversity Impact, Water impact and many other factors. It is also possible to use the environmental rating provided by agencies such as Sustainlytics (An ESG rating agency), which also takes a multifaceted approach in assessing a firm's pollution level.

In terms of ECE, we simply adapted Litt (2013)'s framework in assessing which capital expenditure items can be seen as "Environmental friendly". This has problems with internal and external validity. Internally speaking, the model itself may have missed out certain items that should be classified as ECE, externally, we may have missed certain items that should fall under the criteria, due to the hand-collection of data.

6.5 Analysis of the Explanatory Power

The explanatory power (Pearson Coefficient of Determination, sample R^2) in all of our four models were lower than previous studies done in the U.S. The GLS regression in the previous study showed approximately 0.78 in R^2 (In testing hypothesis 1) and approximately 0.80 in R^2 when testing hypothesis 2. While in our four models, the explanatory power ranged from 0.49-0.69. We believe the main reason that can explain these differences is due to the difference in industry dynamics. In terms of the industry examined, the Paper and Pulp industry is usually considered to be more predictive, the demand for Paper and Pulp product usually strictly follow the economic cycle (Philips, 2009). While the electric utilities industry is more volatile, especially due to regulatory uncertainties in the recent years. The explanatory power is naturally lower for our regression on an industry that is less predictable. We will attempt in later sections to improve the explanatory power of this model by windorizing the far-outside values in the model.

6.6 Discussion of Accounting Regulatory Implications

In this sub-section, we discuss two important accounting implications related to the results of our tests: 1) Disclosure related issues; 2) Capitalization of ECE

As previously referred, the reporting of material ECE is mandatory within the U.S. GAAP context under the current SEC regulations. To our best knowledge, such regulation on ECE reporting does not exist within the European context. In 2014, Directive 2014/95/EU on Disclosure of Non-financial information was introduced (EC, 2014), this required firms to report all the material environmental matters, but there is no specific requirement for firms to discuss their ECE.

According to the decision usefulness approach to financial reporting, financial reporting should be prepared to include the information that investors needs to judge about a company's current status and future, and should help investors to make economic decisions about investing/divesting in a company. Over the last forty years, this approach (That report should include information for economic decision making) has been argued as one of the most important criterion of financial reporting by academics and regulators alike. (Williams and Ravenscroft, 2014). If this approach is followed, then our study suggest that it is logical for the regulators (Such as the European Commission or the International Accounting Standard Board) to dictate companies to disclose their ECE as well as their relative environmental performance wherever this information is material. Many research have shown that in regions where financial reporting include more information that has economic usefulness, there is often a higher degree of efficient resource allocation within the economy (Williams and Ravenscroft, 2014)

Another key implication that our study has on the currently ongoing accounting debate is the issue of capitalization of ECE and recognition issue of it as an asset. Per the International Accounting Standard Board, an asset is to be recognized when it is "a resource controlled by the entity because of past events and from which future economic benefits are expected to flow to the entity". (IASB,2013). It has been debated whether certain pollution/environmental damage abatement costs should be capitalized as assets, as their future "economic benefits" are questionable (CICA, 1993). Our research shows that ECE for firms with inferior environmental performance results often in economic benefits, while ECE for firms with superior environmental performance has questionable economic benefits.

Previous studies, suggest that accounting standards relating to ECE should face a revision: for heavy polluters, it is questionable whether it should be allowed for them to capitalize pollution abatement projects as assets onto their balance sheet. (CLR, 2004).

Our study as well as Gao (2011) have suggested these results are heavily dependent on industry factors, and it works in the opposite direction in the electric utilities sector in US and EU alike. We have also pointed out various limitations with the research in this field, including model (statistical and theoretical) validity and lack of extensive data (time period problem). We thus argue that it is premature to question the capitalization rule of ECE projects, and the debate should be continued once there is a high quantity of good quality research into this field.

6.7 Discussion of Other Implications

This section discusses the other implications of our results, mainly for the managers and investors active within the industry.

For managers, we categorize them into two categories: 1) Accounting/Financial Management professionals (CFO, IR-Manager, Financial Communicator); and 2) Operational/Strategy Managers (CEO, Business Developers among others).

For accounting professionals within inferior environmental performing firms, it is important that they realize the importance of ECE disclosure and utilize this to their firms benefits. Voluntary Disclosure theory for example (Bawley and Li, 2000), suggest that firms can voluntarily disclose information not required by regulators, to signal unobservable pro-active strategy to investors. In our experience, the information related to firms' ECE were always very hidden within the annual reports. For firms with poor environmental performance, it should be instrumental for the financial managers to disclose this information in a more accessible manner. By signalling a proactive environmental strategy, it should be possible to recover lost firm value from previous poor performances.

For operational and strategy managers within poor environmental performing firms, it is important that them to realize the benefits of ECE and continue with their environmentally active investment. For firms with superior environmental performance, it is important to know that although firms often benefit from environmental activism, it is still instrumental to have a good cost discipline (no overinvestment is good).

7. Evaluation

In this section, we perform various sensitivity and robustness controls. We will also discuss and criticize the validity, reliability and comparability of our research.

7.1 Sensitivity Analysis: Investor Reaction Time in Relation to the Financial Reports

In previous analysis, we ran our regression model against the stock price 6 months after the fiscal year end. However, the debate surrounding the time lag between release of financial information and investor response is ongoing, and there is no single conclusion concerning how fast/sluggish investors are concerning release of new financial information (You & Zhang, 2007). We thus decide to run our model against the market value 3 months after the fiscal year end, to test if there is any difference in the regression outcome, all other specifications of our previous models remain unchanged.

All our control variables had similar signs to the original regression, with abnormal earnings gaining greater significance. $\beta_2 + \beta_3$ coefficients remained the same, although the size of the slope (coefficient) were all lowered in four models. We argue that this is since in many of our sample firms, the depth of discussion of the capital expenditure is usually not so great in the initial earning announcement, so discussion of ECE occurs only at a superficial level (thus the lower coefficients). The discussion of capital expenditures is usually expanded to include ECE in the full annual report and sustainability reports, which are rarely released within 3 months after the fiscal year end.

Table 5 Scaled GLS Regression (3 months share price used)

Parameter	Variable Name	Model I (1 for <50% Carbon Factor)		Model II (1 for <25% Carbon Factor)		Model III (1 for >50% Carbon Factor)		Model IV (1 for >75% Carbon Factor)	
		Coefficient	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Intercept	-	30.441	0.000***	17.829	0.000***	39.013	0.000***	38.462	0.000***
Adjusted BV	ABV	0.741	0.130	0.809	0.124	0.741	0.130	0.817	0.121
Abn. Earning	AE	5.076	0.076*	5.414	0.044**	5.076	0.076*	5.591	0.042**
ECE	ECE	1.173	0.294	1.403	0.262	-1.397	0.270	-1.499	0.279
Non ECE Capex	NECE	4.150	0.000***	4.061	0.000***	4.150	0.000***	5.100	0.000***
Pollution	EMISSH	37.916	0.000***	41.204	0.000***	-37.916	0.000***	-37.991	0.000***
ECE * Pollution	ECE*EMISSH	-7.072	0.143	-5.202	0.161	7.072	0.143	8.914	0.130
Other Statistics									
R^2		46.2%		64.3%		46.2%		48.1%	
Sample Size (N)		140		140		140		140	

Dependent Variable in this Model is the Stock Price (3 months post FY end). Adjusted BV is the Book value – Capex. Abnormal Earning is Earning – (Cost of Equity*Book Value) Environmental Capex is the Environmental Capital Spending. Carbon Factor is defined as Kg of CO2 emission per Kilowatt, which is an industry standard measurement for pollution level. The Pollution variable (Dummy) assigns the value 1 for firms within the defined interval of Carbon Factor. The model is scaled by Shares Outstanding. *** Indicates significance at 1% alpha, ** indicates significance at 5% alpha while * indicates significance at 10% alpha

7.2 Robustness Test: Multicollinearity

Multicollinearity occurs when two or more explanatory (predictor) variables are highly correlated with each other. This affects the predictive power of individual explanatory variable, for example if ECE is highly correlated with other variables, the coefficient sign and the p-value (Statistical significance) might be wrongly estimated (Newbold, 2009). When investigating for multicollinearity, the variable of interest is the research variable and not the control variables, since multicollinearity only affects individual variable's predictive value, but does not undermine the model wholly. (Wooldrige, 2012)

The most common test for multicollinearity is the Variance Inflation Factor (VIF) test, a high level of VIF indicates multicollinearity, however the definition of what constitutes high VIF remains to be a topic of discussion. Marquart (1970) argues that VIF above 10 is unacceptable for reliable statistical analysis, however more recently, other researchers have argued that 4 or 5 should be the maximum acceptance of VIF (O'Brien, 2007).

We present our result of VIF test on our research variable (ECE) below, in all four models, VIF are all below the most rigorous cut-off point (VIF=4), we conclude that our statistical tests of our hypothesis were not severely influence by the problem of multicollinearity.

Table 6: Variance Inflation Factor (VIF) Test for the Research Variable (ECE)

	Model 1	Model 2	Model 3	Model 4
VIF	2.37	2.29	2.36	2.30

Higher VIF indicates greater multicollinearity

7.3 Robustness Test: Winsorizing Far-outside Values

As previously discussed, our model's explanatory power is lower than previous studies done in the U.S., one of the reason (That the electric utilities sector is more volatile than the Paper and Pulp industry) has already been addressed. Another reason however, might be that we have not treated our Far-outside values.

Far-outside values (Extreme observations), often affects the explanatory power of a model adversely (Newbold, 2009). Winsorization heals the problem of extreme observations, by changing their values to the highest allowed percentile and the lowest allowed percentile.

We perform a 95%/5% winsorization, which means all observations above 95^{th} quartile and below 5^{th} quartile will be changed to the value at 95^{th} / 5^{st} quartile, and the results are presented in Table 7. All four models experienced an slight increase in explanatory power after the winsorization, however the individual predicators showed no differences in terms of coefficient sign, since our models' explanatory power still fall significantly below other previous studies, we attribute those differences in industry and country differences.

Table 6 Scaled GLS Regression ($95^{th}/5^{st}$ Percentile Winsorization)

Parameter	Variable Name	Model I (1 for <50% Carbon Factor)		Model II (1 for <25% Carbon Factor)		Model III (1 for >50% Carbon Factor)		Model IV (1 for >75% Carbon Factor)	
		Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Intercept	-	41.920	0.000***	29.214	0.000***	37.151	0.000***	40.020	0.000***
Adjusted BV	ABV	1.290	0.117	0.910	0.137	1.290	0.117	0.881	0.166
Abn. Earning	AE	6.412	0.047**	6.291	0.052*	6.412	0.047**	5.849	0.097*
ECE	ECE	4.975	0.061*	5.144	0.051*	-3.434	0.209	-6.440	0.034**
Non ECE Capex	NECE	5.231	0.000***	4.947	0.000***	5.231	0.000***	5.009	0.000***
Pollution	EMISSH	43.011	0.000***	35.160	0.000***	-43.011	0.000***	-39.225	0.000***
ECE * Pollution	ECE*EMISSH	-12.974	0.064*	-10.773	0.082*	12.974	0.064*	10.946	0.079
Other Statistics									
R^2		50.6%		71.0%		50.6%		64.9%	
Sample Size (N)		140		140		140		140	

Dependent Variable in this Model is the Stock Price (6 months post FY end). Adjusted BV is the Book value – Capex. Abnormal Earning is Earning – (Cost of Equity*Book Value) Environmental Capex is the Environmental Capital Spending. Carbon Factor is defined as Kg of CO2 emission per Kilowatt, which is an industry standard measurement for pollution level. The Pollution variable (Dummy) assigns the value 1 for firms within the defined interval of Carbon Factor. The model is scaled by Shares Outstanding. *** Indicates significance at 1% alpha, ** indicates significance at 5% alpha while * indicates significance at 10% alpha

7.4 Reliability and Validity

We deem the reliability and reproducibility of our study as high. Firstly, we have taken strong care of the references used in our study all arrive from reliable and reputable journals and official sources, no anecdotal evidence has been used in the process. In terms of the reliability of our data sources, most of the data were accessed through the SSE library and Swedish House of Finance. As previously stated, Skogsvik (2002) has performed a series of checks concerning errors in these databases, and concluded that there is no systematic errors in them. Some of the ECE data were provided by a Management Consultancy firm, which they collected through reputable data providers, this is also deemed as reliable.

Concerning the validity of this study, we have taken strong care in terms of choice of variables, sample firms as well as statistical tests. We have performed various sensitivity and robustness controls to ensure that our results are not influenced by statistical problems such as multicollinearity and extreme observations. However, we recognize that there are some validity issues with this study, mainly concerning the subjective judgement of ECE, choice of proxy variables in the regression model as well as the adaption of the theoretical framework from another industry. Since they have been discussed extensively, we will only recap them briefly here.

As previously mentioned, Litt (2013)'s framework was used for deciding which activities constitute Environmentally friendly initiative, and ECE was assigned manually based on the financial reports and this framework. This judgement is to a certain extent subjective and can have margins of error, this impact the validity and reproducibility of this study negatively.

The choice of proxy variable (PollutionLevel) can be improved through the use of other more multifaceted environmental indicator. While the theoretical framework should be significantly revised for the electric utilities sector.

8. Future Outlook

This study has examined the value relevance of environmental performance to investors in the electric utility industry and suggests different firm value for firms with high and low environmental performance if over compliant with regulation or low-performer. There are several areas that not could be included in the scope of this project that could be of interest for future research that we will discuss here.

Our study was performed on the European market and previous research has been made on the US market with similar results. However, the difference between countries' regulations when it comes to reporting standards of environmental performance makes it interesting to examine the value relevance of environmental performance in other regions of the world. In such studies other variables might be considered due to these differences and that would add to the existing literature since such studies would develop and evaluate the models used here.

How regulation impacts environmental performance and value would be interesting to examine in many different industries where capital expenditure requirements are high and environmental problems are in focus. Our study was performed on the electric utility market and previous research has been made on the pulp and paper industry. Our study has provided interesting revelation on how one industry's results is not necessarily replicable in another setting. Different industries require adjustments of the model's variables including new definitions of environmental performance. Such studies would give new valuable insight in the research field. One interesting example is the automotive industry, an industry that also is burdened with environmental regulations and is fairly capital intensive; the mineral extraction (mining, oil, gas) industry is another good example, since these industries are capital heavy and have a strong environmental impact.

9. Conclusion

By examining firm-level data on EU/EES listed electric utilities firms through the period 2011-2015, we have investigated whether environmental capital expenditures (ECE) is value relevant within this industry. Evidence from our empirics suggest that the metric of ECE is indeed value relevant, investors tend to assign a negative value to ECE for firms with lower pollution and tend to assign a positive value to ECE for firms with higher pollution. This challenges the notion that spending on environmental activities for high-polluters are often viewed as a "regulatory burden" while spending on environmental activities for low-polluters are often viewed as a proactive strategy that increases shareholder's value. We have provided various explanations into these interesting results by challenging the existing theory's validity in the EU and electric utilities context, as well as offering various methodological improvement suggestions.

There are some accounting regulatory and managerial implications of these results. For accounting regulators, these results refutes previous research's argument for ECE's capitalization in high-polluting firms, by arguing that the industry difference are too significant and more research is needed. We also argue that EU/EES countries can improve the decision usefulness of financial reports by obligating companies to report ECE metric, wherever that is material.

To our best knowledge, all studies on ECE's value relevance has been conducted within the U.S. and mostly on the Paper and Pulp industry. We have contributed to the existing body of literature by finding contrasting results within the European context. Although the research field within environmental performance metrics and their roles in accounting and finance is quite intermediate or even mature, the field of ECE research is still very nascent, we certainly believe that it would be interesting and meaningful to expand this research to other industries, countries with other institutional settings as well as another period.

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